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# DRYING APPLES IN AN INFRARED DRYER

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***Abstract***

*The article discusses the drying of apples in an infrared dryer. The results of modern research in the field of apple drying have been studied. It has been established that infrared drying of apples provides a reduction in the duration of dehydration, energy efficiency, uniform heating and high quality of the finished product. Experimental studies on combined infrared and convective drying of apples were carried out. The drying curves for apples are shown at heating temperatures of 55 and 60 $^0$C and slice thickness 3; 5; 7; 9 and 11mm. Since sliced apples quickly darkened in air due to the action of oxidative enzymes, after cutting they were processed by blanching in a solution of salt, citric or ascorbic acid. The best organoleptic characteristics are exhibited by samples with a slice thickness of 9 mm, treated with a solution of citric and ascorbic acid. This is facilitated by a fairly fast drying time, not exceeding 5 hours, which confirms the high efficiency of infrared heating process. The advantage of the described dehydration method is a combination of infrared and convective heat exchange.*

***Keywords:****Apple, infrared, curves, drying, combined, sensory indicators, heating.*

## INTRODUCTION

Apples (Malusdomestica L.) are juicy seaded fruits that are one of the most common fruits around the world. According to statistical data, in 2022 in Kazakhstan, 6,844.4 hectares were occupied by apple trees, from which 2,498.2 hectares were in Turkestan region, 92.2 hectares in Shymkent [1].

Apples are distinguished by high content of iron, vitamins, organic acids, polyphenols, antocians and minerals [2]. Apple cellulose improves activity of the gastrointestinal tract. Apples are consumed in fresh condition and in canning food such as jam, puree, juice, etc. Drying of apple is one of distributed technological operations because in dehydrated state fruit are not able to store during long time but also can be applied to make desserts, refreshments, breakfasts, compot etc.

Lack of moisture content into a product decreases activity od enzymes, pace of undesirable chemical changes and growth of microorganisms. Moreover, it is accompanied by lowering volume and mass of a finished product that is a crucial factor at transportation and storage [3]. Apple sun drying is most assessable drying techniques but it characterizes by long duration (few days) and pollution of the dried product. Selection and analysis of an efficient way of apple drying is on top on relevance.

There is a number of researches devoted to advancement of apple drying processes.

A. Reyes, A. Mahn and P. Huenulaf investigated a freeze drying Fuji apple in atmospheric pressure (AFD) and vacuum freeze drying (VFD) with infrared (IR) radiation [4]. A factorial design was used in each case, with particle size, freezing rate, infrared (IR) radiation, and air temperature as factors. The effect of these factors on moisture content, duration of drying, rehydration properties, color, and texture were determined. The drying times obtained for VFD were shorter than the drying times obtained for AFD. It was discovered that the particle size and IR application to be the significant parameters that affect duration of drying for both AFD and VFD. At that sensory quality was not altered by AFD or VFD and alterations in food nutrition at atmospheric freeze drying were similar to convective drying.

Kahraman O, Malvandi A, Vargas L, Feng H. explored application of power ultrasound for drying of apple slices without the application of heat [5]. The non-thermal ultrasound contact drying (US-CD) was performed in the presence of an air stream (26–40 °C) flowing over product surface to remove mist or vapor produced by the ultrasound treatment. The effects of the non-thermal US-CD, hot-air drying (HAD), and freeze drying (FD) on the changes in rehydration ratio, pH, titratable acidity, water activity, color, glass transition temperature, texture, antioxidant capacity, total phenols, and microstructures of the samples were evaluated. The moisture content of the apple slices reached below 5% (w.b.) after 75–80 min of US-CD, which was about 45% less than that of the HAD method. The antioxidant capacity and total phenol contents of the US-CD samples were significantly higher than that of the AD samples.

Dumitru Velesçu, I. et al conducted convective drying of apricots ((Neptun variety) and apples (Golden Delicious variety) at 50 °C, 60 °C, 70 °C, and 80 °C, air speeds of 1.0, 1.5, and 2.0 m/s, and relative air humidity levels of 40–45%. Apricots are cut into halves, apples - into 4 mm thick slices. Increased air velocity and temperature had the expected effect of increasing water loss, solid gain, and shrinking [6].

Ahmad Aboud conducted research to investigate the drying characteristics of apple slices and the quality parameter of apple slices (color, rehydration ratio) undertaken the slice thickness (5, 10 mm) pre-treatment and the drying method by using a Passive Shelf Solar Dryer (PSSD) and in the Open Sun Drying (OSD). It was established that duration of drying in Passive Shelf Solar Dryer decreased by 22-40% (depending on thickness of slices) comparison to the Open Sun Drying system. Rehydration ration also affected by the slices thickness and the slices treating by ascorbic acid, where the rehydration ratio values at the drying air temperature of 40°C increased by 41.7% and by 33.3% for treated and untreated slices when the slices thickness increased from 5 mm to 10 mm respectively [7].

At reviewing modern methods of apple drying the authors concluded that application of combined drying methods, microwave or infrared drying, has a beneficial effect on the quality and structural properties of dried apples compared to traditional methods of drying apples [8].

The use of combined drying methods, microwave or infrared dehydration has beneficial effects on quality and structural properties of dried apples in comparison with conventional apple drying techniques

Microwave drying utilizes very fast nearly instantaneous volumetric heating due to the microwave energy coupling with foods, while conventional drying relies on slow transfer of heat from the surface to the interior of the food, the presence of air at a certain flow in addition to improve the product quality is used to carry away the moisture from the surface of the product. Some researchers reported that using microwave reduces drying time (25-90%) and applying energy at lower level improves quality of final products, such as color, rehydration capacity, density and porosity [8].

Infrared heating offers many advantages over conventional drying under similar drying conditions. These may include decreased drying time, high energy efficiency, high quality finished products, uniform temperature in the product while drying, and a reduced necessity for air flow across the product.

In another research the dehydration tests were conducted at three drying methods to evaluate the drying curves and the energy uptake. Apple (Malus domestica L.) cubes were dried under different processing conditions, applying freeze-drying (FD) method, supplemented by hot air (HA) and infrared radiation drying (IR) techniques. The IR heating method produced a higher drying rate than HA drying during the predehydration. The water activity, color, firmness and rehydration ratio (RR) of finished products were measured. The dried material produced with IR-FD resulted the desirable color, moreover higher RR and lower firmness than the other samples dried by HA-FD ones. The drying process combining infrared method and FD provides a potential alternative to the FD of apple. Further research work is required to determine the adequate change point in drying curve and chemical component of the final product [9].

It can be concluded from the material studied that vacuum freeze drying promotes preservation the apple quality maximally and combination of vacuum freeze drying with infrared drying contributes retaining of desired color, as well as the high rehydration ability of the dried product, which has lower hardness compared to analogues. Meanwhile, drying apples using the infrared method ensures reduced drying time, energy efficiency of the process, high quality of the finished product and uniform heating of the product.

Based on this conclusion, a combined method of infrared and convective drying of apples in a cabinet dryer is selected in this study.

## EXPERIMENTAL METHODS

The infrared dryer is an electrical cabinet of the “Universal – SD-4” brand with sections mounted in tiers with tubular heating elements having a special coating. Above each tier of heating elements, two baking trays are located in one row for drying food, which can be easily taken away. .At the top of the cabinet there is a hood with an exhaust fan. The operation of the dryer is based on a combination of infrared and convective drying methods. The inner surface of the dryer is a system of screens that creates targeted reflection of radiation, air movement and moisture removal. The control unit ensures automatic maintenance of the medium temperature, as well as forced air circulation through the product [10].

Fig.1. «Universal-SD-4» infrared drying cabinet

Combined infrared and convective drying of apple in one layer was conducted at moderate temperature heating 55 and 60 $^0$C.

Apples are sorted, washed and sliced with thickness 3,5,7,9 and 11 mm. Apple slices are processed in salt, citric or ascorbic acid solution in order to exclude darkening due to action of oxidation enzymes. Slices with different thicknesses and treated with the above solutions were simultaneously dried. Control samples were not treated. Ready material is weighted, put on trays in one layer and dried.

The dried material mass is weighted on analytical balance every 60 minutes.

Moisture content of the material is determined by the equation:

$$\omega = \frac{m_1 - m_2}{m_1} \cdot 100,\%$$

where: $\omega$ –humidity of material related to initial mass, %; $m_1$ and $m_2$ – initial and final mass of material, kg.

The weighted material is put again in the drying cabinet; decreasing mass of material subjected to drying was identified till achieving final humidity 20%.

The initial moisture content of the apples was 87%. During the experiments, the drying time required to achieve the specified final moisture content was determined, as well as the organoleptic characteristics of the dried product.

Drying curves were designed on the data of intermediate humidity (fig. 2-9).

## RESULTS AND DISCUSSION

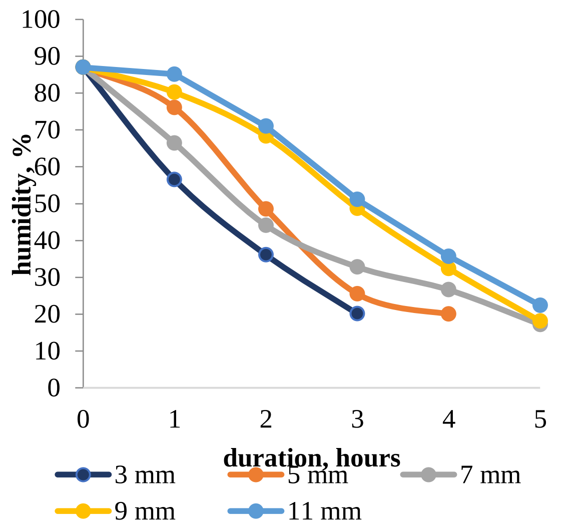


Fig. 2. Curves for combined infrared and convective drying at temperature 55 $^0$C of control samples of apple slices

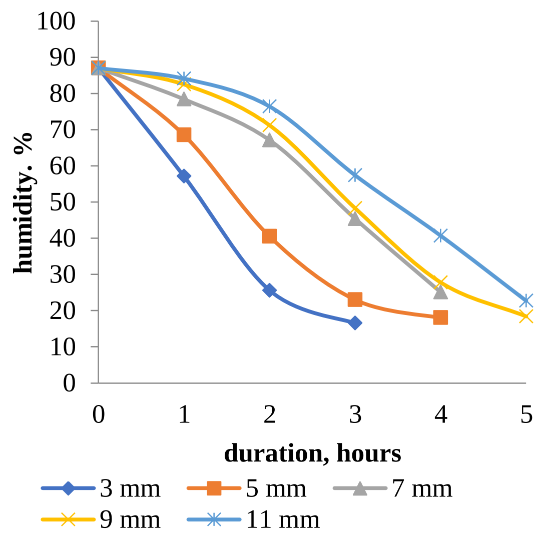


Fig. 3. Curves for combined infrared and convective drying at temperature 55 $^0$C of apple slices treated by citric acid solution

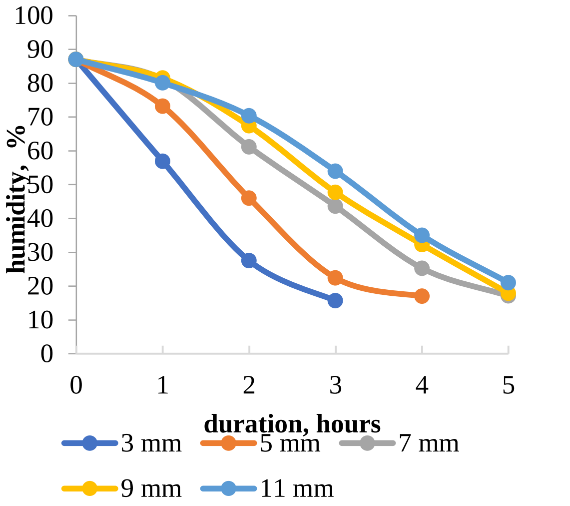


Fig. 4. Curves for combined infrared and convective drying at temperature 55 $^0$C of apple slices treated by ascorbic acid solution

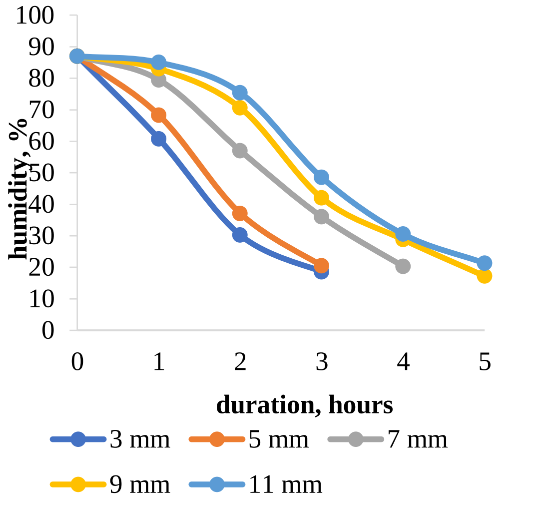


Fig. 5. Curves for combined infrared and convective drying at temperature 55 $^0$C of apple slices treated by salt solution

As can be seen from the given curves for drying apples at 55 $^0$C, the drying duration varies within 3÷5 hours for all of the above examples. Fluctuations are ±10÷15 minutes. A shorter drying time is observed for slice thicknesses of 3 and 5 mm, and a longer time for 9 and 11 mm. Samples treated with a solution of ascorbic acid and salt have shortest duration of drying. However, the best sensory color indicators were observed for samples treated with solutions of citric and ascorbic acid. From the point of view of the thickness of the slices, the most uniform consistency, tenderness of the pulp, and uniformity of color were observed for the 9 mm samples. The worst brown with dark spots color was characteristic for the control samples that had not exposed to pretreatment.

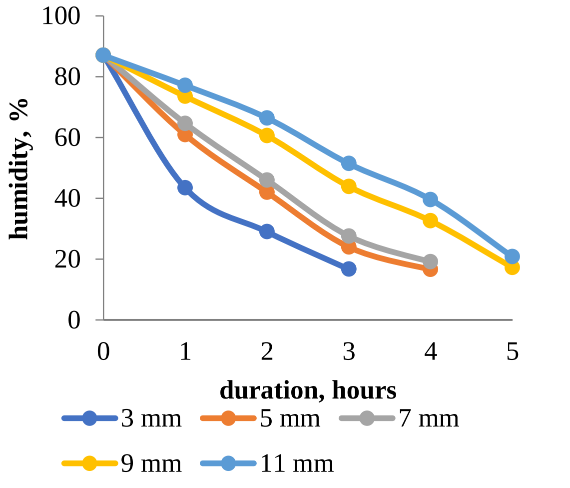


Fig. 6. Curves for combined infrared and convective drying at temperature 60$^0$C of control samples of apple slices

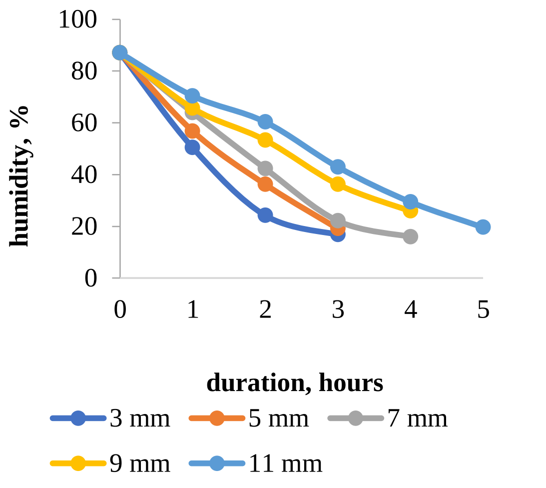


Fig. 7. Curves for combined infrared and convective drying at temperature 60 $^0$C of apple slices treated by citric acid solution

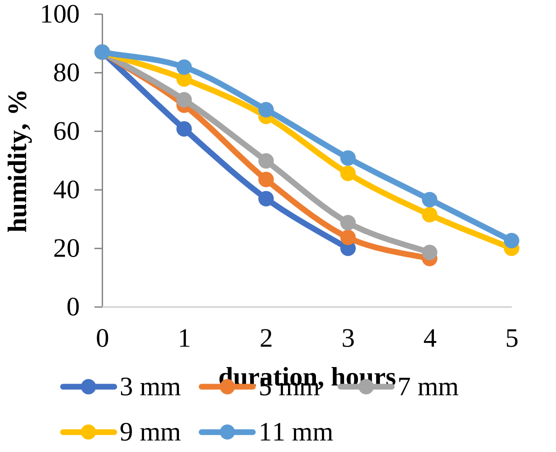


Fig. 8. Curves for combined infrared and convective drying at temperature 60 $^0$C of apple slices treated by ascorbic acid solution

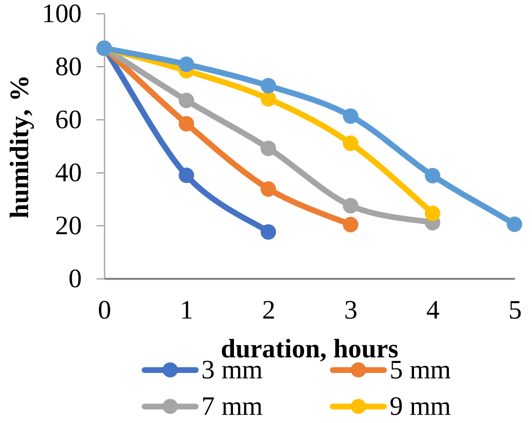


Fig. 9. Curves for combined infrared and convective drying at temperature 60 $^0$C of apple slices treated by salt solution

Analysis of apple drying curves at 60 $^0$C shows that the drying duration varies within 2.8÷5 hours for all of the above examples. A shorter drying time is observed for slice thicknesses of 3 and 5 mm, and a longer time for 9 and 11 mm. The best color and the fastest drying time are observed for samples treated with solutions of citric and ascorbic acid. As in the previous example, the most uniform consistency, tenderness of the pulp, and uniformity of color were observed for the 9 mm samples. The worst color - brown with dark spots - was characteristic of the control samples that did not undergo pre-treatment.

## CONCLUSION

On all curves it is possible to observe periods of heating, as well as constant and decreasing drying rates, which will allow their mathematical processing to derive experimental dependences of the drying duration, and determine the critical points characterizing the period of constant drying rate.

The best sensory indicators owned by samples with a slice thickness of 9 mm, treated with a solution of citric and ascorbic acid. This is facilitated by a fairly fast drying time, not exceeding 5 hours, which confirms the high efficiency of the infrared heating process. The advantage of the described dehydration method is a combination of infrared and convective heat exchange: infrared rays penetrate deep into the material and heat it, while forced convection not only warms the surface of the product, but also removes evaporating moisture vapor.

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# DEVELOPMENT OF A RECIPE FOR A NEW TYPE OF COMBINED MEAT AND VEGETABLE PRODUCT FOR FUNCTIONAL PURPOSES

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***Abstract***

*The basis of the state policy of the Republic of Kazakhstan in the field of healthy nutrition of the population is the preservation and strengthening of public health, the prevention of diseases caused by inadequate and unbalanced nutrition. To achieve this goal, food products are developed that are enriched with essential components, including dietary fiber. The article discusses the development of a recipe for a new type of combined meat and vegetable product for functional purposes. Horse meat, lamb and turkey meat were used as meat raw materials in combination with individual plant components. A mixture of pumpkin seed powder and licorice root, as well as barley bran, were used in the form of plant components. The functional, technological and organoleptic characteristics of minced meat models with different amounts of vegetable additives were studied, as a result, the optimal dose of administration was established and a recipe for a new type of combined meat-vegetable product for functional purposes was developed. The results of this work will make it possible to enrich the food market of the Republic of Kazakhstan with new biologically complete combined meat and vegetable products for functional purposes and contribute to the improvement of the population of the Republic of Kazakhstan.*

***Keywords****: combined meat-vegetable product, dietary fiber, recipe, plant components.*

## INTRODUCTION

In recent years, functional nutrition has played a special role in the food industry [1].

The main objective of functional nutrition is a beneficial effect on the human body using products of natural origin [2]. It has a functional focus and can affect both the body as whole and vital organs individually [3].

An important task of the meat industry is to expand the range of sausages in accordance with dietary requirements [4].

Today, more than ever in the food industry, the problem of creating products that have a therapeutic and prophylactic effect is acute. This problem can be solved by developing combination food technologies using functional ingredients [5].

Recently, an important task of the food industry is the production of new types of food products of increased nutritional and biological value, the production of products for dietary, therapeutic and prophylactic purposes. The introduction of non-traditional raw materials (medicines and melons) into a product without changing quality indicators is largely determined by their functional properties. However, the use of these additives in production is limited. This is explained, in particular, by the lack of fundamental research on the effect of such additives on product quality, primarily organoleptic, physicochemical, rheological and other properties. The development of the meat industry in socio-technological terms is focused on maximum satisfaction of consumer demands and the production of high-quality products of a new generation, environmentally safe and healthy in medical and biological terms [6]. Of particular interest is the development of combined meat and vegetable products for functional purposes, enriched with various proteins of inexpensive plant origin and dietary fiber (fiber).

According to many scientists [7,8], it is important to obtain and consume the cheapest and most complete proteins obtained from various inexpensive proteins of plant origin.

In developing the recipe, horse meat, lamb and turkey meat were used, and a mixture of pumpkin seed powder and licorice root and barley bran were used in the form of plant components. Horse meat contains a minimal amount of fat (it accumulates most often in the rib region). The water content in the product is quite high, which means that it is easier for the body to digest such food, and it is also a "supplier" of high-quality protein to the human body. The vitamins and substances contained in meat help normalize metabolic processes in the body [9].

Lamb is one of the meat products richest in vitamins and microelements. It contains phosphorus, iodine, sodium, magnesium and potassium. The latter are necessary for normal heart function. Lamb also contains a lot of vitamins: E, PP, group B. It also contains lecithin, which serves as a good prevention of diabetes. It stimulates the pancreas. The nutritional properties of lamb allow it to be considered a dietary product [10].

Turkey meat is easy to digest due to its low insoluble fat content and limited connective tissue content. The advantage of turkey meat is its hypoallergenicity, and therefore it can be recommended for baby food [11].

Natural pumpkin flour was obtained by drying and grinding washed, peeled seeds. The peoples inhabiting India, Brazil, and South America have long noticed the healing power of crushed pumpkin seeds. This product is especially interesting these days, when healthy eating comes to the fore. The high biological and nutritional value of pumpkin flour is largely due to its unique mineral composition (pumpkin flour contains more than 50 macro- and microelements) [12].

Pumpkin protein is a source of complete, highly digestible protein, the content of which in the product is at least 40%, which contains both essential and essential amino acids. Eating pumpkin with meat ensures rapid and good absorption by the body [13].

Licorice is one of the most ancient medicinal plants, widespread in Kazakhstan, Central Asia and the southern regions of Russia. Licorice, a cheap raw material that grows in the wild, has not yet found application in the national economy. Licorice root preparations are widely used in the food industry abroad in the production of confectionery products. It is known that a decoction of licorice root can neutralize the effects of many poisons. Licorice preparations can have anti-inflammatory and antiallergic effects. There is evidence that the flavonoids contained in licorice promote the healing of stomach ulcers [14]. Cereals for the production of certain types of boiled and liver sausages use shelled peas (shelled), lentils, millet, barley (pearl barley, barley) and rice cereals [15].

Grain bran (mainly wheat, barley, oat, rye) are by-products in the production of flour and have great functional potential due to their high content of dietary fiber, antioxidants, microelements and other biologically active compounds [16].

In connection with the growing interest of meat processing enterprises in the production of functional food products, it served as the basis for our research to develop a recipe for a new type of combined meat-vegetable product for functional purposes.

## EXPERIMENTAL PROCEDURE

The object of the study is horse meat, lamb and turkey meat, plant components - a mixture of pumpkin seed powder and licorice root and barley bran.

Model minced meat and finished heat-treated products were studied. Using standard methods, the following indicators of minced meat were determined before heat treatment: pH, WBC (water-binding capacity) to total moisture, water-holding capacity. After heat treatment: ultimate shear stress, shear stress and cutting work [17].

The number of introduced components and their choice were justified using mathematical modeling. The control was minced meat without additives; the test samples were minced meat with inclusions of a plant fortifier component in the recipe. Test samples weighing 100 g were formed from the prepared minced meat. To ensure comparability of the results obtained, raw materials from the same batch were used. Experiments were carried out in triplicate. The number of experimental model samples corresponded to the selected content of the plant component of the fortifier: 10, 15 and 20%, which corresponds to samples No. 1, No. 2, No. 3 and the content of dietary fiber (barley bran-fiber) - (1,3,5%). According to the recipe for a boiled sausage product, single-grade trimmed horse meat was ground, then mixed with chopped single-grade trimmed lamb, kept for 2–3 hours (ripening process) and a vegetable fortifier component (a mixture of pumpkin seed powder and licorice root) and dietary fiber (barley bran) were added -fiber), salt, spices and auxiliary materials, and then molding and heat treatment were carried out by frying at a temperature of 90–100 ° C and cooking at a temperature of 73–78 ° C.

The introduction of plant enrichment components and dietary fiber into the recipe made it possible to reduce the mass fraction of fat in the finished product and made it possible to enrich the product with dietary fiber, vegetable protein and vitamins.

## RESULTS AND DISCUSSION

For all types of minced meat, the following were studied: pH, moisture-binding and water-holding capacity, ultimate shear stress, shear stress and cutting work. As well as organoleptic characteristics of finished samples with herbal additives. The research data are given in table. 1 and 2.

Table 1- Organoleptic characteristics of samples with herbal additives

| Samples | Organoleptic characteristics | | | | |
|---|---|---|---|---|---|
| | Appearance | Smell | Consistency | Color | Taste |
| Control | Surface smooth, clean and dry shell | Pleasant smell of meat and spices | Dense | Pink-red color | Pleasant meaty taste with a hint of spices |
| Sample № 1 | Surface smooth, clean and dry shell | Pleasant smell of meat and spices | Elastic | Pink-red color | Pleasant meaty taste with a hint of spices |
| Sample № 2 | Surface smooth, clean and dry shell | Pleasant smell of meat and spices | Elastic | Pink-red color | Pleasant meaty taste with a hint of spices |
| Sample № 3 | Surface smooth, clean and dry shell | Pleasant smell of meat, spices and vegetables | Elastic | Light pink color | Pleasant meat taste with a hint of spices and vegetables |

There are no significant deviations in organoleptic indicators; the samples have almost identical characteristics, exceSurface smooth, clean and dry shell for sample No. 3 with the addition of 20% of the plant component of the fortifier (a mixture of pumpkin seed powder and licorice root) and barley bran (5%), where inclusions of flakes and a slightly pleasant vegetable taste are noticeable and a sweetish taste.

Table 2. Functional and technological properties of minced meat systems with vegetable additives

| Samples | pH | Moisture-binding capacity, % | Water holding capacity, % |
|---|---|---|---|
| | 6,32 | 82,73 | 63,7 |
| Control | 6,38 | 89,12 | 64,3 |
| Sample № 1 | 6,45 | 91,25 | 66,1 |
| Sample № 2 | 6,52 | 93,07 | 67,5 |
| Sample № 3 | | | |

The active acidity of the control sample is 6.32 units; the addition of the additive changes the active reaction of the minced meat medium by 0.06–0.2 units. to the alkaline side. Changes in the pH of the environment towards the alkaline side entail changes in moisture-binding capacity by 10.1–14.0%. The water holding capacity ranges from 63.7 to 67.5%. Experimental studies have shown that increasing the dose of additive leads to an improvement in the technological properties of minced meat, but the amount of additive more than 20% is undesirable due to changes in organoleptic characteristics.

With the introduction of different concentrations of the plant component of the fortifier (a mixture of pumpkin seed powder and licorice root) and dietary fiber (barley bran-fiber), the values of shear stress and cutting work decrease, which indicates a decrease in the mechanical strength of the model systems. The quality of samples can be most fully judged by their structural and mechanical characteristics, which determine the rheological properties of the samples. Structural and mechanical characteristics of model minced meat systems are presented in Table. 3.

Table 3- Structural and mechanical characteristics of model minced meat systems

| Samples | Ultimate shear stress, $10^3$Па | Shear voltage, $10^4$Па | Cutting work, $10^2$ j/m$^2$ |
|---|---|---|---|
| | 0,83 | 7,43 | 4,73 |
| Control | 0,82 | 7,35 | 4,51 |
| Sample № 1 | 0,81 | 7,28 | 4,15 |
| Sample № 2 | 0,80 | 7,12 | 3,98 |

According to the developed recipe, several samples of combined meat and vegetable products for functional purposes were experimentally produced: a control sample - without plant components of fortifiers and samples No. 1, No. 2, No. 3 - with the addition of plant components of fortifiers (10, 15 and 20%) and content dietary fiber (barley bran-fiber) – (1.3.5%). Production tests of control and prototype samples of combined meat and vegetable products for functional purposes were carried out. A batch of control samples of boiled sausages was developed according to the invention "Method for the production of boiled sausages" (RU 2001114555/13, A23L1/317A) dated February 27, 2003.

Pilot production of combined meat-vegetable products for functional purposes has shown that the use of a plant component of a fortifier (a mixture of pumpkin seed powder and licorice root) and dietary fiber (barley bran-fiber) in the production of cooked sausages allows for the rational use of meat raw materials and reduces costs products, improve the nutritional and biological value of products, which affects the organoleptic characteristics of products and consider the resulting product therapeutic and prophylactic, that is, functional.

The introduction of a new type of combined meat-vegetable product for functional purposes does not require additional capital investments, since their production can be carried out on existing equipment for the production of cooked sausages.

## CONCLUSIONS

In accordance with the task, a recipe has been developed for a new type of combined meat and vegetable product for functional purposes with improved nutritional and biological value, with good organoleptic indicators for dietary, therapeutic and prophylactic purposes for the general population. It should be noted that the proposed combined meat-vegetable sausage product obtained using the proposed method can be used by people of different religions, that is, as a "halal" product.

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UDC 635.67

## CORN MARKET ECONOMIC EVALUATION

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***Abstract***

*This review article presents an analysis of the corn market in the world and in the Republic of Kazakhstan. The corn market is one of the most important and largest agricultural commodities markets in the world. Corn, being one of the most basic grain crops, is grown in many countries of the world, especially in the USA, China and Brazil, and is also used as canned food, animal feed and in some cases as biofuel. The article examines the world production of corn, as well as the area for their collection in the period 2015-2021. The leader in these indicators was the USA (production) and China (collection area). At this time, the volume of corn production in Kazakhstan increased by 50%. Also, the structure of acreage in the Republic of Kazakhstan was considered, where the Almaty region occupies more than half of the acreage for corn.*

***Keywords:*** *corn, market, corn market, world market*

### INTRODUCTION

Corn is the most popular grain crop in the world, it is grown by most countries, but half of the world market is provided by the USA and China. In addition, the aforementioned countries are the largest consumers and producers of deeply processed corn products. Thanks to many years of experience in the development of this market segment in China, the products of deep processing of corn have the longest technological chain, as well as the greatest variety in the processing of crops. Today, after deep processing, corn is represented by 2000 different types of products, 100 of which are present in all aspects of human life. Most of them are used in such areas as: food products, medical products, consumer goods, industrial production, animal feed and others. [1]

The parts of sweet corn suitable for food are ripe grains of sweet corn in frozen, canned and dried form. Canned sweet corn is made from crushed or whole grains of sweet corn, in addition, other vegetables can be added to canned food [2].

In addition, it is no secret that sweet corn among other vegetable crops has the greatest nutritional taste properties of sweet corn compared to tooth corn contains twice as much fat and sugar, starch and dextrins. And corn also contains a large amount of defective protein - zein. Summing up, sweet corn is superior in calories and nutrition even to green peas and beans. In addition, corn syrups are made from corn, which are used as sweeteners to replace sucrose. Most often they are used for the production of confitures, completely or partially replacing sugar [3].

It can also be noted that the secondary resources of corn processing (silms, fresh roots and grains) have decent antioxidant properties and are considered as a source of biologically valuable substances. Their effective use makes it possible to produce products with high nutritional value [4].

Recently, interest has increased considerably in finding naturally occurring antioxidants for use in foods or medicinal materials to replace synthetic antioxidants that are being restricted due to their carcinogenicity [5].

In the United States, sweet corn is canned as whole grains, a cremogenized product that must consist of a mixture of whole grains and grains that have been mashed. In addition, sweet corn is sometimes canned with tomatoes, sweet peppers that have been cut into whole and crushed grains [6].

Almost all varieties of sweet corn that are cultivated in the Republic of Kazakhstan belong to common corn and its following subspecies: European, South American or Arizona or hybrids of these subspecies. The ears of sweet corn are removed in two or three steps. In the evening and morning, the collection of sweet corn cobs is carried out. Also, sweet corn needs quick cooking or canning, as it cannot be stored for a long time. After harvesting, the corn is immediately put into processing. If corn is not processed in time, then a day after harvesting it loses 50% of its sugar at 30 ° C or 17% of sugar at 10 ° C. In addition, sweet corn should not be digested, as the grains of digested corn become very dense and tough. The taste qualities of overcooked corn deteriorate greatly compared to corn that was quickly cooked [7].

The trade agreement between America and China became an important catalyst that influenced the production of corn, which led to an increase in demand for it, at the same time, the market for corn processing products (canned food, feed and other products) increased significantly [8].

The structure of maize consumption by sector in the world in 2018 is shown in Figure 1.

deep processing processes; 31.1 food products; 12,2 animal feed;56.7

Fig.1. Structure of corn consumption by sector in 2018, %

Source: compiled by Karnaushenko A. on the basis of data from the Food and Agriculture Organization of the United Nations and inventure.com.ua

Deep processing technologies that meet the demand of the end user for high-quality products are actively developing all over the world. Currently, 78 plants for deep processing of grain crops are operating in Europe, located in 20 countries [9], [10], [11].

There are only 21 such plants in the USA, but the production capacity of each plant is higher than in Europe [12],. The industry of deep grain processing is developing at an accelerated pace in China, therefore, starch products, alcoholic beverages, glutamic acid, lysine, citric acid are produced during corn processing. In addition, the production of corn oil and polyol has been organized. The production of corn starch, as the main product of deep processing, is rapidly developing [13]. In 2017, China increased the processing of corn from 104 to 137 million tons, in 2018 the positive trend continued [14].

For Ukraine, deep processing of corn is a new direction of development of the agricultural sector, which will contribute to the growth of the economy with its added value. At the same time, when processing in Ukraine is only developing, in the USA about 36% of the corn crop, or 145 million tons, is subjected to deep processing [15], [16].

## RESULTS AND DISCUSSION

According to the United Nations Food and Agriculture Organization ) And the U.S. Department of Agriculture (USDA), since 2013, there has been a rapid increase in corn consumption and production. Positive trends were observed both in the field of corn crops and in yields per hectare (c/ha). By 2021, while maintaining positive dynamics, we should expect a doubling of corn production compared to 2000. World corn production, taking into account the forecast for the agricultural year 2024/2025 in millions of tons is shown in Figure 2.

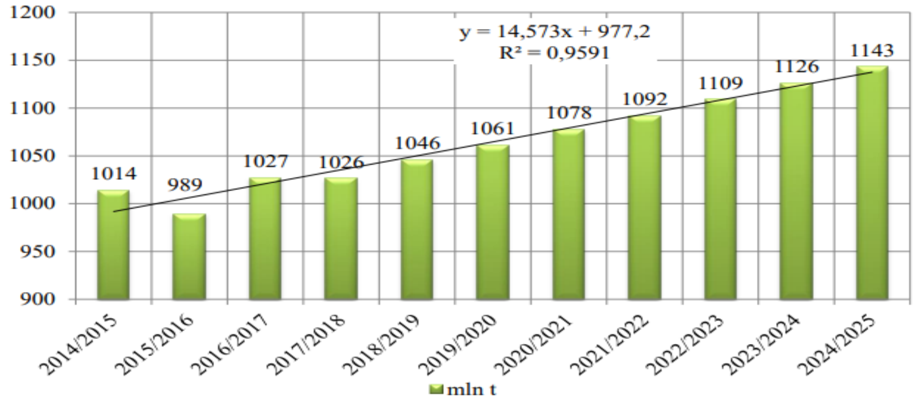


Fig.2. World corn production, taking into account the forecast for the agricultural year 2024/2025, million tons.

After analyzing Figure 2, it was found that corn production in the world continues a limited but stable growth in the total yield and tends to increase. Given this forecast, we should expect the volume of corn grown in the amount of 1143 million tons in the agricultural year 2024/2025, which is 7.73% more than was harvested in the agricultural year 2018/2019, and 11.4% more than in the agricultural year 2014/2015. According to the results of the agricultural years 2017/2018 and 2016/2017, the growth rate of the total corn harvest in the world was 1.95% and 1.85%, respectively. In the agricultural year 2015/2016, there was a significant decrease in corn production, which amounted to 980 million tons, which is 2.97% lower than in the previous agricultural year. In the agricultural year 2023/2024, there is an increase in corn production growth by 1.7% compared to the agricultural year 2022/2023.

The amount of corn produced by countries for 2015-2021 is shown in Table 1.

Table 1. The amount of corn produced by countries for 2015-2021, million tons.

| Years | | Manufacturing countries | | | | | | | | | | In total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | USA | China | Brazil | Argentina | India | Indonesia | Mexico | Ukraine | Kazakhstan | Other countries | |
| 2015 | mln t. | 345.5 | 265.1 | 85.3 | 33.8 | 24.2 | 19.6 | 24.7 | 23.3 | 0.73 | 229.9 | 1053 |
| | % | 32.79 | 25.17 | 8.1 | 3.21 | 2.3 | 1.86 | 2.35 | 2.21 | 0.07 | 21.84 | 100 |
| 2016 | mln t. | 412.2 | 263.7 | 64.2 | 39.8 | 22.6 | 23.6 | 28.2 | 28 | 0.76 | 239.5 | 1123 |
| | % | 36.73 | 23.49 | 5.71 | 3.55 | 2.01 | 2.10 | 2.51 | 2.50 | 0.07 | 21.33 | 100 |
| 2017 | mln t. | 371 | 259.2 | 97.9 | 49.5 | 25.9 | 28.9 | 27.8 | 24.7 | 0.78 | 253.9 | 1139 |
| | % | 32.55 | 22.74 | 8.58 | 4.35 | 2.27 | 2.53 | 2.44 | 2.17 | 0.07 | 22.3 | 100 |
| 2018 | mln t. | 364.2 | 257.3 | 82.3 | 43.4 | 28.7 | 30.2 | 27.1 | 35.8 | 0.86 | 254.3 | 1124 |
| | % | 32.4 | 22.89 | 7.32 | 3.86 | 2.55 | 2.68 | 2.41 | 3.18 | 0.08 | 22.63 | 100 |
| 2019 | mln t. | 345.9 | 260.9 | 101.1 | 56.8 | 27.7 | 19.6 | 27.2 | 35.9 | 0.9 | 261.51 | 1137 |
| | % | 30.39 | 22.94 | 8.89 | 4.99 | 2.44 | 1.72 | 2.39 | 3.16 | 0.08 | 23 | 100 |
| 2020 | mln t. | 358.4 | 260.8 | 103.9 | 58.4 | 28.7 | 24.7 | 27.4 | 30.3 | 0.95 | 268.53 | 1162 |
| | % | 30.81 | 22.46 | 8.94 | 5.03 | 2.47 | 2.13 | 2.36 | 2.61 | 0.08 | 23.11 | 100 |
| 2021 | mln t. | 383.9 | 272.7 | 88.4 | 60.5 | 31.6 | 20 | 27.5 | 42.1 | 1.1 | 281.8 | 1210 |
| | % | 31.74 | 22.56 | 7.30 | 5 | 2.62 | 1.65 | 2.27 | 3.48 | 0.09 | 23.29 | 100 |

Source: compiled by the authors based on data from the United Nations Food and Agriculture Organization [Official website of the United Nations Food and Agriculture Organization, 2020, https://www.fao.org/faostat/en/#data/QCL ].

After analyzing table 1, it became clear that the United States of America and China are the absolute leaders in corn production, thereby occupying half of the corn production market. The United States peaked in corn production in 2016, producing 412.2 million tons of product. This was followed by a sharp decline of 10% in 2017 and the indicators continued to decline until 2020. By 2021, there was a 3.48% jump in production compared to last year. At this time, the Chinese corn market, despite a slight decline, increased by 5.64% in 2021 compared to 2018. Brazil and Argentina occupy 1/10 of the world corn market, and are also the largest producers in South America. By 2021, corn production in Argentina increased by 44.1% compared to 2015, while Brazil reached the peak of corn production in 2020, producing 103.9 million tons of raw materials.

Despite the fact that the corn market in Kazakhstan is small, it continued to grow in subsequent years, by 2021 the corn market in Kazakhstan increased by 50.6% compared to 2015 and reached its peak during the period presented.

The area for harvesting corn by country for 2015-2021 is shown in Table 2.

Table 2 – Area for harvesting corn by country for 2015-2021, million hectares.

| Years | | Manufacturing countries | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | USA | China | Brazil | Argentina | India | Indonesia | Mexico | Ukraine | Kazakhstan |
| 2015 | mln ha | 32.7 | 44.9 | 15.4 | 4.6 | 9.2 | 3.8 | 7.1 | 4.0 | 0.14 |
| 2016 | mln ha | 35.1 | 44.2 | 14.9 | 5.3 | 8.7 | 4.4 | 7.6 | 4.2 | 0.13 |
| 2017 | mln ha | 33.5 | 42.4 | 17.4 | 6.5 | 9.6 | 5.5 | 7.3 | 4.5 | 0.13 |
| 2018 | mln ha | 32.9 | 42.1 | 16.1 | 7.1 | 9.4 | 5.7 | 7.1 | 4.6 | 0.15 |
| 2019 | mln ha | 32.9 | 41.3 | 17.5 | 7.2 | 9.0 | 3.6 | 6.7 | 5.0 | 0.16 |
| 2020 | mln ha | 33.3 | 41.3 | 18.2 | 7.7 | 9.5 | 4.3 | 7.1 | 5.4 | 0.16 |
| 2021 | mln ha | 34.5 | 43.3 | 19.0 | 8.1 | 9.8 | 3.5 | 7.1 | 5.5 | 0.19 |

Source: compiled by the authors based on data from the United Nations Food and Agriculture Organization [Official website of the United Nations Food and Agriculture Organization, 2020, https://www.fao.org/faostat/en/#data/QCL ].

According to Table 2, China is the world leader in the area for harvesting corn, which occupies 30% of the total area presented in the table. Despite this, the area for harvesting corn in China continued to decline and by 2020 decreased by 8% compared to 2015. It was by 2015 that the collection area in China reached its peak during the period under review. The second largest collection area is occupied by the USA, which achieved the highest result in 2016 (35.1). From this year until 2019, the area for harvesting corn in America decreased, until by 2020 it increased by 1.2% compared to last year. The remaining countries occupy 40-50% of the total collection area in the countries under consideration.

Figure 3 shows the structure of corn areas for grain in different regions of the Republic of Kazakhstan in 2020.

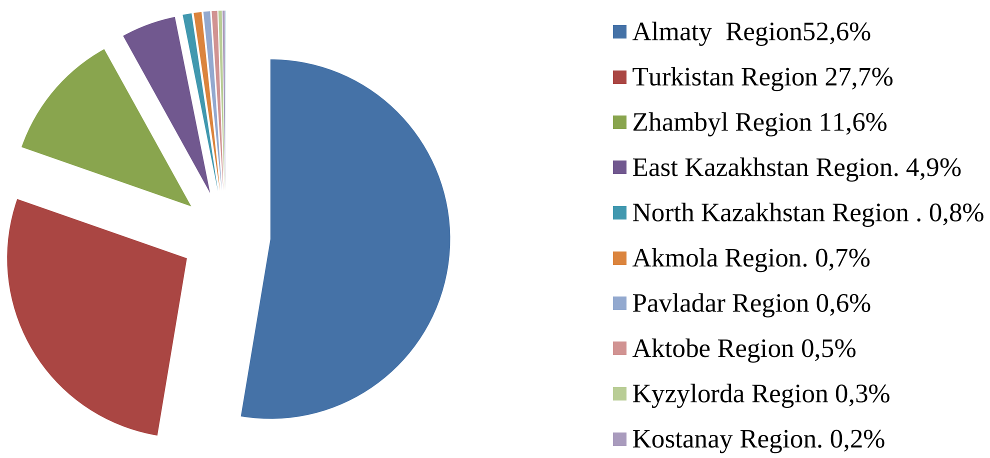


Fig.3. Structure of acreage of corn for grain by regions of the Republic of Kazakhstan in 2020, %

The total area of crops for corn was 164.3 thousand hectares. As can be seen from the image, more than half (52.6%) of the acreage is located in the Almaty region and a significant part (27.7%) of the area for corn is located in the south of Kazakhstan in the Turkestan region. In Zhambyl region, the number of acreage is almost five times lower (11.6) than in Almaty region. The lowest amount of acreage is located in the city of Shymkent (0.04%).

Figure 4 shows the volume of corn production in the Republic of Kazakhstan for the period from 2011 to 2021.

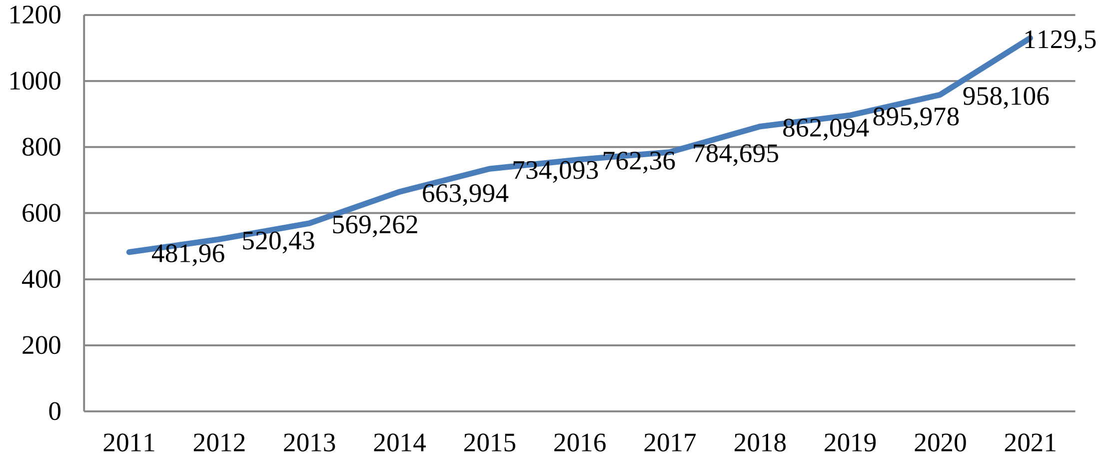


Fig.4. Corn production volumes in Kazakhstan for 2011-2021, 1000 tons

The most significant increase in production occurred in the period 2020-21. During this period, corn production increased by 17.9%. The lowest indicator of product production was recorded in 2011, and from that moment production volumes only grew. The smallest increase in corn production occurred in the periods from 2015-16 by 3.85%. Drawing conclusions, it can be noted that over a period of ten years, corn production in the Republic of Kazakhstan increased by 647.54 thousand. tons, which is logical, since during this period the area for harvesting corn in the Republic of Kazakhstan has significantly increased.

Figure 5 shows the volume of corn harvest in the Republic of Kazakhstan for the period from 2011 to 2021.

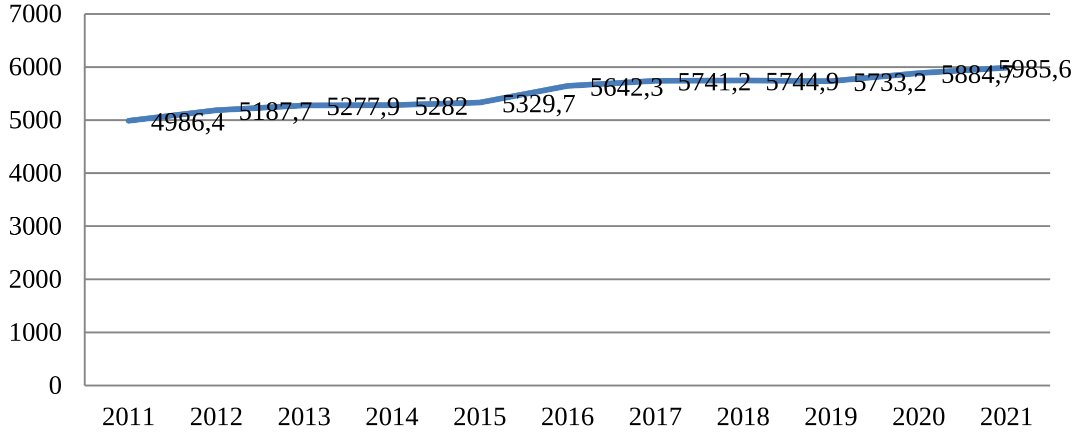


Fig.5. Corn harvest volumes in the Republic of Kazakhstan for 2011-2021, kg/ha

According to the analysis of Figure 5, it can be seen that the corn harvest for the presented period of 10 years has increased significantly. By 2021, crop volumes have increased by 20% compared to 2011. Due to the increase in the area for harvesting corn, there was an increase in the corn harvest. The most significant increase in crop volumes was recorded in the periods from 2015 to 2016 by 5.86%, during the same period there was a peak in the growth of corn production.

## COLNCLUSION

Corn plays a key role in the modern world agriculture and food industry. Its multifaceted use, ranging from food products such as canned food to animal feed, makes corn one of the most influential grain crops in the world.

In this article, the world corn market and the corn market in the Republic of Kazakhstan were considered. The study showed an increase in corn production in most countries, including Kazakhstan. This correlates with the growth of the area for harvesting corn around the world. In Kazakhstan, the area for harvesting corn has grown by 35.7%. Most of the acreage for corn is occupied by Almaty and Turkestan regions.

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UDC 005.4

# METHODOLOGICAL APPROACH TO BUILDING INTEGRATED MANAGEMENT SYSTEMS TAKEN INTO ACCOUNT OF BUSINESS RISKS

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**_Abstract_**

*"The ISO 9000 series of international standards are based on the understanding that all work is accomplished through processes. The work is done through a network of processes. The network structure is usually not a simple linear one, but rather a rather complex structure. Given the complex structure of most organizations, it is important to identify the main processes and to simplify and rank processes depending on the objectives of quality management. Every organization must define, establish, and manage its network of processes and interfaces."In addressing these issues, almost many enterprises have entered a new stage of integration of management systems based on ISO 9000 series standards. Unfortunately, the approach to management from the standpoint of risk management has not yet become one of the basic principles of ISO 9001. The task of business is to integrate put this approach into practice and use it in a broader sense, including within the framework of quality management. In fact,*

*simultaneously with the application of the process approach, one should begin to assess risks; the objects of this process can be market trends, strategic directions for business development, competence, operational activities, consumer satisfaction of products and services of a particular organization. By implementing a process approach together with risk assessment, organizations will be able to focus more on meeting the needs and expectations of their customers and other stakeholders, as well as better manage environmental aspects and ensure the health and safety of employees in the workplace.*

***Keywords:*** *processes, ranking, competitive, integrated, management, risk, effective, hormonization, identification.*

## INTRODUCTION

Economic development, crisis phenomena, a highly competitive market, the need to quickly respond and adapt to changing economic conditions, increasingly confront domestic enterprises with the need to search for new approaches to improving management efficiency. One of these approaches is the creation of integrated management systems (IMS) of an organization based on international standards that summarize positive experience in the field of management and related practical activities. Integrated management systems that meet the requirements of several international standards began to be created in the late 90s. XX century, when specialists began to think about increasing the effectiveness of the organization's management system on the basis of integrated management of various areas of activity (quality, ecology, labor protection, social responsibility). One of the clear advantages of this approach is the achievement of a synergistic effect, in which case the overall result of coordinated actions is greater than the simple sum of the individual results.

An IMS should be understood as a part of an organization's general management system that meets the requirements of two or more international standards for management systems and functions as a single whole [1]. The most common today are the quality management system (QMS) according to the ISO 9000 series, the environmental management system (EMS) according to the ISO 14000 series, and the management system in the field of occupational health and safety according to OHSAS 18000.

ISO standards of the 9000 series in modern conditions act as an organizational and methodological platform for IMS, since they formulate basic concepts and principles that are most consistent with similar elements of general management. As a rule, organizations that have already implemented a QMS and have felt the real managerial and economic effect of system management are thinking about building systems in other areas of activity.

## RESULTS AND DISCUSSION

The introduction of the principles of two or more international standards for management systems into the activities of an enterprise means the presence of IMS of various levels of integration, since these systems are part of the overall management system, therefore, their interaction is inevitable.

The level of system integration will largely determine the success of its development. There are many examples of how organizations, without thinking through the aspects of integration, implemented various management systems. As a result, the new management system worked ineffectively and had an extremely negative impact on the existing system due to the emergence of duplicative management structures, confusion in document management and struggle among managers for resources. Obviously, in order to avoid such mistakes, organizations need some kind of model for assessing the level of integration. Thus, specialists from the certification body - FGU Test-St. Petersburg - developed a methodology for assessing the level of integration of management systems and tested it at more than 10 enterprises [2]. According to this methodology, integration levels can be classified as follows:

• minor (or initial) - systems were created separately, they are managed by different people, policies for systems are not harmonized, planning mechanisms and approaches to the generation of documentation differ, management analysis is carried out autonomously;

• medium - harmonization of policies, presence of a system coordinator, general analysis by management and awareness of staff about key processes of the systems;

• high—common elements of systems are integrated in most areas;

• excellent - the presence at the enterprise of a single integrated system that includes all common elements, i.e. harmonized policies and obligations, common set and management of documents, common performance analysis, etc.

Before the assessment begins, auditors, together with the management of the enterprise, prepare a checklist containing a list of questions (for example, such as “Are the organization's goals integrated?”, “Are there general plans necessary to implement the goals?”, “Is there a common service responsible for coordinating functioning of the IMS?”, “Is the document management procedure integrated?”, “How aware is the staff of the integrated aspects of their activities?”, “Are integrated internal audits carried out?”, “Are risk analysis activities integrated?”), developed by experts and affecting elements of management systems common to integrated systems. The purpose of discussing these issues with the organization's specialists is to determine the weight of the elements being assessed. The weighting coefficient refers to the degree of importance of a particular element for the organization's activities.

Further, during the audit, the levels of integration of individual system elements are assessed. The resulting total score (taking into account the weight of specific elements) is divided by the maximum possible, from which the total indicator of the level of integration of the management system is determined - which is the most important indicator of the maturity of the organization. In particular, it characterizes management flexibility, the ability to change, which is important in a market economy. By developing the level of integration, the enterprise moves to new stages of its development and business improvement. As a result, the integration of a management system is not only its ability to satisfy the requirements of various management standards (ISO 9001, ISO 14001, etc.), but also the presence of mechanisms that allow the most effective use of the common elements of system design specified in these standards.

One of the main elements for building an IMS is risk management. All “core” management system standards contain aspects of risk management to varying degrees, including:

• identification of critical aspects, risks or criteria,
• assessment and identification of significant risks;
• defining the requirements that must be met;
• development and implementation of control mechanisms.

Currently, the international community has developed a number of documents related in one way or another to the standardization of approaches to risk management. Work in this area is being carried out by ISO and the International Electrotechnical Commission (IEC). In addition, some national standards bodies and non-governmental organizations contribute to the development and practice of unified approaches to risk management.

By applying the process approach suggested by ISO 9001:2008, organizations strive to meet the needs and expectations of both internal and external customers. Quality management is no longer the exclusive prerogative of manufacturing enterprises; the process approach has proven to be a valuable tool for organizations in the service sector, healthcare, finance, transport, and local government. Also, an inherent advantage of using ISO 9001:2008 is the continuous improvement of the processes operating in the organization due to the implementation of the relevant requirements of the standard.

Traditionally, the QMS is developed according to the following scheme: the basis is its purpose or mission, then the organization’s policy is formed and goals are structured, the system is built around the policy to achieve the goals. There was no place for explicitly reflecting risk management in this chain.

Meanwhile, the risk management approach is an integral part of other management system standards: ISO 14001 and OHSAS 18001. Organizations must identify and assess each of the risks they face. Unsystematic risks with minor consequences must and sufficiently be taken into account and controlled. Significant risks with severe consequences must be managed in such a way as to either eliminate them completely or reduce the frequency of their occurrence and the severity of the consequences.

Organizations that have implemented ISO 14001 conduct a constant analysis of their EMS, an integral part of which is the consideration of significant environmental aspects associated with emissions into the atmosphere and water discharges, waste disposal, land pollution, use of raw materials and natural resources, etc. The style of thinking and behavior is such The organization meets the expectations of its stakeholders as it manages risks and is responsible for its environmental stewardship.

Organizations that have implemented OHSAS 18001 identify hazards and conduct risk assessments associated with daily work activities, the presence of subcontractors and visitors to the workplace, and the operation of equipment. The key stakeholders are the people within the organization itself who create the risk management culture.

Unfortunately, the approach to management from the perspective of risk management has not yet become one of the basic principles of ISO 9001. The task of business is to integrate this approach into practice and use it in a broader sense, including within the framework of quality management. In fact, simultaneously with the application of the process approach, one should begin to assess risks; the objects of this process can be market trends, strategic directions for business development, competence, operational activities, consumer satisfaction of products and services of a particular organization. By implementing a process approach together with risk assessment, organizations will be able to focus more on meeting the needs and expectations of their customers and other stakeholders, as well as better manage environmental aspects and ensure the health and safety of employees in the workplace. The latest version of ISO 9001:2008, namely the introduction, explicitly emphasizes for the first time that the development of a QMS must take into account the environment in which the organization operates, changes in that environment, and the risks associated with that environment. However, it further states that ISO 9001 does not contain requirements for other types of management, in particular environmental management, health and safety management, financial management or risk management. Meanwhile, another standard in the ISO 9004 family of standards proposes more strongly to manage risks.

## CONCLUSION

The need for further development of risk management aspects in the ISO 9000 series of standards is recognized by the world community. In February 2009, the next meeting of ISO TC 176, which is responsible for the development and updating of ISO 9000 series standards, was held in Tokyo. Of particular interest is the working group formed to identify common concepts and ideas that could form the basis for future activities of ISO TC 176 on updating ISO 9001. In the future, the terms of reference for the revision of ISO 9001 will be formed based on these ideas and proposals from stakeholders such as business, standardization bodies, accreditation, certification, and other ISO technical committees.

Accordingly, it is necessary to resolve the issues of separating the topic of risk into a separate area and identifying the objects in relation to which it should be considered (products, organization, QMS, business continuity, supply chain management, resources and infrastructure). It is clear that the formal inclusion of risk management in this important document will meet the realities of today and will help organizations

• Identify and analyze risks associated with the market
• Identify and analyze risks related to QMS processes, products, services and their management.
• Effectively distribute and use resources required for QMS and product release processes
• Manage suppliers effectively
• Improve operational activities, deepen staff engagement
• Establish a connection between the QMS and the financial aspects of the intermediary
• Become more flexible to implement improvements

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# QUALITY AND SAFETY OF PASTA PRODUCTS MADE FROM PLANT RAW MATERIALS


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***Abstract***

*In this work, we added rice grain cereals produced in whey to increase the nutritional, biological and physiological value of pasta. When adding cereals of rice grains produced in whey, we note an improvement in the organoleptic and physico-chemical parameters of pasta.This newly acquired product has many benefits for the human body. Complex carbohydrates and dietary fiber of rice reduce blood sugar levels and the risk of diabetes, prevent heart, kidney disease, vascular and other organ tension. Products with rice are often used in children's and dietary nutrition. During this experiment, we paid special attention to the quality and safety of pasta products.*



***Keywords:*** *pasta, whey, rice, cereals, plant raw materials, mineralmixture, biologicalvalue, dietarynutrition, low calorie food.*


## INTRODUCTION

All over the world, due to the increase in the population, food products necessary for life are also increasing. Our current nutritional capabilities, which constantly meet new requirements and meet the needs of the population of the corresponding regions, are the result of a long development that has gone down a long history.

For the development of the concept of state policy in the field of healthy nutrition, as the first measures for the development of the structure of nutrition, it is proposed to increase the share of consumer products with high nutritional and biological value.

Pasta is a well-known and beloved product all over the world, which has long been called a convenient product, which allows it to be attributed even to a modern food product. They are made from different flour varieties, as well as using different raw materials as enrichers and enhancers. Due to the development of the range of pasta products, including those intended for dietary and preventive nutrition, increasing the nutritional and biological value is of great importance and practical importance.

The task of increasing the biological value of pasta is solved in a number of areas, one of which is the use of non – traditional raw materials of various plant origin as additional recipe components.

Among plant crops, the first place in terms of production volumes and growth rates is occupied by crops. The protein resources produced by these crops can satisfy the entire population if they supplement the human diet with missing amino acids. The main limiting amino acids for crop proteins are lysine, tryptophan, and methionine. Oats, barley, rice, guest corn, corn, millet, buckwheat belong to the group of cereals. Seeds of the crop contain 7-13% protein, some contain up to 15%.

In recent years, the rational use of material resources is one of the main factors for strengthening and preserving the country's economic potential. Today, due to the high demand for wheat grains, we decided to introduce a method of using non-traditional raw materials, including rice, in the production of pasta around the world.

Sri Lankan scientists studied 15 varieties of rice cereals that contain different amounts of starch and protein. The technological properties of the flour obtained by pulling the grain to different mills are determined. It was found that flour with a particle size of 180-212 microns is suitable for the production of pasta.

Rice contains all the basic substances necessary for the normal existence of humans.The composition of flour obtained from grain crops is rich in physiological and biochemical properties, which have a higher value than the composition of flour obtained from traditional grain crops. Such flour contains natural components, including amino acids, some vitamins, calcium,phosphorus, iron, iodine, as well asbetta-glucan, which reduces cholesterol levels.

The second most productive crop in the world and one of the most widely used crops is rice Groats This crop is the main nutritious food and makes up half of the diet of the population of the globe. In terms of caloric content, it is easily and quickly absorbed, in terms of dietary properties, rice occupies the first place, and in terms of nutritional value exceeds root vegetables and bakery products.

Rice is a carbohydrate-rich crop that contains easily digestible proteins, vitamins, and mineral salts. Its chemical composition depends on its varietal characteristics, soil and climatic conditions during cultivation, as well as on the agricultural technique used. Rice flour is a very fine-grained product with an average grain size of 72.5 – 90.0 microns. Rice flour contains silicon, a large amount of biotin, which contributes to the process of metabolism in the human body, as well as other microelements of important medical and biological significance.

The nutritional value of rice cereals directly depends on the quality of rice and its production, the chemical composition of cereals from which flour is obtained is diverse.

Rice has a powerful property that cleanses the human body well. From its different varieties, food is prepared. From rice grain, which is one of the main feed crops – alcohol, starch is obtained, beer is brewed, and paper is made from straw. Bran is animal feed, and you can also get high-quality oil from it.

According to experts, rice is a low-calorie food. Researchers explain the secret of the beauty of Asian sculpture, its longevity, because it consumes a lot of rice. Rice contains 80% carbohydrates and 3% fiber. For this reason, rice is also served as a side dish to dishes made from vegetables.

With the help of heavy carbohydrates contained in rice, the content of sugar and fat per day in the human body is regulated at its own rate. Rice also absorbs and neutralizes harmful substances that have entered the body with other foods. Therefore, when following a diet (diet) through rice, salt and waste (slags) are released from the body. As a result, the nervous system works well, sleep is restored, the skin color of the face is improved, and there is no unpleasant smell from the mouth. This is, of course, the main advantage of eating rice dishes.

In connection with the above, a study aimed at increasing the nutritional and biological value of pasta based on the use of rice grain cereals produced in whey, improving their organoleptic and physico-chemical indicators is of great importance.

There are a number of functional types of pasta products. One of them is pasta with the addition of vegetable raw materials. The peculiarity of this pasta product is that it is very nutritious and healthy. At the same time, the main advantage of rice flour, which we use, is the high biological value of its grain. It is this pasta that is recommended to be consumed by people who are overweight and suffer from diabetes. In addition, pasta with the addition of dill to rice flour regulates the metabolism in the human body, removes excess substances, and provides the body with vitamins and minerals.

## RESEARCH OBJECT AND METHODS

Table 1-organoleptic parameters of rice cereals and wheat cereals We studied the quality indicators of the main raw materials.

| Indicators | Rice | Wheat |
|---|---|---|
| Color | white powder | White |
| Smell | No foreign odors, no mold smell, no mold smell, clean grain smell | No foreign odors, no mold smell, no mold smell, clean grain smell |
| Taste | The taste of pure grain without foreign taste, not sour, not bitter | The taste of pure grain without foreign taste, not sour, not bitter |
| Presence of a mineral mixture | Does not crunch when chewing | Does not crunch when chewing |
| Metal magnetic mixture, mg per 1 kg of flour; individual particle size with a maximum linear size of 0.3 mm and /or no more than 0.4 mg | 2,1 | 2,1 |
| Presence of pests | Not allowed | Not allowed |

Table 2. quality indicators of wheat grain cereals produced in whey

| Quality indicators | Description of indicators | | |
|---|---|---|---|
| | №1 | №2 | №3 |
| Granulometric particle size, microns | 160 | 168 | 177 |
| Organoleptic indicators | | | |
| Color | White with grayscale | | |
| Taste,smell | specific | | |
| Crunching | not noticed | | |
| Physical and chemical indicators | | | |
| Humidity, % | 11,8 | 12,1 | 12,3 |
| Raw gluten mass fraction, % | 30,6 | 26,2 | 28,4 |
| Raw gluten quality, IDK-1 device unit | 66,2 | 61,2 | 64,0 |
| Number of increase, s | 308 | 310 | 309 |
| Pest damage | Not found | | |

Table 3. quality indicators of rice grain cereals produced in whey

| Quality indicators | Description of indicators | | |
|---|---|---|---|
| | №1 | №2 | №3 |
| Granulometric particle size, microns | 170 | 175 | 180 |
| Organoleptic indicators | | | |
| Color | White | | |
| Taste,smell | specific | | |
| Crunching | not noticed | | |
| Physical and chemical indicators | | | |
| Humidity, % | 15,5 | 15,5 | 15,5 |
| Number of increase, s | 283 | 278 | 274 |
| Pest damage | Not found | | |
| Metal magnetic mixture, mg per 1 kg of flour; individual particle size with a maximum linear size of 0.3 mm and /or no more than 0.4 mg | 3 | 3 | 3 |
| Presence of a mineral mixture | 0,05 | 0,05 | 0,05 |

Currently, the method of dressing macaroni products developed in the functional direction is widespread.And the addition of whey has a very high biological value, which is why it is used in the preparation of various dairy products. When 50% of the dry matter of milk is transferred to whey, the proportion of the transition of each cortical substance is as follows: fat 10-22%, protein 20-25, lactose 85-95, mineral substances 55-65%. Yellow water contains all water-soluble vitamins with a caloric content of 237 kcal. When you add whey to your pasta, it is fully provided with protein, increasing its biological and taste qualities. By adding whey, you can improve the quality of pasta and extend the shelf life of pasta. Prevents macaroni from spoiling. In addition, whey is used in the production of confectionery products (waffles, cookies, gingerbread). Cheese whey in its unprocessed form is used in agriculture, as feed for pigs and cattle.

Pasta is used by people of all ages. Therefore, updating and enriching their species, as well as ensuring their quality and safety, is one of the most pressing issues at the moment.

**Purpose:** to obtain a healthy,high-quality and safe product using non-traditional raw materials for pasta.

**Novelty:** we obtained a new product by making a mixture using rice grain cereals and wheat groats produced in whey. We paid special attention to its quality and safety.

We have strengthened the quality of pasta products and increased their value.With this method, it is possible to bring significant benefits to the human body.

In the course of the study, a composite mixture was obtained – wheat flour of the first grade, corn grain groats produced in whey, wheat grain groats produced in whey, with a ratio of 90:10 (5:5).

Figu. 1. Rice grain cereals produced in whey, wheat grain cereals produced in whey, Composite mixture made on the basis of cereals

Table 4-Chemical composition of rice groats and rice groats in whey

| Indicators | Rice groats in whey | Rice groats |
|---|---|---|
| Starch, G | 89,7 | 82,2 |
| Proteins, G | 8,5 | 8,1 |
| Oils, G | 0,7 | 1,2 |
| In mono and disaccharide, G | 0,4 | 0,8 |
| Cage, G | 0,4 | 0,5 |
| Ash, G | 0,5 | 0,8 |
| Iron, mg | 0,37 | 0,38 |
| Manganese, mg | 1,2 | 0,8 |
| Copper, MCG | 130 | 125 |
| Potassium, mg | 76 | 72 |
| Calcium, mg | 13 | 13 |
| Magnesium, mg | 35 | 29 |
| Energyvalue, kcal | 403,0 | 384,0 |

In the direction of its more rational use as flour in food production, it is important to master the properties of dough in order to regulate the structural, mechanical and rheological characteristics of the dough. To produce a high-quality product, pasta dough must be sufficiently stable and have elastic-elastic properties. The addition of additives to the dough changes its structural-mechanical and rheological parameters and is also evident in the quality of pasta.

## CONCLUSION

1.A composite mixture has been developed that increases the nutritional and biological value of pasta products, which contains wheat groats in optimal proportions, rice groats produced in whey,wheatgroats produced in whey 90:10 (5:5) and has a higher content of nutrients for the human body than pasta made from wheat groats

2.According to the above-mentioned analysis, the addition of a composite mixture in the amount of more than 10% did not allow us to get a positive effect on the quality indicators of the studied finished products and the technological process of manufacturing.

4.In all research samples of pasta products, including those subjected to the cooking process, it was found that the content of non-volatile amino acids is high, although the protein content is reduced.

5. In comparison with products made from wheat groats, the content of the following vitamins in the composition of pasta with the addition of a composite additive has increased: biotin-0.024 mg/%, niacin-0.2 mg/%, riboflavin-0.115 mg / % and folic acid-0.33 MG/%, which is 20%, 33%, 15%, 10% it shows that it is high.

6.During the storage of macaroni products with composite additives, physical, chemical and organoleptic quality indicators were studied, and the shelf life of the new product was determined to be 6 months.

7.To determine the annual economic effect, the amount of income from the introduction of new products into production and the number of working days per year (250) will be 5208 tons of tenge per year, providing 13.44 tons of products per day. The conducted economic calculations have shown that the composite mixture is useful and effective for use in the production of pasta.

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## GLUTEN-FREE FLOURS RESEARCH METHODS AND PRINCIPLES

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***Abstract***

*I decided to do my research on three types of gluten-free flour. They are: rice flour, flax flour, amaranth flour. In order to find out the technological characteristics of gluten-free flours, I first studied its organoleptic properties, and then conducted studies of its physico-chemical indicators. Next, we studied the chemical composition, mineral composition and vitamin composition. The water-binding and fat-binding capacity of gluten-free flour is determined by weighing a sample of 0.25 g of gluten-free flour in a test tube, adding 7.5 g of water or fat to it, and centrifuging it for fifteen minutes, according to the standard method. It means 3000 rpm. After centrifugation, he pours off the liquid or oil from the tube, and then leaves the filter paper at an angle for 10 minutes to remove excess moisture, only after the filter paper is weighed.*

***Keywords****: gluten, flour, rice flour, flax flour, amaranth flour, protein, fat, carbon, microelements, macroelements*

### INTRODUCTION

Flax flour is a type of product obtained by processing flax seeds. Here, to obtain a dry massanv, it is necessary not only to grind a set of seeds, but also to defat them to remove linseed oil from the powder. Flax flour has a brown appearance. The taste of flax flour is characterized by subtle pleasant grainy notes. Flaxseed flour is considered suitable as a base for baking bread and other types of food.

Amaranth flour is a real treasure for those who follow a healthy diet and a healthy lifestyle. It can be considered that this type of product does not differ from exotic products. In addition to its health benefits, amaranth flour can change the taste of homemade confectionery.

Rice flour is a type of flour obtained from milled rice grains. It differs from rice starch. This is because rice flour does not contain gluten at all, so it can be used very often in children's and diet foods. The benefit of rice flour is that it removes toxins from the body, saturates the body with useful trace elements, and improves the work of the cardiovascular system [1].

### RESEARCH WORK

In the results and their discussion, first of all, we decided to compare the organoleptic characteristics of gluten-free flour types. Sensory evaluation helped us to discuss those types of flour. Sensory evaluation was conducted by three other graduate experts. The sensory evaluation performed is shown in Table 1.

Table 1 - Organoleptic evaluation of flax flour, amaranth flour and rice flour

| o. | Indicator | The value of the indicator | | |
|---|---|---|---|---|
| | | Flax flour | Amaranth flour | Rice flour |
| | Color | Brown color | Light orange | White color |
| | Appearance | Shredded | Shredded | Shredded |
| | Taste | The taste of the product is distinguished by delicate and pleasant grainy notes | It has soft, delicate nutty tones and malty notes | Tasteless |
| | The smell | It has its own smell | It has a characteristic smell | Odorless |

In summing up our assessment, we found that the flax meal was brown in color and furthermore, the appearance of the flax meal was in a crumbly form. As for the taste of linseed flour, we have made sure that it is distinguished by its characteristic delicate and pleasant grain notes, and has a characteristic smell.

The second studied is amaranth flour. Amaranth flour is pale yellow in color and has a crumbly appearance. As for the taste of amaranth flour, it has a soft and delicate nutty flavor, and in addition, a malty note is felt. The smell is distinctive with a little nutty smell [2].

The last studied type of flour is rice flour. The color of the rice flour is white, and the external appearance is crumbly. If we focus on the taste and smell, the taste is tasteless, and the smell is odorless.

You can see the appearance of flax flour, amaranth flour and rice flour in Figure 1.

a) b) c)

Fig 1. Appearance of gluten-free flours: a) flax flour, b) amaranth flour, c) rice flour

Flax flour is a type of product obtained by processing flax seeds. Here, to obtain a dry massanv, it is necessary not only to grind a set of seeds, but also to defat them to remove linseed oil from the composition of the powder. Flax flour is brown in appearance. The taste of flax flour is characterized by subtle pleasant grainy notes. Flaxseed flour is considered suitable as a base for baking bread and other types of food. Amaranth flour is a real treasure for those who follow a healthy diet and a healthy lifestyle. It can be considered that this type of product does not differ from exotic products. In addition to its health benefits, amaranth flour can change the taste of homemade confectionery. Rice flour is a type of flour obtained from milled rice grains. It differs from rice starch. This is because rice flour does not contain gluten at all, so it can be used very often in children's and diet foods. The benefit of rice flour is that it removes toxins from the body, saturates the body with useful trace elements, and improves the work of the cardiovascular system [3-5]. Let's move on to our next study, which is the physico-chemical properties of gluten-free flours. What is a physico-chemical property? - Moisture content, acidity and percentage of gluten mixture of our studied flours. You can see the results of our research in Table 2.

Table 2 - Physico-chemical properties of flax, amaranth, rice flour

| No. | Indicator | Humidity, % | Acidity, % | Gluten, % |
|---|---|---|---|---|
| 1 | Flax flour | ≈ 7.7 | ≈ 5 | No |
| 2 | Amaranth flour | ≈ 8.6 | ≈ 7.2 | No |
| 3 | Rice flour | ≈ 15 | ≈ 2 | No |

First, the moisture content of the studied flour was determined according to GOST 13586.5. The moisture content of flax flour was 7.7%, which is significantly less than that of amaranth flour and rice flour. Moisture content of amaranth flour is 8.6% on average, while rice flour is 15%.

The acidity of the flour is due to the hydrolytic decomposition of flour fat, acid phosphates, as well as the presence of small amounts of acidic proteins and organic acids. Our amaranth flour has the highest acidity. Since it is approximately 7.2%, it is recommended to add amaranth flour to the liquid dough. Due to the products included in the composition of amaranth flour, the ability of the flour to produce sugar and gas increases. Due to this, the fermentation activity of yeast increases significantly. Summing up, according to GOST 10844-74, the maximum acidity of amaranth flour is 7.2%, the acidity of our flax flour is 5%, and the acidity of our rice flour is 2%.

According to GOST R 54478-2011, all three types of flour do not contain gluten.

After examining the physico-chemical properties, we next examined the caloric and nutritional value of gluten-free flours. The research results are shown in Table 3.

Table 3 - Calorie and nutritional value of gluten-free flours

| No. | Indicator | Flax flour | Amaranth flour | Rice flour |
|---|---|---|---|---|
| 1 | Kcal | 270 | 298 | 366 |
| 2 | Akuuz, g | 36 | 8,9 | 5.95 |
| 3 | May, g | 10 | 1.7 | 1.42 |
| 4 | Carbohydrate, g | 9 | 61.7 | 80,13 |

After researching, we found out that flax flour has 270 kilocalories. The next thing we looked at was that it had 36 grams of protein, 10 grams of fat, and 9 grams of carbohydrates.

If we focus on amaranth flour, we made sure that it has 298 kilocalories. Its protein content is 8.9 grams, fat content is 1.7 grams, and carbohydrate content is 61.7 grams. This means that the carbohydrate content of amaranth flour is much higher than that of flax flour.

The next type of gluten-free flour studied is rice flour. It showed 366 kilocalories of rice flour. Now, if we focus on the amount of protein, it reached 5.95 grams. It means that the protein content of rice flour is less than that of flax and amaranth flour. The next study had a fat content of 1.42 grams and a carbohydrate content of 80.13 grams. In summary, rice flour had the highest amount of kilocalories and carbohydrates, while flax flour had the highest amount of protein and fat [6-9].

Next, we have research findings on micro- and macronutrients in gluten-free flours. It is shown in Table 4.

Table 4 - Micro and macro elements in gluten-free flours

| No. | Indicator | Flax flour | Amaranth flour | Rice flour |
|---|---|---|---|---|
| 1 | Calcium, mg | 280.5 | 8 | 10 |
| 2 | Iron, mg | 6.3 | 0.32 | 0.35 |
| 3 | Magnesium, mg | 431.2 | 21 | 35 |
| 4 | Phosphorus, mg | 706.2 | 200 | 98 |
| 5 | Potassium, mg | 894.3 | 400 | 76 |
| 6 | Zinc, mg | 4.8 | 0.41 | 0.8 |
| 7 | Copper, mg | 0.1 | 0.028 | 0.13 |
| 8 | Manganese, mg | 2.73 | 0.024 | 1,2 |
| 9 | Selenium, mg | 27.94 | 36.5 | 15.1 |

According to the results of the study of micro- and macroelements in gluten-free flours, the highest amount of calcium, magnesium, phosphorus, potassium, zinc, and manganese was determined in flax flour. The highest amount of selenium was found in amaranth flour, and the highest amount of manganese was found in rice flour.

After knowing the micro and macro elements in gluten-free flours, we conducted research to find out the vitamins in those flours.

Why did we conduct separate research on vitamins? This is because we are trying to answer the question of whether or not vitamins have a negative effect on the human body. According to the results of the research, we made sure that most of the vitamins help the human body a lot. For example, vitamin B1 is part of the main enzymes of carbohydrate and energy metabolism, which provide the body with energy and plastic substances, branched amino acid metabolism. Deficiency of this type of vitamin leads to disorders of the vascular, digestive and cardiovascular systems.

Vitamin choline plays a role in the synthesis and metabolism of phospholipids in the liver, it is a source of methyl groups and acts as a lipotropic factor.

Let's talk about vitamin B5, it participates in protein, fat, carbohydrate metabolism, cholesterol metabolism, synthesis of some hormones, hemoglobin, affects absorption of amino acids and sugars in intestines. Vitamin content of gluten-free flours is shown in table 5.

Table 5 - Vitamin composition of gluten-free flours

| No. | Indicator | Flax flour | Amaranth flour | Rice flour |
|---|---|---|---|---|
| 1 | Vitamin B1 , thiamine | 1.8 mg | 0.025 mg | 0.138 mg |
| 2 | Vitamin B2 , riboflavin | 0 , 1 8 mg | 0.06 mg | 0.21 mg |
| 3 | Vitamin B 4 , choline | 86.6 mg | 69.8 mg | 5.8 mg |
| 4 | Vitamin B5, pantothenic | 1.08 mg | 0.15 mg | 0.819 mg |
| 5 | Vitamin B6 , pyridoxine | 0.52 mg | 0.24 mg | 0.436 mg |
| 6 | Vitamin B9 , folate | 95.7 μg | 82 mcg | 4 mcg |
| 7 | Vitamin C, ascorbic acid | 0.66 mg | 4.2 mg | - |
| 8 | Vitamin E , alpha tocopherol, TE | - | 1.19 mg | 0.11 mg |
| 9 | Vitamin K , phylloquinone | 4.73 mcg | - | - |

## CONCLUSION

In summary, the most Vitamin B1 (thiamine), Vitamin B2 (riboflavin), Vitamin B4 (choline), Vitamin B5 (pantothenic acid), Vitamin B6 (pyridoxine), Vitamin K (phylloquinone) is found in flax meal, and Vitamin C (ascorbic acid), Vitamin E (alpha tocopherol, TE) is present in amaranth flour. We made sure that rice flour contains less vitamins than flax flour and amaranth flour.

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UDC 664.682

# DEVELOPMENT OF TECHNOLOGY FOR THE PRODUCTION OF PUFF PASTRY WITH DATE PASTE


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***Abstract***

*Based on the research carried out in the article, a patent information search was carried out and information was collected on the principles and prospects for creating products for rational nutrition. The modern range and technologies of flour confectionery products for feeding various consumer groups are analyzed. The problems of improving the functional properties of biscuit products through the use of non-traditional types of raw materials, including date paste, and analyzing the compatibility of their chemical composition are discussed. The nutrition of people living in regions with unfavorable environmental factors was assessed. Based on the analysis, the goals and objectives of the dissertation research are formulated.*


***Keywords:*** *rational nutrition, flour confectionery products, functional properties, biscuit products, non-traditional raw materials, date paste*

## INTRODUCTION

Over the past 10-15 years, significant changes have occurred in the nutritional structure of the population. The changes are mainly due to less consumption of high-value foods such as fruit. A deficiency of vitamins C, A, B, as well as important macro- and microelements, which characterize the antioxidant, immunological state and antianemic activity, as well as its resistance to the influence of adverse environmental factors, has been established [1]. .

Cookies are flour confectionery products of various shapes, medium thickness and low humidity. Made from flour, sugar, butter, eggs, dairy, flavorings and chemical raising agents. Depending on the technology and recipe, cookies are divided into 3 types: sugar, sugar, puff pastry. Cookies each type of biscuit has its own texture, shape, thickness, recipe, moisture content and technology. In this case, the cookie dough depends on the type: sugar cookies are made from soft dough, sugar cookies are made from flexible dough, puff pastries are made from different types of dough, and biscuits and croutons are made from dough fermented with yeast.

The different state of the dough depends on the amount of sugar, fat, technological preparation and processing [2]. Consider making date paste based cookies. There, the cookie technology, production and the product itself as a whole will be comprehensively studied, and I believe that the raw materials added to it will fully ensure the quality of the finished product, and I will contribute to further accelerating the production of this product. Scientists generally say that a person can only have dates and water to live a full life for a year or two, if there are no other benefits. Nutritionists believe that one date a day can provide the minimum nutritional requirements of the human body. Date paste includes all the substances contained in dates: carbohydrates, proteins, fats, fiber; minerals in the form of potassium, phosphorus, calcium, magnesium, sodium, iron, zinc, manganese; vitamins – C, A, B1, B2, B3, B5, B6, B9. But the most obvious component of pasta and dates is still fiber, which is high in this product (Figure 1).

Fig.1. Date paste

The main beneficial property of dates is the rapid saturation of the body, which is facilitated by various nutrients and vitamins, which are presented in large quantities in this product. They allow the body to receive everything it needs for the construction of new cells and the normal functioning of every vital organ and system.

## EXPERIMENTAL METHODS

The study was conducted according to standards and generally accepted methods in the Food Engineering cafe. Expert studies - physical and chemical studies of the finished product were carried out three to five times according to generally accepted standard methods. Experimental studies were carried out using the following modern methods, based on a set of indicators for characterizing raw materials and finished products. Determination of general chemical composition. The general chemical composition is determined from one portion of the test sample. Method for determining humidity. Definition of humor. Determination of organoleptic indicators.

## RESULTS AND DISCUSSION

In the laboratory of the Department of Food Engineering, crumbly cookies were prepared using date paste. Four samples were prepared and a different percentage of date paste was added to each sample. 3% date paste was added to sample No. 1, 6% to sample No. 2, 9% to sample No. 3, and 12% to sample No. 4. Date paste was added when preparing shortbread dough. Qualitative studies of date paste were carried out in accordance with the MemST 51074 standard. Cookies with different amounts of mixture were studied (Fig. 2, 3). According to data obtained as a result of research, the mass fraction of moisture is:

Fig.2. Date paste production process

$X_1$ = (19,8 - 18,8) :15,5 :100 = 8 %
$X_2$ = (19,8 - 18,55) :15,5:100 = 7 %
$X_3$ = (19,8 - 18,87) :15,5:100 =6 %
$X_4$ = (19,8 - 19,02) :15,5:100 =4 %

Table 1 - Organoleptic quality indicators of date paste

| № | Indicators | Observer | Model |
|---|---|---|---|
| 1 | Appearance | Pink color, uniform | Full, clean, no softening, no damage. |
| 2 | Subsequence | It is pliable, elastic and holds its shape. | |
| 3 | Form | A long rod-shaped plate. | - |
| 4 | Taste | Sweet and sour, grains of sugar visible | Sweet taste is felt, no foreign aftertaste is felt |
| 5 | Smell | - | Has a characteristic aroma of dates. |
| 6 | Color | Light brown, brown | Light brown |

Fig.3. Cookie rolls

Based on the obtained values, a diagram was constructed (Figure 4).

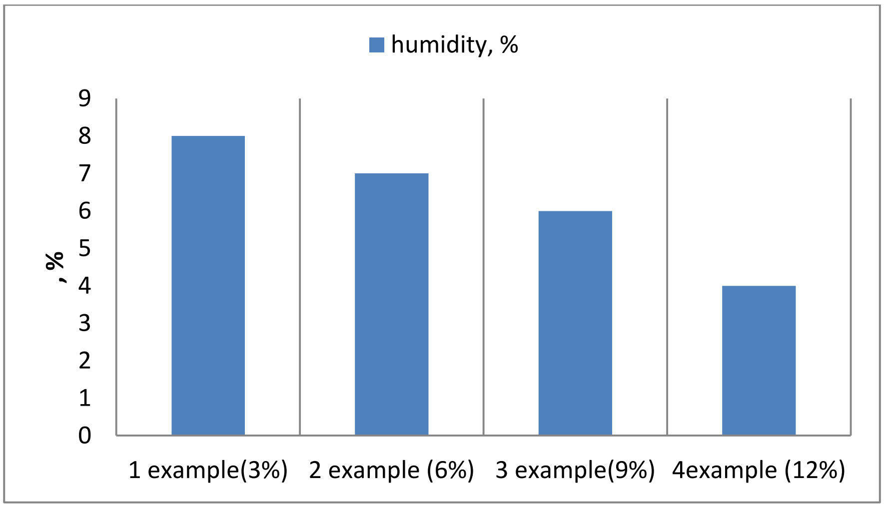


Fig.4. Graph of the dependence of the moisture content of cookies on the amount of mixture

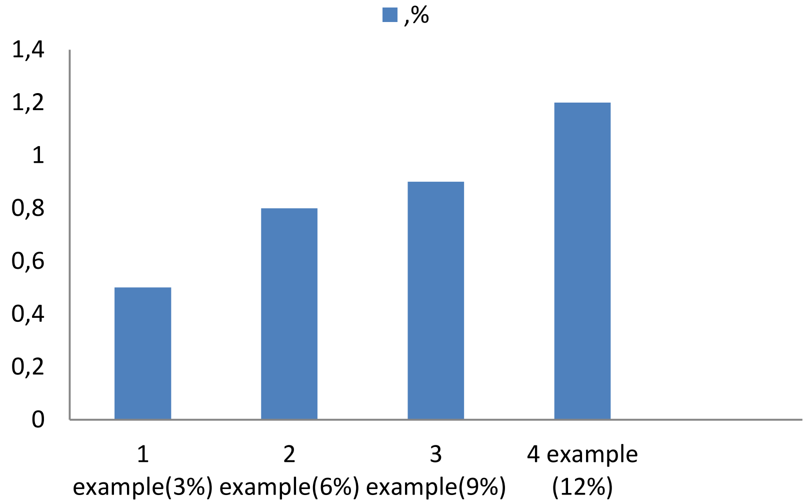


Fig.5. Graph of the dependence of the ash content of cookies on the amount of mixture

According to the standard, the humidity of rolled out cookies should not deviate from 3-9%. The models under study are standard; model No. 3 is optimal. The ash content of cookies with the addition of date paste was determined and a diagram was constructed (Fig. 5). According to physical and chemical studies, the following values were determined. During the work, crumbly cookies based on date paste were obtained. Date paste replaces a certain amount of sugar, that is, it is considered for people with diabetes. This work examines the classification and classification of crumbly biscuit products and conducts patent searches.

When describing the raw materials, I focused on the products included in the crumbly biscuit product and listed the technological methods for preparing crumbly biscuits.

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## STUDYING THE COMPOSITION AND MODE PARAMETERS OF THE COMBINATION OF STARTING RAW MATERIALS FOR THE PRODUCTION OF MEAT CHIPS

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***Abstract***

*Meat snacks differ from traditional meat products by their specified functional characteristics, which add nutritional and biological value to them. The formation and development of the market for domestic meat products such as snacks will expand the capabilities of Kazakhstan's meat industry enterprises in the production of innovative food products on the one hand, and the growing demand of the population for new meat food products on the other, which makes it advisable to develop technologies for meat chips using technological techniques that allow maintain the stability of consumer properties of products. As a research methodology, experimental research methods were used, including statistical sampling of raw materials and preparation of samples for research, expert methods for determining the organoleptic properties of products, and instrumental methods for determining the physical and chemical parameters of finished products. The purpose of our research is to study the composition of the original meat raw materials for their combination with the selection of the most suitable technological properties in the manufacture of the final product - meat chips. The article presents the results of research on the selection of the composition of the feedstock and methods of combining them. The main types of meat were selected, their mineral composition, the ratios of their combination were studied, the consistency that was optimal for obtaining meat chips, the required size and thickness, and the temperature conditions for drying semi-finished products were selected. It has been established that the combination of three types of meat - horse meat, beef and chicken fillet gives the optimal composition of minced meat, as the most convenient form for forming meat chips, as well as in consistency, juiciness, taste and smell and reducing the time for their production by drying with air convection. The mineral composition of the original meat samples showed that they contained trace elements such as potassium, phosphorus, magnesium and sodium. Horsemeat contains, in weight%, K-29.25, P-16.96, Mg-1.69. Na-4.12; in beef, in wt.% K-31.02, P-13.38, Mg-1.26. Na-4.12; in chicken pulp, in wt.% K-30.27, P-17.94, Mg-1.89. Na-1.89, which indicates the equivalence of all types of meat for these microelements.*

***Keywords:*** *types of meat, meat chips, raw materials, combination, mineral composition, modes, drying*.

## INTRODUCTION

The change in the diet of modern people is due to the increasing pace of life, especially the urban population, an increase in its number, which must be provided with the required volumes of food products on the one hand, and on the other hand, to solve pressing issues of preserving their health and working capacity through the supply of vital substances to their bodies [1]. One of these food products, which has been used by humans almost since its inception, is meat, which contains large quantities of animal protein, which includes essential amino acids involved in the construction of tissues by the body, synthesis and metabolism, as sources of energy. Vitamins of the B group predominate in meat, and among minerals it contains a lot of potassium, phosphorus, magnesium and iron, which is absorbed much better than iron from plant products.

In Kazakhstan, due to historical traditions, the diet is dominated by meat and meat products, the types and nomenclature of which are quite diverse[2]. However, in this segment there are no new types of meat products that are beginning to spread abroad as functional products. In the global meat market, products called meat chips (snacks), which for the most part are dry-cured, raw smoked or dried meat products, but with specified functional characteristics that add nutritional and biological value to them, are rapidly gaining popularity [3,4]. It should be noted that the prototypes of this type of food product have historical roots in the cuisine of many peoples of the world, for example, dry (dried, dried) meat products, their production and consumption were developed in the countries of South and North America, South Africa, and among northern peoples[4, 5]. In the national cuisine of Kazakhstan, you can also find meat products that have been dried or dried. Thus, the preparation of meat for the winter diet was carried out by introducing a large amount of table salt into the prepared pieces of meat, usually horse meat, which was subjected to natural drying in a dark and cool place, bringing it to a state of drying and/or a dry product called “sogym”. It was consumed throughout the winter period until warm days arrived, since such a product required low storage temperatures[6].

An analytical review of available scientific developments showed the presence of research by Russian scientists that is closest to our work - the development of a technology for making chips from poultry meat using vacuum infrared drying. Data were obtained characterizing changes in the physicochemical and microbiological parameters of salted semi-finished products for chips using sodium lactate and protective cultures of microorganisms depending on the concentration of sodium chloride and the duration of salting [7,8,9]. However, almost all studies use one type of meat as raw material. We have proposed a combination of several types of meat, which allows you to balance both the organoleptic and physico-chemical characteristics of the finished product.

Kazakhstan, having significant reserves of environmentally friendly meat raw materials, can develop a new direction in the production of modern meat processing products - the market of meat snacks using natural functional ingredients, which will allow domestic producers to expand the range of new products of high quality and nutritional value, resistant to bacterial spoilage over long periods of time. storage, which is an urgent task for meat processing enterprises in our country.

## EXPERIMENTAL METHODS

As an object of research, we selected 3 types of meat, which should be characterized by a high protein content and low fat, since it is these types of meat that meet the requirements for raw materials for the production of dry products such as chips. The choice of these types of meat is due to the presence of a good base for their production in Kazakhstan, which predetermines the consistency of meat raw materials for the production of meat chips. Horse meat was chosen both for the prevalence and volume of its production in our country, and for its lower fat content, which improves the quality of the final product. Beef is also produced in large volumes and is characterized by high levels of protein, fat and minerals, especially iron. The choice of chicken meat is due to the fact that it makes it possible to soften the consistency of the resulting minced meat, as well as due to its lower fat content, which helps balance the composition of semi-finished products. The number of selected meat samples, 300 g of each type: sample No. 1 - beef, sample No. 2 - horse meat, sample No. 3 - chicken breast. Figure 1 shows samples of meat varieties selected for research.

Samples of selected varieties of meat were tested for mineral composition in the certified regional engineering testing laboratory "IRLIP" of SKU named after. M. Auezova. The quantity of each sample is 100 g. The samples were burned in a muffle furnace to produce ash, in which the mineral composition was determined by the X-ray spectral method on a scanning electron microscope. The results for each type of meat are shown in Figures 1-3.

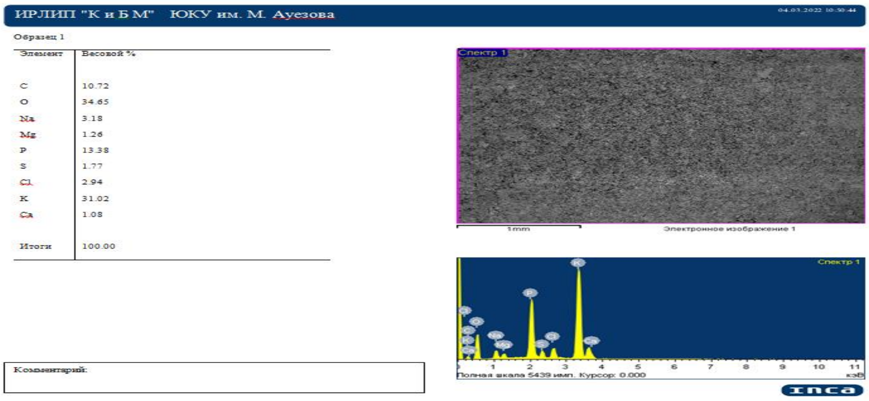



Fig. 1. Mineral composition of beef

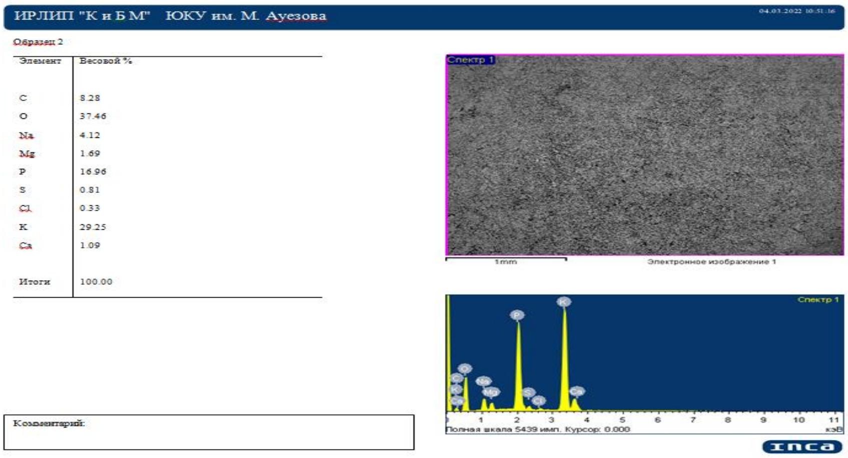



Fig.2. Mineral composition of horse meat

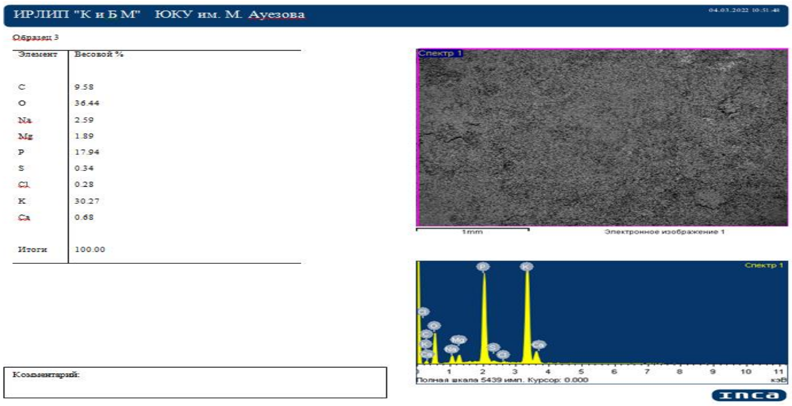



Fig. 3. Mineral composition of chicken fillet

Weighing of meat samples was carried out on electronic laboratory scales brand CAS MWP-150, measurement accuracy - 0.005 g. The prepared meat samples were combined in the following ratios:

1. 60 g horse meat +30 g chicken breast
2. 6b g beef + 30 g chicken breast
3. 30g horse meat+30g beef+30g chicken breast

All three combinations were separately processed into minced meat in an electric laboratory meat grinder. The amount of minced meat obtained for each combination was 90g, the number of prepared minced meat samples for each combination was - 3. After preparing the combined minced meat, we carried out work on preparing the composition of semi-finished products for the production of meat chips, with the following ratio of components, mass. % per 100 g of product:

1) combined minced beef and chicken breast -90%, 5% starch, 3% salt, 0.5% ground black pepper, 0.3 dried garlic, 0.2 ground red pepper.

2) combined minced horse meat and chicken breast -90%, 5% starch, 3% salt, 0.5% ground black pepper, 0.3 dried garlic, 0.2 ground red pepper.

3) combined minced beef, horse meat and chicken breast -90%, 5% starch, 3% salt, 0.5% ground black pepper, 0.3 dried garlic, 0.2 ground red pepper.

After thorough mixing, each sample of semi-finished products was formed into a sausage shape and placed in a refrigerator at a temperature of +4°C – +5°C for cooling for 2 hours and subsequent cutting of the samples. The cooled samples were cut into circles 0.8-1.2 mm thick, with a diameter from 35 mm to 60 mm, placed on a baking sheet covered with parchment paper, and subjected to 3-mode drying. Figure 4 shows the processes of cutting and preparing semi-finished products.

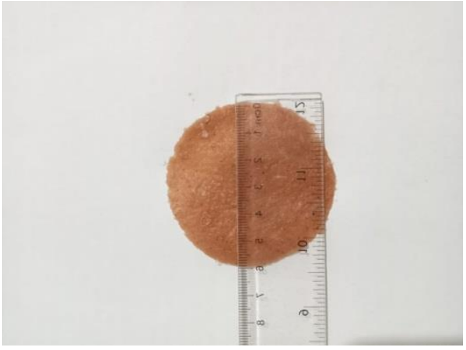
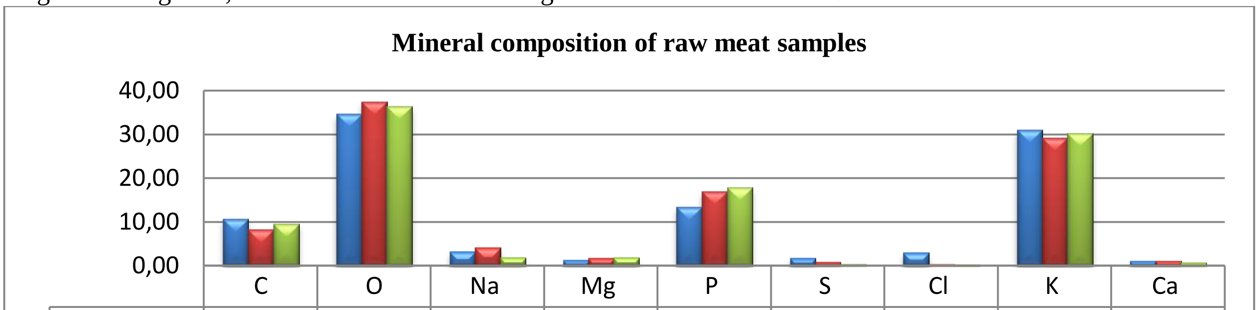


Fig.4. Measuring the dimensional parameters of meat chips

Drying was carried out in a drying oven with convection blowing brand ShS-80, manufactured by OJSC Grodtorgmash, Republic of Belarus. Operating parameters: 1st drying for 1 hour at a temperature of 70 0C, 2nd drying for 5 hours at a temperature of 600C, 3rd drying for 4 hours at a temperature of 500C. Total drying time 9 hours. The finished product was cooled and organoleptically assessed by appearance, smell, taste.

## RESULTS AND DISCUSSION

The results of experiments on the mineral composition of each type of meat are presented in the form of diagrams in Figure 5, based on which the following conclusions can be drawn.




| | C | O | Na | Mg | P | S | Cl | K | Ca |
|---|---|---|---|---|---|---|---|---|---|
| Образец 1 | 10,72 | 34,65 | 3,18 | 1,26 | 13,38 | 1,77 | 2,94 | 31,02 | 1,08 |
| Образец 2 | 8,28 | 37,46 | 4,12 | 1,69 | 16,96 | 0,81 | 0,33 | 29,25 | 1,09 |
| Образец 3 | 9,58 | 36,44 | 1,89 | 1,89 | 17,94 | 0,34 | 0,28 | 30,27 | 0,68 |

Sample 1 – beef
Sample 2 - horse meat
Sample 3 - chicken fillet

Fig.5. Mineral composition of meat varieties intended as feedstock

As can be seen from Figure 5, almost all types of meat are rich in potassium content, slightly less in horse meat (29.25 mg%), at the same time, the phosphorus content in horse meat (16.96 mg%) is ahead of beef, but in chicken breast the highest phosphorus content is 17.94 mg%, as well as magnesium content (1.89 mg%) in comparison with beef (1.26 mg%) and horse meat (1.69 mg%). The highest sodium content is in horse meat (4.12 mg%), the smallest amount is in chicken breast (1.89 mg%), in beef the sodium content is 3.18 mg%, calcium in horse meat and beef is an order of magnitude higher than 1.08 and 1. 09 mg%, respectively, than in chicken breast - 0.68 mg%.

Thus, the mineral composition of each type of meat is rich in potassium, phosphorus, magnesium and sodium, as well as calcium. The content of carbon and oxygen in almost all types of meat is the same. When combining each type of meat to produce minced meat, the composition of mineral substances is averaged.

The choice of consistency and sausage-shaped form of the semi-finished product to obtain images of meat chips during the experiments was due to the negative results of initial experiments in forming them from whole pieces of each type of meat, which, after drying, both in taste and shape, did not correspond to the aesthetic and dimensional characteristics of the finished product. Therefore, it was decided to combine types of meat and choose the most optimal option, which was given to us by a combination of three types of meat.

Thus, the composition for the preparation of meat chips, including, wt. %: Minced meat in a combination of three types of meat – 90% Starch - 5% Table salt - 3% ground black pepper - 0.5% dried garlic - 0.3% ground red pepper - 0.2% The preliminary composition of the initial raw meat in the form of minced meat proposed by us will be supplemented in the process of further experiments to enhance the taste by adding protein components and various herbal additives that will increase the nutritional and biological value to obtain a functional product. For high-quality cutting, it is necessary to cool the sausage-shaped form of the resulting composition of the combined raw meat raw materials, which we carried out during a 2-hour cooling process in the refrigerator. However, it was found that it is necessary to continue experiments on deep freezing the semi-finished product in a freezer at a temperature of -18-24 $^{0}$C, since the industrial production of meat chips will require the use of special slicing machines.

The dimensional parameters of cutting chilled semi-finished products selected during the experiments showed that the thickness from 0.8 to 1.2 mm and the round shape allows the drying process to be carried out most efficiently in terms of time parameters, the total drying time was 9 hours, which is much lower than those available in the literature sources (up to 36 hours). It should be noted that to give a crispy crust and an attractive appearance, the 1st stage of drying is required for 1 hour at a temperature of 70 0C. The round shape of meat chips with a diameter of 60 mm is the most optimal for further packaging in consumer packaging. Figure 6 shows samples of the resulting finished meat chips.

Fig. 6. Ready-made meat chips

## CONCLUSION

The research carried out made it possible to select the composition of the initial raw materials, methods of preparing the semi-finished product according to the dimensional characteristics and consistency convenient for the production of meat chips, drying parameters that ensure the production of crispy products. Experimental samples of meat chips were obtained. It has been established that combining three types of meat - horse meat, beef and chicken breast in a 1:1:1 ratio gives the optimal composition in terms of taste and the content of mineral elements such as K, P, Mg, Ca, and at the same time, reduces the fat content. It has been established that combined meat raw materials must be ground in the form of minced meat, which makes up the mass. % per 100 g as part of the semi-finished product -90%, with the addition of 5% starch, 3% table salt, 0.5% ground black pepper, 0.3% dried garlic, 0.2% ground red pepper. To speed up the drying process up to 9 hours, the semi-finished product must be given a sausage shape, cooled for 2 hours and cut into a round shape 0.8-1.2 mm thick, with a diameter of at least 60 mm. This will allow you to obtain a crispy crust and dimensional parameters of the finished meat chips, convenient and optimal for further packaging in consumer packaging.

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UDC 65.09.03

# RESULTS OF STUDIES ON THE MINERAL COMPOSITION OF APPLES GROWED IN THE TURKESTAN REGION FOR APPLICATION AS A STARTING RAW MATERIAL FOR THE PRODUCTION OF APPLE CHIPS

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***Abstract***

*In the line of fruit snacks that have begun to be actively produced and consumed abroad, the most common are apple chips, since the availability of apple raw materials, both in volume and the prevalence of their cultivation in almost all regions of the world, makes it possible to produce new products that, in their properties, can be classified as healthy food products. Fruit chips are considered a good alternative to potato chips, as they contain natural vitamins and microelements that act on the body faster and more gently than chemically synthesized vitamin and mineral complexes. When developing a technology for the production of apple chips, it is necessary, first of all, to examine the original apple raw materials for safety indicators, the standards of which, for manufacturers in the countries of the customs union, are laid down in the technical regulations on food safety. The article presents the results of studies of samples of apple varieties grown by the farm "DALA-FRUIT.KZ" LLP for safety indicators - the content of pesticides and nitrates, as well as mineral composition, for their selection as feedstock in the developed technology for the production of apple chips. Tests were carried out in accredited laboratories - RSE "National Center of Expertise" KKKBTU MH RK and IRLIP YuKU named after. M. Auezova on samples of five varieties of apples - Idared, Granny Smith, Nicole Granny, Fuji and Golden, grown by the farm DALA-FRUIT.KZ LLP, the results of which confirmed the presence in them of essential microelements important for the body and the almost complete absence of nitrates and pesticides.*

***Keywords:*** *apples, variety, mineral composition, tests, safety indicators, requirements of Technical regulations for food safety, results.*

## INTRODUCTION

The development of the agro-industrial complex is one of the main long-term priorities of state economic policy. The Kazakhstan 2050 strategy sets the task of carrying out large-scale modernization of agriculture in the context of growing global demand for agricultural products. The result of the measures taken should be an increase in the share of agricultural products in the country's gross domestic product by 5 times by 2050. In order to implement the long-term goals and objectives of the Strategy "Kazakhstan - 2050", the Strategic Plan of the Republic of Kazakhstan 2025 determines that policy in the agro-industrial complex will be focused on increasing agricultural productivity, deepening the processing of agricultural products, ensuring the country's food security and increasing the export of environmentally friendly products. The state program of the agro-industrial complex provides for the priority development of certain industry areas, including intensive horticulture [1]. Development of the agro-industrial complex In accordance with the Concept of industrial and innovative development of the Republic of Kazakhstan for 2020 - 2025, approved by Decree of the Government of the Republic of Kazakhstan dated December 20, 2018 No. 846, the policy of industrial and innovative development is focused on solving the problems of the manufacturing industry in order to obtain food products with high added value cost and provision of the population with high-quality food products in the volumes and assortment necessary for the formation of a correct, comprehensively balanced diet at the level of physiologically recommended consumption standards [2]. Development of the agro-industrial complex Among fruits, a special place is occupied by apples, which contain vitamins A, C, B1, B2, PP and E, as well as magnesium, phosphorus, iodine, iron, selenium, potassium, calcium and zinc. Together, they give the human body vitality, help cope with stressful situations, improve brain function and strengthen the cardiovascular system[4]. Fresh fruits are the most useful, however, due to the seasonality of their growth, the question arises of their processing, which makes it possible to smooth out seasonal fluctuations in the consumption of fruits and vegetables, provide the population with adequate nutrition in all regions of our country, increase or decrease the calorie content of food products, increase nutritional value and digestibility obtained as a result of processing products. In this regard, scientists always face pressing questions regarding the development of scientifically based methods and technologies for the production of a wide range of food products from fruits, in particular apples, with a certain functional focus to improve the nutritional structure of the population [5,6]. The scientific literature has standardized the concept of “functional food product”, which is understood as a product intended for systematic use as part of diets by all age groups of the population, reducing the risk of developing nutrition-related diseases, preserving and improving health due to the presence of physiologically functional ingredients [7].

The development of the agro-industrial complex with processed products of fresh apples, such as apple juice, jams, marmalade, dried fruits, is familiar to many of our consumers, however, in recent years, such a direction in the range of processed products as apple chips, belonging to the segment of fruit snacks, with high dietary and taste properties. Apple chips are an innovative product in form and content for our country. This is a natural “food supplement” that contains natural, not chemically synthesized, vitamins and microelements that act on the body faster and more gently than vitamin complexes that can quickly satisfy hunger, improve intestinal function and have a general strengthening effect on the entire body. All fruit chips contain useful components such as fructose, glucose, malic acid, fiber, pectin, and iron[8]. Particularly noted is the need for the human body to obtain minerals, which are vital components of nutrition that ensure normal functioning and development of the body; living organisms cannot synthesize minerals on their own..

Development of the agro-industrial complex In this regard, a person receives the bulk of mineral elements through food, according to the content of which in the body, they are conventionally divided into two groups - macroelements, more than 0.01% and microelements, less than 0.01%.

Development of agro-industrial complex: macroelements include phosphorus (P), calcium (Ca), sodium (Na), potassium (K), magnesium (Mg), sulfur (S), chlorine (Cl), microelements iron (Fe), zinc (Zn ), copper (Cu), iodine (I), selenium (Se), manganese (Mn), molybdenum (Mo), fluorine (F), chromium (Cr), cobalt (Co), silicon (Si), vanadium (V ), boron (B), nickel (Ni), arsenic (As) and tin (Sn). Regardless of their content, their presence in the human body is due to the fact that minerals are part of all cells, tissues, bones, maintain acid-base balance in the body and influence metabolism [9,10].

The development of the agro-industrial complex is the role of some mineral elements in the development and maintenance of the vital functions of the human body, shown in the table 1[11].

Table 1. The role of mineral substances for the human body

| Name of elements | Meaning | Sources |
|---|---|---|
| Potassium | regulates water content in tissues, maintains water-salt balance, improves heart function | fresh and dry fruits, nuts, bananas, legumes, potatoes, avocados, meat, milk |
| Calcium | is part of human bones and teeth, participates in the process of blood clotting and transmission of nerve impulses, increases the body's resistance to infections, deficiency leads to rickets. | milk and dairy products, egg yolk, bread, vegetables, legumes, lettuce, sorrel, shellfish, corn |
| Sodium | regulates fluid balance in the body, metabolism, osmotic pressure in tissues | table salt, cheeses, eggs, caviar, yeast extract |
| Magnesium | reduces cholesterol in the blood plasma, has a vasodilating property, participates in the formation of bones and teeth | legumes, nuts, dried figs, green leafy vegetables, oatmeal, rye bread |
| Iron | the main component of hemoglobin, part of a number of enzymes | meat, liver, brains, buckwheat and oatmeal, egg yolk, berries and fruits, especially apples, are well absorbed in combination with vitamin C. |
| Phosphorus | is part of human bones and teeth in combination with calcium, participates in the process of digestion of carbohydrates, proteins and fats | fish, vegetables, mushrooms, cheese, meat, rye bread, eggs, nuts, potatoes, cereals, dairy products |
| Iodine | necessary for the thyroid gland to produce hormones that affect the development and functioning of brain cells, metabolism, proper development and gestation of the fetus during pregnancy | iodized salt, seafood, cod liver oil, fruits, vegetables |

Also, it should be noted that some microelements entering the body in doses exceeding the norm can cause poisoning. The standards do not allow the content of elements such as lead and arsenic in products, and the amount of tin and copper minerals is strictly standardized[12]. In practice, the amount of minerals in a food product is determined by the amount of ash remaining after complete combustion of the product[13]. Since the starting raw material for the production of apple chips is apple fruits, it is necessary at the stage of selecting such raw materials to investigate the presence of various toxic elements, pesticides and other substances that can pass into processed products and have a negative effect on the consumer’s body. Requirements for the safety of fruits and their processed products on the territory of countries included in the Eurasian Economic Space, which includes Kazakhstan, are laid down in the Technical Regulations of the Customs Union 021/2011 “On the safety of food products”[12], as well as standards for the content in fresh apples radionuclides, toxic elements, pesticides, helminth eggs and intestinal pathogenic protozoan cysts, in accordance with state regulations that have adopted the GOST 34314-2017 standard[14]. In this work, we examined the content of pesticides and nitrates in selected samples of apple varietiesк.

## EXPERIMENTAL METHODS

As samples for studying the chemical (nitrates and pesticides) and mineral composition, 5 varieties of apples were selected, grown on the farm of DALA-FRUIT.KZ LLP, operating in the Sairam district of the Turkestan region and stored in its own fruit storage facilities . Samples of Idared, Granny Smith, Nicole Granny, Fuji and Golden apple varieties were tested:

1) for mineral composition in the certified testing regional engineering laboratory "IRLIP" SKU named after. M. Auezova, based on application No. 727, dated March 2, 2021[15]. The quantity of each sample is 0.5 kg. The samples were burned in a muffle furnace to produce ash, in which the mineral composition was determined by the X-ray spectral method using a scanning electron microscope. The results for each apple variety are shown in Figures 1-5.

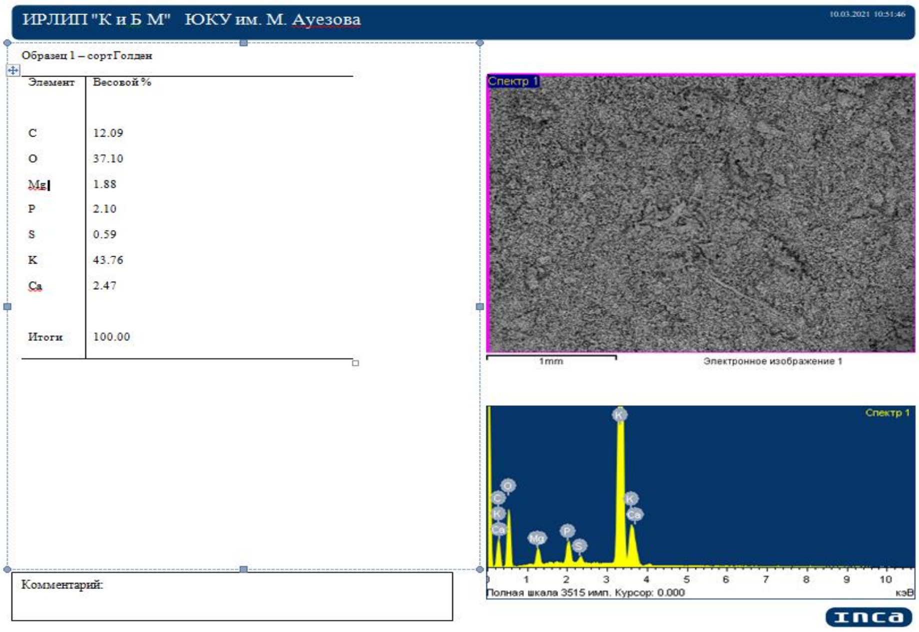



Fig. 1. Mineral composition of Golden apples

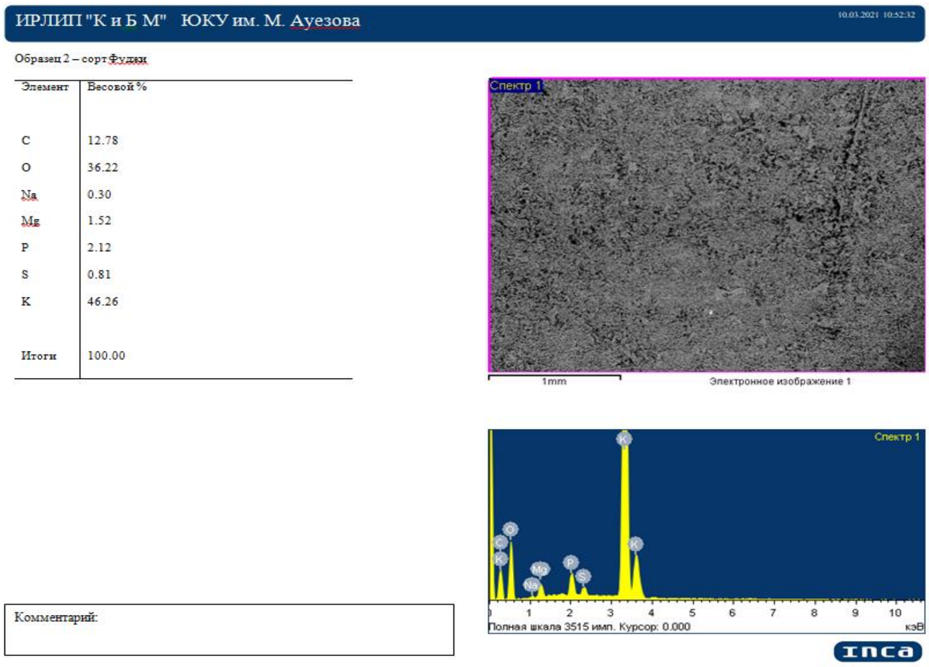
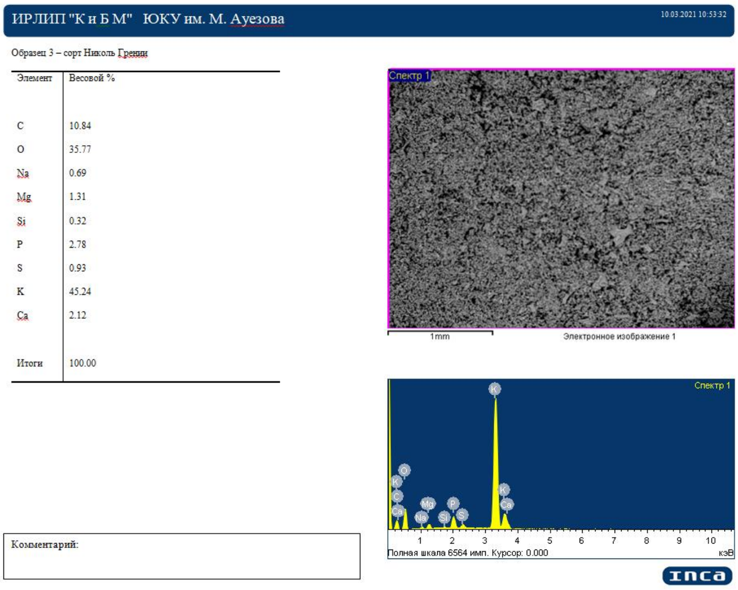
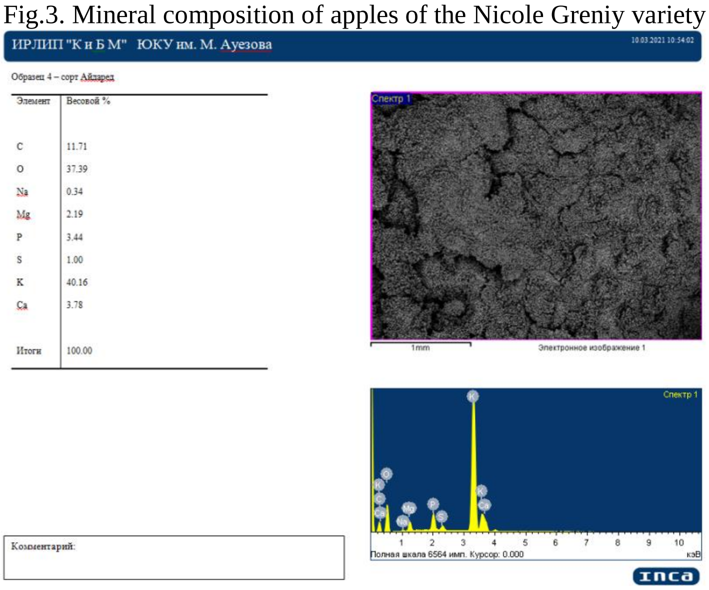



Fig. 2. Mineral composition of Fuji apples



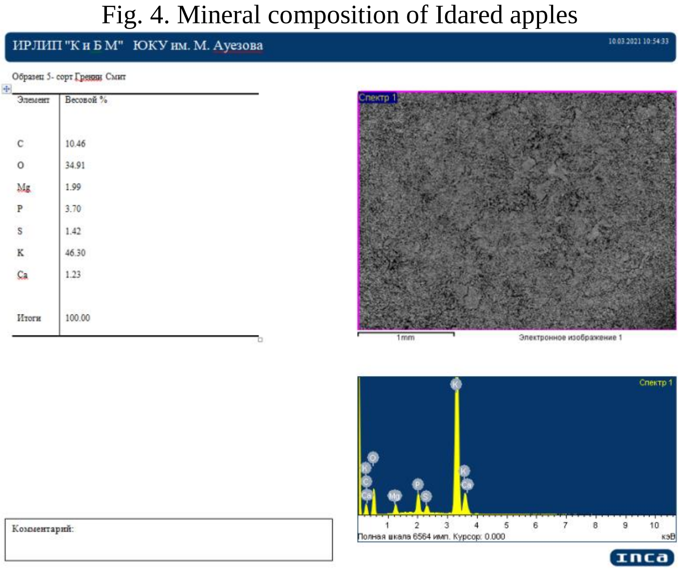

| Элемент | Весовой % |
|---|---|
| C | 10.84 |
| O | 35.77 |
| Na | 0.69 |
| Mg | 1.31 |
| Si | 0.32 |
| P | 2.78 |
| S | 0.93 |
| K | 45.24 |
| Ca | 2.12 |
| Итоги | 100.00 |

Fig.3. Mineral composition of apples of the Nicole Greniy variety




| Элемент | Весовой % |
|---|---|
| C | 11.71 |
| O | 37.39 |
| Na | 0.34 |
| Mg | 2.19 |
| P | 3.44 |
| S | 1.00 |
| K | 40.16 |
| Ca | 3.78 |
| Итоги | 100.00 |

Fig. 4. Mineral composition of Idared apples




| Элемент | Весовой % |
|---|---|
| C | 10.46 |
| O | 34.91 |
| Mg | 1.99 |
| P | 3.70 |
| S | 1.42 |
| K | 46.30 |
| Ca | 1.23 |
| Итоги | 100.00 |

Fig.5. Mineral composition of Granny Smith apples

2) Determination of nitrates and pesticides content. We selected samples of apple varieties from the farm "DALA-FRUIT.KZ" LLP, which operates in the Sairam district, Karasu rural district, Aiteke bi village, Turkestan

region. Samples of 5 apple varieties - Idared variety, Granny Smith variety, Nicole Granny variety, Fuji variety, Golden variety - were tested for elements such as pesticides, mg/kg (HCCH (α, β, λ-isomers, DDT and its metabolites). The analysis was carried out in an accredited testing laboratory of the branch of the RSE at the PPV "National Center of Expertise" of the KKBTU Ministry of Health of the Republic of Kazakhstan in the Turkestan region, located in the city of Shymkent. Pesticides were determined in accordance with ST RK 2011-2010. Water, food, feed and tobacco products. Determination of organochlorine pesticides chromatographic methods [16].

The next elements, the content of which is standardized in the original apple raw material, are nitrates. We analyzed samples of 5 varieties of apples - the Idared variety, the Granny Smith variety, the Nicole Granny variety, the Fuji variety, and the Golden variety. The analysis was also carried out in the accredited testing laboratory of the branch of the RSE on the PVC "National Center of Expertise" of the KKKBTU of the Ministry of Health of the Republic of Kazakhstan for the Turkestan region.

## RESULTS AND DISCUSSION

1) Based on the test results, a comparative table 2 was built for the content of mineral elements in weight %, 5 varieties of apples.

Table 2 – Mineral composition of apple varieties, in weight %, DALA-FRUIT.KZ LLP

| Apple variety | K, mg % | Mg, mg % | P, mg % | Ca, mg % | Na, mg % | S, mg % | C, mg % | O, mg % |
|---|---|---|---|---|---|---|---|---|
| Golden | 43,76 | 1,88 | 2,1 | 2,47 | - | 0,59 | 12,09 | 37,10 |
| Fuji | 46,29 | 1,52 | 2,12 | - | 0,30 | 0,81 | 12,78 | 36,22 |
| Nicole Greney | 45,24 | 1,31 | 2,78 | 2,12 | 0,69 | 0,93 | 10,84 | 35,77 |
| Idared | 40,16 | 2,19 | 3,44 | 3,78 | 0,34 | 1,00 | 11,71 | 37,39 |
| Granny Smith | 46,30 | 1,99 | 3,70 | 1,23 | - | 4,42 | 10,46 | 34,91 |

As can be seen from Table 2, almost all varieties of apple samples are rich in potassium content, the least amount in the Idared variety (40.16 mg%), at the same time, the Idared variety is ahead of other varieties in terms of magnesium content, and the least in the Nicole Granny variety. The Granny Smith and Idared varieties are rich in phosphorus; the Golden variety has the least phosphorus. The Adared variety surpasses all varieties in calcium content - 3.78 mg%, the least of it is in the Granny Smith variety, sodium is found only in the Fuji, Nicole Granny (twice as much as the others) and Idared varieties. In terms of sulfur content, the Granny Smith variety is the leader - 4.42 mg%, the least is in the Golden variety - 0.59 mg%, the carbon and oxygen content in almost all varieties is the same. Of all the apple varieties taken as samples for research on the content of mineral elements, the Idared variety is the richest.

2) According to the requirements of Appendix 3 of the technical regulation TR CU 021/2011 “On the safety of food products”, section Hygienic safety requirements for food products, 6. Fruit and vegetable products, the content of pesticides HCH (α, β, γ isomers), mg/kg, should not exceed 0.05, DDT and its metabolites - 0.1.

According to the test reports shown in Figure 6, no pesticides were found in any sample of 5 varieties of apples from the farm "DALA-FRUIT.KZ" LLP, which indicates the environmental friendliness of growing apples at this farm.

TR CU 021/2011 imposes requirements for the nitrate content only in juice products from fruits and vegetables. The results of the analysis of 5 apple samples for nitrate content, presented in the test report in Figure 7, showed their presence in all apple varieties - Idared variety - 16 mg/kg, Granny Smith variety - 18 mg/kg, Golden variety - 21 mg/kg, variety Nicole Granny -17 mg/kg, variety Fuji -19 mg/kg. If we compare with the requirements of TR CU 021/2011 for the content of nitrates in juice products from fruits and vegetables, the norms of which range from 60 to 700 mg/kg, we believe that the content of nitrates in the apple samples we studied is quite low according to the classification group the ability of fruits to accumulate nitrates belongs to the very last, 3rd group. According to hygienic requirements for food products, the maximum permissible standards of nitrates for an adult are no more than 5 mg per 1 kg of body weight, i.e. 0.25 g per person weighing 60 kg, the nitrate content in the studied samples is within acceptable limits.

## CONCLUSION

Thus, according to the results of the research, it was revealed that the apples grown by the farm "DALA-FRUIT.KZ" LLP in the Turkestan region do not contain pesticides, and the nitrate content is within acceptable standards, therefore they can be used as apple raw materials for processing into apple chips.

Conducted studies of the mineral composition of apples grown in the south of Kazakhstan confirm the presence in them of essential minerals important for the body, the content of which, during their subsequent processing, will increase compared to raw materials, as this will be associated with a decrease in the mass fraction of moisture and an increase in the content of dry substances in finished products, in particular apple chips during their production.

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UDC 687.1

## THE EFFECTS OF DIFFERENT TANNING METHODS ON THE FUNCTIONAL CHARACTERISTICS OF LEATHER

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***Abstract***

*This article examines the effect of various synthetic oxidants on the performance properties of the leather of the upper part of the shoe. Synthetic oxidants used in the process of adding the peel by oxidation with chromium were used for the study. The indicators of the strength properties of the cladding are determined. The comparison of the quality of the studied oxidants was carried out by their chemical and analytical parameters, as well as by determining their leather-technological properties. According to the research results, it can be concluded that the quality of domestic synthetic oxidizers is higher than imported ones.*

***Keywords:****leather, technology, oxidation, leather tanning processes, tanning methods, leather properties*

### INTRODUCTION

Tanning is the most common type of genuine leather products that allows processing raw materials, making it suitable for use and eliminating its negative properties. This procedure gives the product strength, elasticity, as well as durability. Now there are both natural and chemical methods of tanning that allow you to achieve decent results. Leather is a natural material made from the skins of various animals. Just as there are no two identical animals, so there are no two identical pieces of skin. These natural features are not defects, but only add uniqueness to each finished product. This is especially true for exotic leather.

Leather processing is probably one of the oldest crafts on earth. Primitive people began to process animal skins many thousands of years ago. This process can be called the very first manufacturing industry. According to archaeologists, the remains of leather clothing that was made in the 13th century BC were found in ancient Egypt. Almost everything was made of leather. Ancient people used primitive shoes to protect their feet: they wrapped their feet with pieces of animal skins and secured them with leather strips or veins. The very first shoes of a person where sandals, which instead of a sale had a plank tied to the foot with leather straps.

## TYPES OF TANNING OF GENUINE LEATHER

Chrome. At the same time, the skin is treated with basic chromium salts. This allows leather products to be soft, elastic and heat resistant. Such products are elastic, elastic and quickly moisturize, easily pass water.

Plant. The use of tannins is based on special tannins that are contained in the bark and leaves of trees. The final product has high thickness, density, water resistance, but low temperature resistance. This method is used in combination with others.

Cubic zirconia. A zirconium compound is used here. This method is designed to produce white leather with high strength and wear resistance, which is not afraid of exposure to water and sweat.

Synthetic. Synthetics give the skin a natural elasticity and an attractive appearance. This method is used in combination with others.

Fat. This method of tanning natural leather is carried out using fish oil, as well as marine animal oil.

Aluminum. Oxidation is based on the effect of aluminum salts. When using this method, they acquire softness and elasticity, but they are afraid of water exposure. The leather goods industry traditionally plays an important role in the country's economy, since in many industries it provides a wide range of leather, wool for the production of products. Therefore, its rapid development contributes to the creation of a large number of innovative materials and technologies.

An important process of skin treatment is oxidation, in which collagen is structured by substances whose molecules can interact with polar groups of polypeptide chains, forming hydrolytic permanent bridges between them. A significant part of oxidants refers to compounds that form complex compounds with active groups of collagen. These are mainly inorganic substances related to basic salts (chromium, aluminum, zirconium) or tungsten, molybdenum, silicon in poly- and heteroacids.

Despite significant technological difficulties and environmental problems associated with chromium oxidation, 80-90% of all leather produced in the world is produced using it. This is due to the high quality of the resulting chrome semi-finished product. However, an urgent task is the development and implementation of technologies and techniques that contribute to the intensification of the oxidation process, the effective use of chemical materials, as well as solving the problems of reducing the content of chromium compounds in waste solutions and the disposal of chromium-containing waste. This is confirmed by numerous publications of foreign and domestic scientists concerning the search for alternative oxidation methods that ensure the quality of the semi-finished products obtained and have a negligible impact on the environment.

In Kazakhstan, Turkish firms (Turan skin) and others are actively working on the market, which offer a wide range of chemical materials for skin treatment.

In the course of the work, domestic and foreign processing technologies will be considered. Hence, we can conclude about the high leather-technological properties of domestic synthetic oxidizers compared to imported ones. In this paper, the influence of various characteristics of synthetic tanning on the working properties of leatherette for street shoes is considered. Synthetic tannins used in the process of secondary tanning of leather by chrome tanning were used for the research. Some factors are long-term, characteristic of the skin. The comparison of the quality of the studied tannins was carried out by their chemical-analytical coefficient, as well as by determining their leather-technological characteristics. As a result of the conducted research, it can be concluded that the quality of two domestic synthetic oxidizers is higher than that of imported ones. It is impossible to draw a conclusion about the higher leather and technological characteristics of domestic synthetic oxides compared to imported ones. The influence of tanning methods on the performance properties of leather has not been studied enough and is practically ignored in the manufacture of shoes. To date, no work has been carried out on a comprehensive study of the consumer properties of leather for the upper of shoes made using various oxidizing agents. Taking into account the quality requirements of the produced skins of new species, the purpose of the addition process has changed significantly.

## CONCLUSIONS

Leather is one of the most valuable and versatile materials for the production of shoes and other leather products. Tanning methods used in different countries have a significant impact on the characteristics and quality of leather products. Let's look at the specifics of these methods in several countries and their impact on the final product. Italy is known for its high-quality leather goods and the art of their manufacture. In Italy, * vegetable tanning* is widely used. This method preserves the natural texture and color of the skin, giving the shoes an elegant and natural look. Italian tanners are also known for their handmade craftsmanship, which makes each shoe unique. These factors highly value Italian shoes in the fashion world.

France pays special attention to the style and aesthetics of shoe production. Synthetic tan is widely used here, which allows shoe designers to experiment with colors and textures. French shoes are known for their great design and attention to detail. This reflects current fashion trends. The UK specializes in * mineral tanning* of leather with a long history of shoe manufacturing. This method makes the shoes durable and stable, which is suitable for both working and agricultural shoes. British brands are known for their durable and reliable shoes designed to be worn in high-load conditions. The USA, like France, offers a wide range of tanning methods depending on specific brands and styles of shoes. It uses synthetic oxidation and chrome plating, which makes it possible to produce sports and casual shoes taking into account the various needs of customers. China, as one of the largest shoe manufacturers in the world, offers many ways to tan. Chinese manufacturers are adapting to different markets, including methods appropriate to their target audience.

It should be noted that the methods of tanning leather vary in different countries, depending on the traditions, styles and purposes of production. Italian shoes are known for their natural elegance, and French shoes are known for their style and fashion.

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UDC 311 (075.8)

# APPLICATION OF THE ISHIKAWA DIAGRAM AS A BASIS FOR QUALITY CONTROL IN THE PRODUCTION OF VEGETABLE OILS


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***Abstract***

*Product quality is the most important indicator of the competitiveness of an enterprise. To reduce costs and achieve a level of quality that satisfies the consumer, methods are needed that are aimed not at eliminating defects (inconsistencies) of finished products, but at preventing the causes of their occurrence during the production process. The use of statistical methods allows us to judge with a given accuracy and reliability the state of the studied phenomena (objects, processes) in the quality system; predict and regulate the occurrence of quality problems; develop optimal management decisions, not on the basis of emotions, sensations and intuition, but on the basis of studying factual data, trends and patterns. The production of low-quality fat and oil products is directly related to the lack of necessary organization and compliance with technological processes in the fat and oil industry. The quality of prepared high-quality fat and oil products is largely determined by the quality of seeds supplied for processing, the timing and conditions of storing seeds before pressing and depending on the technology used and the quality requirements of the final product. The article discusses the use of statistical control methods to assess the quality of vegetable oils. The quality and safety of food products is an important factor in increasing the efficiency of vegetable oil production. The use of statistical methods of quality management allows enterprises to timely identify and eliminate defects that arise during the production process. One such method is the Ishikawa principle. The essence of the Ishikawa principle is that the greatest effect comes from focusing attention and effort on small, critical, vital factors, while minor, numerous factors can be neglected. Using the Ishikawa method, an analysis of inconsistencies in the quality of vegetable oils was carried out.*



***Keywords:*** *fat and oil industry, fat and oil products, edible vegetable oils, quality control tools, statistical method, quality control.*


## INTRODUCTION

Quality control occupies a special place in product quality management. The specificity of the oil and fat industry is that the quality of the finished product is directly related to the quality and safety of the raw materials used. Most enterprises operating in a modern market economy are interested not only in obtaining maximum profit from the sale of their products, but also in improving their quality. Despite the fact that every enterprise is interested in producing products of the highest quality, not a single technology can do without producing products of lower quality, including defects [1].

To increase the efficiency of the organization and the competitiveness of goods and services, statistical methods of quality control have been developed, which are used to analyze the quality of products and processes. Using data obtained from quality analysis and statistical methods, the relationship between accurate and measured quality characteristics is determined. The analysis of the process allows us to establish a connection between causal factors and the results of production activities, such as quality, cost, productivity, profitability. To ensure the smooth functioning of the vegetable oil production process, it is necessary for enterprises to monitor the process. The main results of the control process are quality, cost and labor productivity[2].

Statistical control of product quality and technological processes for its production is one of the most important components of product quality management in the production process. The most advanced and rational ways of organizing such control are based on the use of statistical methods. These methods are one of the main management tools and have remained relevant for many years. In the consumer market, the decisive role belongs to large enterprises and companies, of which preference is given to regional representative offices. The advantage of these campaigns is manifested in lower production costs, the ability to ensure environmental safety, deep complex processing of raw materials with minimal losses, as well as investment in the production of oils and in the development of new equipment and technologies. In recent years, in the Republic of Kazakhstan there has been a trend towards consolidation of agricultural production and the consolidation of all parts of the food market.

## EXPERIMENTAL METHODS

Increasing the technical level in the oil and fat industry and the quality of products is the main source of increased production efficiency. Under the influence of scientific and technological progress, various innovative processes occur, the development and improvement of all elements of the productive forces: means and objects of labor, labor, technology, organization and production management. Technical and economic developments involve the selection of the most promising developments from an economic and technical point of view.

To ensure the most important requirements for quality parameters, it is necessary to systematically monitor product quality. It is obvious that systematic control cannot be continuous, otherwise its labor intensity would exceed the labor intensity of production. This is where the need arises for statistical methods that make it possible to control the quality of products, judge the quality of the technological process and regulate it. The key quality control methods include the following: – check sheet, – histogram, – scatter diagram, – Pareto diagram, – Ishikawa diagram, – control chart, – stratification [2].

The above methods can be used as separate quality control tools, and can also be considered as a system within the framework of comprehensive quality control. The use of statistical methods contributes to understanding the variability of quality indicators, and helps to improve the effectiveness and efficiency of decisions made. The algorithm for introducing statistical methods and statistical control includes the following stages, shown in Figure 1.

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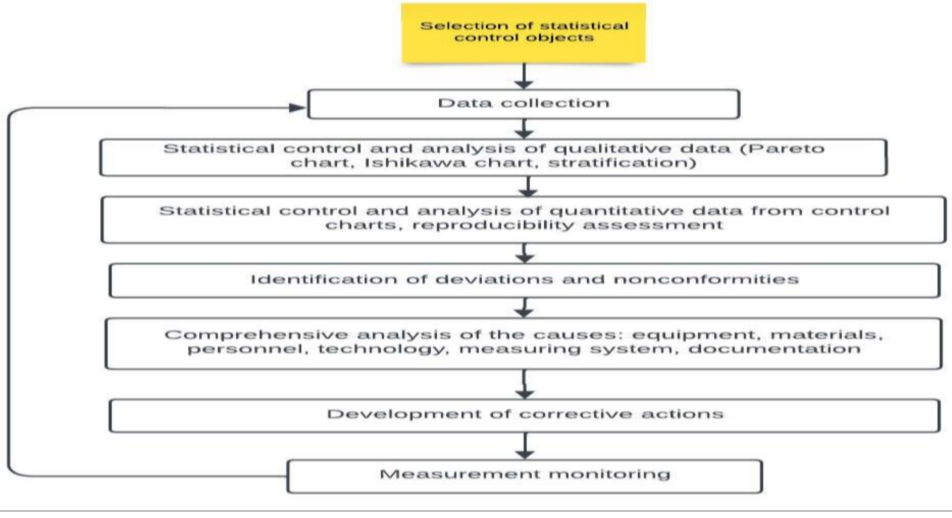


Fig. 1. Statistical control algorithm

The choice of object of statistical control in our case is the production site. Statistical analysis of the technological process uses the results of technical control of vegetable oils based on quantitative characteristics, obtained during selective control, with the subsequent calculation of statistical characteristics by which a decision is made on the state of the technological process. After data collection, statistical analysis of qualitative data must be carried out.

## RESULTS AND DISCUSSION

Thus, the current level of development of scientific and technological progress allows us to place high demands on the technical level and quality of products as a whole and their individual elements. A systematic approach allows you to objectively select the scale and direction of quality management, types of products, forms and methods of production that provide the greatest effect of the efforts and funds spent on improving product quality. One such method is the cause-and-effect diagram or Ishikawa diagram.

A cause-and-effect diagram is a graphic image that, in a compact, logically ordered form, displays the influence of various causes, factors, and events on the final result of a process. It is compiled to identify the causes of non-compliance of products with specified parameters. Using Ishikawa's scheme, it is possible not only to determine the composition and interdependence of factors influencing the object of analysis, but also to identify the relative importance of these factors [3].

Based on the research we conducted, we constructed a cause-and-effect diagram, which identified significant factors that contribute to increasing competitiveness and improving the technology for the production of vegetable oils (Figure 2).

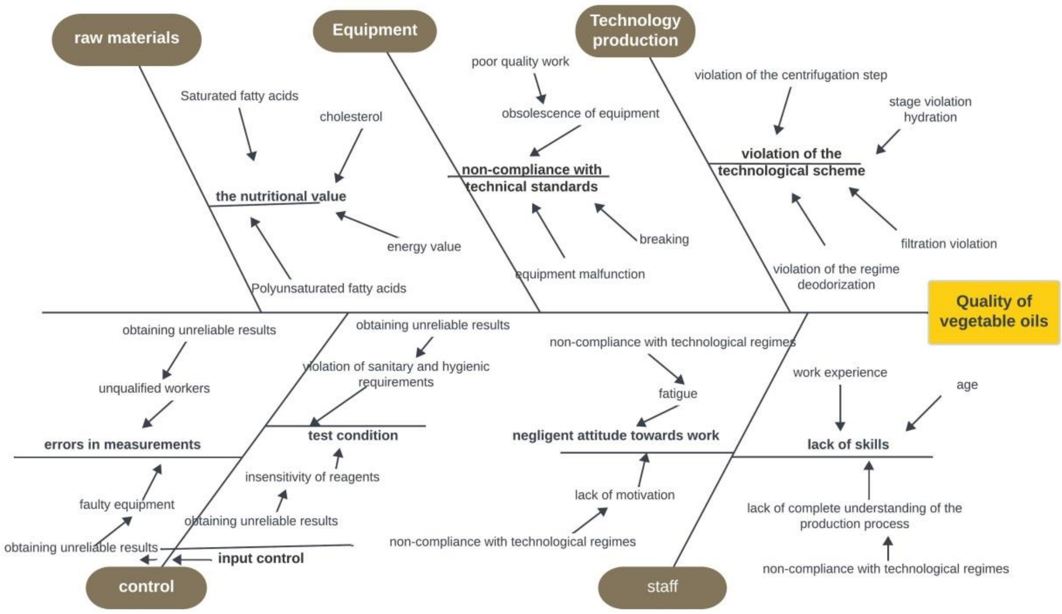


Fig. 2. Ishikawa diagram

## CONCLUSION

The problem under study is increasing competitiveness and improving technology for the production of vegetable oils. The reasons are divided into five key categories - raw materials, equipment, production technology, control (measurement), personnel. The main reasons that reduce the quality and competitiveness of vegetable oils are:

1. Raw materials. The quality of vegetable oils mainly includes taste, smell, color, transparency, sediment, density, refractive index, acid and iodine numbers, saponification number, the presence of unsaponifiable substances and a number of other factors. Vegetable oils have high antioxidant properties, helping to maintain a healthy and youthful body. Vitamins A and E contained in vegetable oil have antioxidant properties and protect cells from damage by free radicals, which reduces the risk of chronic diseases. Vegetable oils have health benefits. They are rich in unsaturated fatty acids, vitamins and some antioxidants. The groups of unsaturated fatty acids that make up vegetable oil are very important for the human body: Omega-6 and Omega-3.

2. Equipment for the production of vegetable oils must be selected taking into account modern requirements. The use of outdated equipment reduces worker productivity, which leads to the production of low-quality products. 3. Production technology. If the technological scheme for the production of cottage cheese is violated, defects in taste, smell, and consistency may occur, which significantly affects the competitiveness of the finished product.

4. Control (measurements). The quality of finished products supplied to the consumer may be affected by measurement errors, such as obtaining incorrect results, using faulty equipment when assessing the quality, and conducting inspections by unqualified personnel.

5. Personnel is a subjective factor on which the quality of the finished product depends. In this case, it is necessary to take into account both the professional level of training, attitude towards work, and the socio-psychological climate at work. The use of statistical methods allows us to better understand the variability of the production process and, therefore, help enterprises in solving problems of improving the quality and competitiveness of their products.Thus, statistical methods are very easy to use and are an effective way to determine the cause of

defects[3].Using statistical methods, it is possible to manage non-conforming processes and products at all stages, from obtaining resources to selling finished products to the consumer. Also identified are the reasons in the graphical displays in the relationship between the problem being solved and the reasons influencing its occurrence, which affect increasing competitiveness and improving the technology for the production of vegetable oils.

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# SELECTION OF STATISTICAL METHODS IN THE SYSTEM OF CONTROL AND QUALITY MANAGEMENT OF FAT PRODUCTS BY THE EXAMPLE OF «SHYMKENTMAY» LLP


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***Abstract***

*The most important condition for the successful development of enterprises producing edible vegetable oils today is the production of competitive products. The basis of competitiveness is quality. Product quality is one of the most important indicators of production and economic activity of industrial enterprises. Improving the quality of products largely determines the pace of scientific and technological progress and becomes one of the main levers for increasing production efficiency, saving material and financial resources, and raising the level of people's well-being. The key point determining successful quality management at the present stage of development of all industrial enterprises is the use of quantitative methods based on statistical data analysis, which ensures objectivity in assessing the situation and making the right decisions by managers. Currently, product quality control at Kazakh enterprises is aimed only at eliminating the consequences of identified inconsistencies, i.e., defective products already received, which leads to irrational use of financial resources. Statistical methods make it possible to solve one of the main problems in product quality control - to prevent the appearance of defective products in advance and to use the least expensive control mechanisms - selective control, on the basis of which an analysis is made of both the product batch and the technological process as a whole. This allows for statistical regulation of all stages of the technological process and taking preventive actions to eliminate the cause of defects.*



***Keywords:*** *statistical methods of control, quality, oil and fat industry, edible vegetable oils, statistical analysis, choice, non-conformity, defective products, production technology*


## INTRODUCTION

Consumer surveys show that among all indicators of the competitiveness of edible vegetable oils, which primarily include price, delivery time, service, etc., the quality of oils determines the decision to choose products by 70%. The development of the common Eurasian market and the entry of the Republic of Kazakhstan into world trade markets intensifies competition among manufacturers, as this allows the buyer to choose goods from almost all global manufacturers. In such conditions, only those who provide high quality of their product at a friendly price for the client survive [1].

All these factors contribute to the development of quality management systems, methods and tools, the use of which allows us to systematize all work in the field of quality improvement, placing them on a scientific basis with increasing production efficiency. Quality tools make it possible to objectively assess the wishes of consumers, transform them into product requirements, establish production capabilities, find weaknesses that prevent the achievement of the required quality, correctly select corrective and preventive actions, assess the satisfaction of consumers and other participants in this production and outline ways for its development.

Today, in the quality management of food industry enterprises, a certified quality management system is important, which is a guarantee of high stability and sustainability of product quality. A quality system certificate allows producers of oil and fat products to maintain a competitive advantage in the market. In industrialized countries, many industries have quality management systems that successfully ensure high quality and competitiveness of products [2].

For Kazakh enterprises in the oil and fat industry, oriented towards international markets and striving to compete on equal terms with Western companies, certification for compliance with international standards is of fundamental importance. The key point determining successful quality management is the use of quantitative methods based on statistical data analysis, which ensures objectivity in assessing the situation and making the right decisions by managers. Therefore, the task of developing methods for quality control and management based on statistical methods for manufacturers of edible vegetable oils is relevant.

Statistical methods for quality control began to be created at the beginning of the 20th century. The methodological basis for quality assurance is the ISO 9000 series standards of the international organization for standardization. In accordance with the requirements of the standards, a quality management system must be created in the organization. A quality management system is a set of interacting processes of an organization and methods (tools) for their implementation. Such tools are methods of mathematical statistics, which is due to the statistical nature of information generated in various processes.

To increase production efficiency and the quality of products, it is necessary to introduce complex systems and technical means based on statistical methods of product quality management. In such control systems, statistical methods provided by software systems make a significant contribution to the collection of information on the quality of products and equipment operation at all stages of production, on the quality of labor of departments and individual performers [4,5].

Statistical methods, first of all, identify defective products, which are separated from quality products. Of course, it is clear that product quality cannot be improved by rejecting low-quality products even when using continuous control, which in turn is very expensive and does not absolutely guarantee the absence of inconsistencies in the accepted products. In some cases, it is no longer possible to correct the defect. Such reasons confront manufacturers with the need to switch to selective control using methods of mathematical statistics and probability theory. These methods allow for reliable quality assessment without using continuous control for all manufactured products and without spending money on identifying defects. These methods, on the contrary, allow you to focus on the prevention of defects and careful control of the production process and conduct your activities in accordance with the concept of “quality assurance”[6].

Analysis of all production operations of product release using scientific processing of observation results, i.e. numerical data obtained during the quality control process is the basis for ensuring product quality using statistical control methods. The use of statistical methods can help in understanding variability and can therefore help in solving problems and improving efficiency and effectiveness. These methods also promote better use of available data to support decision making. Statistical methods can help measure, describe, analyze, interpret and model such variability even with relatively limited data. Statistical analysis of such data can help to better understand the nature, extent and causes of variability, thereby facilitating the resolution and even prevention of problems that may result from such variability, as well as continuous improvement[7].

The study of product quality begins with analysis, with the help of which data on product quality indicators are examined and, based on statistical methods, the relationship between the exact and replaced quality characteristics of the product is determined. Process analysis is an analysis that identifies the relationship between the causal factors of process nonconformity and its results, such as the quality of all stages of the process, cost, productivity, etc. Statistical process control allows you to identify the causal factors of nonconformities that negatively affect the smooth functioning of the production process. Results such as high quality, low cost and high productivity are the results of the statistical control process[3,4].

One of the effective statistical methods is the Pareto chart, the advantage of which is that maximum effect can be achieved with a minimum amount of work. This will allow your team to work more efficiently and focus on specific initiatives. With the help of analysis, you can identify them with maximum accuracy and not spend most of your time doing routine, useless work. You will know exactly which processes are worth your time, but analysis also takes some time, don’t forget about it. The Pareto chart is an opportunity to focus efforts and resources on eliminating the most significant problems. Just like other quality tools, it is easy to use and understand by organizational staff. The use of the Pareto chart helps to increase technological discipline and reduces the number of defective products supplied to the consumer to an acceptable level; the risk to which the consumer and supplier are exposed is specified in advance in regulatory documents.

## EXPERIMENTAL METHODS

The construction of a Pareto diagram involves the selection of factors that shape the quality of vegetable oils, these include raw materials and production technology. To identify the main elements of constructing a Pareto diagram for the production of edible vegetable oils, it is necessary to analyze the range and quality requirements of the finished vegetable oil. In accordance with GOST 30623, vegetable oils, depending on their fatty acid composition, are divided into groups depending on the raw materials used. Table 1 shows the main types of edible vegetable oils produced by enterprises.

Table 1 - Characteristics of edible vegetable oils

| Assortment of edible vegetable oils | Raw materials | Types | Variety | Brand |
|---|---|---|---|---|
| Sunflower vegetable oil | sunflower seeds | unrefined | first class | |
| | | refined non-deodorized | - | |
| | | refined deodorized | | grades "P" and "D" |
| Vegetable cottonseed oil | Cotton seeds | refined non-deodorized | first class | - |
| | | refined deodorized | first class | - |
| Vegetable soybean oil | Soybean seeds | refined, undeodorized, unbleached | | |
| | | refined deodorized | - | - |
| Vegetable safflower oil | Safflower seeds | unrefined | first class | - |
| | | refined non-deodorized | - | - |
| | | refined deodorized | - | - |
| Vegetable rapeseed oil | Rapeseed seeds | refined deodorized low-eruk | - | grades "P" |

*Requirements for raw materials.* To produce oils, vegetable oils should be used:

- sunflower seeds according to GOST 22391;
- technical cotton seeds in accordance with GOST 30446;
- soybean seeds according to GOST 17109;
- safflower seeds according to GOST 12096;
- rapeseeds according to GOST 10583.

Raw materials used for the production of vegetable oils must comply with the requirements of current regulatory documents on standardization and are permitted for use by the State Sanitary and Epidemiological Supervision Authority of the Republic of Kazakhstan, and must also be accompanied by documents confirming their quality (certificates of quality or conformity, laboratory test reports, etc.).

The development of a list of products subject to incoming control, depending on the importance of raw materials and materials, as well as the technical capabilities of the enterprise, is carried out using one of two methods:

-external inspection of products, condition of packaging and labeling, availability of necessary accompanying documents and identification of established requirements and accompanying documentation. In this case, the products must be accompanied by a shipping document; passport, quality certificate and certificate of conformity (if necessary);

-measurement of technical characteristics.

Incoming control begins with inspection and assessment of the condition of incoming raw materials and materials and its compliance is established compliance of the number of packaging units and names with the packing list and purchase contract; availability of a passport, quality certificate and certificate of conformity (if necessary). Incoming control is carried out by the head of the quality control process, and, if necessary, together with the chief technologist, production director, and shop managers.

The results of incoming control are recorded in a journal and brought to the attention of the head of the procurement process.

The head of the procurement process, together with the legal adviser, draws up documents and a message for filing a complaint with the supplier or transport organization, and if necessary, their representative is called.

Purchased products that have passed the incoming inspection are subject to further use in production.

In case of non-conformity of products based on the results of incoming inspection, the head of the quality control process writes a report to the production director with proposals for its further use. The production director, by imposing a resolution on the report, makes a decision on the possibility of using this product for its intended purpose. The warehouse manager isolates products that are unsuitable for use in a specially designated place in the warehouse and attaches a tag with the inscription “Defective, cannot be corrected.”

The next element when constructing a Pareto diagram for the production of edible vegetable oils includes control over compliance with technological processes. This control is carried out according to the following algorithm:

Quality control during the production process is carried out in the following production units and processes:

- *Raw materials department.* Quality control of oilseed raw materials and storage conditions in warehouses is carried out according to the control scheme.
- *Preparatory workshop.* Quality control of oilseeds in the preparatory workshop is carried out according to the control scheme;

- *Extraction shop*. Quality control in the extraction shop is carried out according to a control scheme.
- *Refining shop.* Quality control in the refining shop is carried out according to a control scheme.
- *Deodorization workshop.*Quality control in the deodorization workshop is carried out according to a control scheme.Quality control of acceptance of fatty raw materials and auxiliary materials is carried out according to the control scheme.
- Fat distillation workshop. Quality control in the distillation shop is carried out according to the control scheme.
- Soap shop. Quality control in the soap making workshop is carried out according to the following scheme.
- Site of fat breakdown. Quality control in the splitting shop is carried out according to the scheme.
- Fat hydrogenation area. Quality control in the hydraulic workshop is carried out according to the scheme.
- Wastewater treatment area. Quality control of wastewater treatment is carried out according to the scheme.

## RESULTS AND DISCUSSION

The head of the quality control process develops a Pareto chart based on quality control of finished products, in accordance with regulatory documentation. If a defect is detected at any stage of the product life cycle according to this diagram, a procedure is provided for managing nonconforming products.

Nonconforming products can be classified according to the following criteria:

*At the place of discovery on:*

- defects detected inside the workshop at the stage of the technological process;
- a defect established on the basis of complaint messages.

*According to the nature of the detected defects:*

- fixable marriage;
- irreparable marriage (final).

*For reasons of marriage:*

- defects caused by objective reasons (independent of the personnel);
- marriage caused by subjective reasons (human factor).

It must be remembered that the main task of any production process is not only to increase the quality of the product, but to increase the quantity of usable products.

There are two main concepts used in quality control of the Pareto chart:

1. Measurement of controlled parameters. In statistical control, in order to judge the quality of products, it is not necessary to measure parameters such as the strength of the material, paper, weight of the object, coloring quality, etc.

2. Distribution of controlled parameters. It has been proven that the distribution of the values of the controlled parameter is based on the fact that there are no two parameters of the same products that are absolutely identical in value, since with more accurate measurements, small discrepancies are found in the measurement results of the parameter.

There are 2 types of variability of the controlled parameter:

1. When its values constitute a set of random variables formed under normal conditions;

2. When the set of its random variables is formed under conditions different from normal under the influence of certain reasons.

Since, in this work, research was carried out on the possibility of using statistical methods to assess the quality of production of edible vegetable oils, an analysis was carried out according to the Pareto principle of the statistical method [3].

The Pareto chart is an effective and simplest method of quality analysis. It allows you to identify the reasons influencing the deterioration in quality. The diagram is based on the Pareto principle: a few serious errors or unfavorable factors create the majority of the problem. Hence the conclusion: to effectively improve quality, it is necessary to identify several of the most important ones from among the many problems and begin work by eliminating them. It is usually believed that 3-4 serious miscalculations cause 70-80% of problems.

The Pareto diagram is constructed as follows: a general analysis of the causes is carried out, for example, the number of failures is recorded and the reasons for the failure are determined, a diagram is constructed (on the X axis - the reasons, on the Y axis - the number of failures generated by each reason, and the reasons are arranged in ascending order number of failures)

Currently, we consider the most frequently used, simpler and more visual of the statistical methods to be the use of control charts for statistical control of technological processes in the production of edible vegetable oils.

## CONCLUSION

Thus, at the enterprise, the current quality management system for various processes makes it possible to identify defects, but does not allow them to be prevented, which leads to significant material losses. For this purpose, there are statistical methods of quality management, both technological processes and products in general. Our research will develop a mechanism by which manufacturers can anticipate defects in advance and eliminate the cause, rather than the consequences, of nonconformities. The Pareto diagram method can be used in the operations of incoming control of raw materials, materials, components of the product, during operational control and control of finished products. In statistical quality control, the same results, processed by the Pareto chart method, make it possible to assess the true state of the technological process with a high degree of reliability.

Statistical methods make it possible to reasonably establish a process disorder even when two or three units selected for control turn out to be suitable, since they are highly sensitive to changes in the state of the technological process. Consequently, statistical control of product quality has two goals: firstly, to organize the production process so that the proportion of defective products is minimal; secondly, to exclude the possibility of sending a batch with a high percentage of defects to the consumer. The first goal can be achieved by organizing and conducting statistical regulation of the technological process, the second - by organizing and conducting acceptance control. In production, statistical control methods are used at all stages of the product life cycle.

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## APPLYING OF VEGETABLE OIL WITH LOW GLYCIDIL ESTERS CONTENT IN PRODUCTION OF DAIRY PRODUCTS


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***Abstract***

*The production of edible vegetable oils includes refining and deodorization processes. In these processes, new components that negatively affect human health are formed in the oils produced. One of them is glycidol esters with fatty acids. The negative effect of these components on the human body is that they are transformed into free forms with carcinogenic, mutagenic and toxic properties in the processes of high-temperature treatment.*

*In this article the modern experience of eliminating precursors of the formation of glycidyl esters in oils from vegetable oils was analyzed, and on this basis, a technology was developed to reduce the content of glycidyl esters in vegetable oil from sunflower seeds. The results of studies on minimizing the formation of glycidyl esters in refined vegetable oils from sunflower seeds have shown that a decrease in the content of glycidyl esters in oils is achieved by washing them with 90% ethanol.The paper also provides a developed technological scheme for the production of cottage cheese products using vegetable oils from flax seeds and sunflower seeds. The composition of cottage cheese products is enriched with ingredients obtained from grape seeds isolated by water-alcohol extraction. In order to exclude the separation of the vegetable oil used from the curd mass, flower pollen has been added to the composition of the product being developed, which also additionally enriches the product being developed with useful elements valuable for the human body.*


***Keywords:*** *vegetable oils, refineries, deodorization, glycidol, glycidyl esters, dressing, curd product.*

## INTRODUCTION

Implementation of adequate human nutrition implies meeting the population’s needs for high-quality and safe food products, including fermented milk products. Among fermented milk products curd products are of greatest interest for research, since they are consumed by all categories of people and are in stable demand among consumers.

In [1], based on the results of many years of large-scale research, the desirability of replacing animal fats with vegetable oils in these products is proved.

The main reason for the desirability of replacement is that saturated fats in animal products increase the cholesterol level in the blood of the person who consumes such products. Moreover, in addition to reducing the risk of human illness, replacing animal fats with vegetable fats makes the product cheaper, and also expands the range of dairy products produced.

However, during the production of high-quality vegetable oils, carcinogenic compounds of glycidyl ethers are formed during their high-temperature heat treatment. They are mainly formed during the processing of vegetable oils at the refining stage (at the deodorization stage) at temperatures of 180-270ºC.

In this aspect, the European Union Commission Regulation "Establishment of maximum levels for the determination of contaminants in food products" No. 1881/2006 of 19.12. In 2006 (as amended in 2018), standards for the amount of glycidyl esters of fatty acids were established, the content of which in vegetable oils intended for direct consumption, in terms of glycidol glycidyl esters, should not exceed 1.0 mg/kg [2].

In the Republic of Kazakhstan, these Regulations are in power, so the development of effective technologies to reduce the content of glycidyl ethers in vegetable oils is relevant. In this regard, this study set the goal of developing a technology for vegetable oil from flax seeds and sunflower seeds with a reduced content of glycidyl ethers and developing a technology for the production of a new enriched curd product on this basis.

To achieve the goal of scientific research, research work was carried out to improve the processes of refining vegetable oils produced from flax seeds and sunflower seeds and its use in the developed curd product.

In practice, when addressing the issue of reducing the content of glycidyl esters of fatty acids in vegetable oils, the fourth stage is of greatest relevance - the stage of bleaching and deodorization, and from it - deodorization. This is explained by the fact that glycidyl ethers are formed as a result of chemical reactions at temperatures above 140ºC, and the deodorization process is carried out at temperatures above 180ºC by steam distillation. During the remaining 3 stages - removal of sticky substances, removal of free acids and decolorization, the formation of glycidyl esters does not occur.

Research by Oey S.B. [3] identified the main ways to reduce contamination of vegetable oils.

By comparing different vegetable oils, the researcher found that the content of diacylglycerol, due to which more of their 3-MCPD, 3-MCPD and glycidyl esters are formed, are palm and olive oils. Therefore, the main ways to reduce contamination of vegetable oils Oey S.B. refers to the elimination of possible and existing contaminants before refining; control of bleaching, neutralization and deodorization processes during oil refining. And in order to reduce the formation of 3-MCPD, 3-MCPD and glycidyl ethers in vegetable oils, it is necessary to use as little diacylglycerol as possible during the refining process.

The results of studies by O. Ozdikicierler, B.D. Craft and their co-authors established that the formation, composition and amount of glycidyl ethers strongly depend on the temperature conditions of the oil refining process [4, 5].

Based on this, O. Ozdikicierler achieved a reduction in the formation of 3-MCPD and glycidyl esters in olive oil by optimizing the operating parameters of steam distillation - the optimal steam distillation temperature is 230 ° C; pressure - 4 mbar, water flow - 1.2 ml/min.

Similar data in research aimed to improve the technology of refining and deodorization of sunflower oil, depending on temperature levels, were obtained by experimental studies by O.K. Yunusov and Z.A. Kodirova [8]. These researchers found that deodorization of sunflower oil must be carried out by periodic deodorization for 85-90 minutes at a superheated steam temperature of no higher than 230 $^0$C and a pressure in the deodorizer of no more than 2-3 mmHg.

Yunusov O.K. [6, 7] determined the optimal conditions for refining sunflower oil.

To comply with the minimum content of glycidyl esters of fatty acids in vegetable oils, which are established by the Regulations of the European Union Commission, the researcher recommends using an alkali solution with a concentration of 150 g/l with an excess of 30%. At these conditions the yield of refined sunflower oil is 94.3%, the acid value is 0.18 mg KOH and the color value is 25 mg iodine.

The most complete work on minimizing the formation of glycidyl ethers in refined vegetable oils was carried out in [8, 9].

The main results achieved in the work is the reduction of glycidyl ether precursors - chlorine and acylglycerides, which is achieved by washing vegetable oils before deodorizing. The researchers selected the following solvents: water, ethanol 90% and ethanol 75% with an oil to solvent ratio of 2:1. Phase separation is recommended to carried out at a temperature of about +40°C.

## EXPERIMENTAL METHODS

Physico-chemical composition, nutritional and physiological value is carried out using standard research methods.

The following materials have been selected for production of curds using vegetable oil with a low content of glycidyl ethers: cow's milk; vegetable oil from flax seeds and sunflower seeds; grape seed extracts; a curd product made from cow's milk.

Determination of such physical and chemical indicators of vegetable oils as moisture, volatile substances, acid number, iodine number was carried out using standard measuring and analytical instruments in accordance with the requirements of regulations in force in the Republic of Kazakhstan.

The determination of mineral content using atomic absorption spectrometry was carried out in Regional engineering testing laboratory of M.Auezov SKU; content of fatty acid esters and glycidyl esters of fatty acids identified by enzymatic hydrolysis; composition of fatty acids was analyzed using a Kristall-4000 gas-liquid chromatograph with a flame ionization detector and processing with the NetChrom program.

Many works have been devoted to the development, improvement of production technologies and enrichment of the composition of cottage cheese and curd products, of which the following are of greatest interest.

E.K. Grishkevich [9] considers general trends in the improvement of curd products.

The positive results of E.K. Grishkevich are achieved on the basis of their enrichment with iodine-containing substances. The disadvantage of the work is that the results of the study do not cover the principles of replacing animal fat in cottage cheese products with vegetable oils.

Improving the technology of curd products and composition of curd mass is carried out in dissertation work of O.E. Khodyreva. [10]. The author selects plants that are recognized sources of essential macro- and micronutrients as enrichment components. A positive result is achieved by using low-fat cottage cheese, Jerusalem artichoke paste and stevioside as a sweetener.

However, the disadvantage of the work is that O.E. Khodyreva considers only technologies for improving glazed curd cheeses and ice cream, which reduces the value of this research.

T.Yu. Gorokhova [11] developed the composition of the formulation of low-fat curd products obtained by the acid-rennet method. The researcher showed the possibility of using a complex flavoring filler: dried apricots, fruits and berries in the form of pieces and cocoa powder to enrich the composition of low-fat curd products.

The way to achieve uniformity of different curd products is shown in the work of Imangalieva Zh.K. [12]. The homogeneity of curd mass is achieved at the grinding stage.

What is of interest in this work is that the flavor additive (pumpkin puree) was added to the product being developed in a finely dispersed state in an amount of 5 to 20% of the volume of the curd mass.

In works [13, 14] authors make contribution to formation of functional properties and organoleptic characteristics of curd products through widespread use of food additives. For this purpose, they add various herbal additives and natural ingredients of plant origin to curd products, such as milled grain, dietary fiber, fruit, berry, and vegetable fillers, enriching these products with vitamins, macro- and microelements, pectin substances and carbohydrates. Unfortunately, the technology proposed by the authors cannot be used for this curd product under development, because the components used are not cultivated in Kazakhstan.

The method for producing new enriched curd products was proposed by S.Yu. Bogunov and co-authors [15].

The authors achieved a positive result by using a normalized milk-vegetable mixture prepared from skimmed milk powder reconstituted in drinking water and adding a milk fat substitute. However, it has a drawback - the use of reconstituted skim milk powder instead of fresh milk, which will lead to a significant decrease in the quality of the finished product.

A method for producing curd enriched with vitamins A, D, E and selenium has been developed and patented [16].

The advantage of this patented method is the possibility of using the main stages of the technological scheme for the production of the product being developed in this dissertation research.

One of the closest to the research problem in this work is the results of research by V. Simova [17]. She proposed to enrich curd product with quince and pumpkin, traditionally cultivated in the Republic of Kazakhstan, are used to enrich it.

Based on the analysis of the above research results on the production of curd products, it can be considered relevant to produce a curd product by traditional acid-rennet method using vegetable oil from flax and sunflower seeds with a low content of glycidyl ethers.

## RESULTS AND DISCUSSION

Experimental studies were carried out in 2 stages:

- 1$^{st}$ stage - development of technology for reducing the content of glycidyl ethers in vegetable oil from flax seeds and sunflower seeds. A positive result was achieved by improving the deodorization process,
- 2$^{nd}$ stage – development of technology for the production of a new enriched curd product using flax seed oil and sunflower seed oil with a reduced content of glycidyl ethers.

Experimental research at the first stage was carried out as follows. Vegetable oil from flax or sunflower seeds, having a temperature of 70°C at the outlet of the reactor, was cooled to 55°C. Then 250 ml of a washing solution - 90% ethanol was added to the test oil and stirred for 15 minutes at a stirrer speed of 250 rpm. Afterwards, the oil was allowed to settle for phase separation at 40°C. After phase separation, the oil samples were subjected to vacuum drying. Then, in order to remove residual ethanol and water, an aliquot of the oil phase was subjected to deodorization, after which the content of glycidyl ethers in the studied flaxseed or sunflower oil was determined.

Analysis of the physicochemical parameters of vegetable oils from flax and sunflower seeds after deodorization, such as acid number, peroxide number, color number, degree of transparency, mass fraction of moisture, volatile substances and phosphorus-containing substances, turned out to be fully consistent with the requirements of TR CU 024/2011 Technical Regulations for oil and fat products.

Experimental studies at the second stage were carried out in the following order.

The development of curd product was carried out in accordance with requirements of the group of interstate standards "Food and Flavoring Products", "Meat and Dairy Products", subgroup "Milk and Processed Milk Products": GOST 32927-2014, GOST 31453-2013, GOST 31534-2012 , GOST R 52790-2007, GOST 32923-2014.

The main stages of production of curd product were planned based on the above analysis of literary and patent data. As a result, the production scheme for enriched curd product using the traditional acid-rennet method is summarized as follows:

- Reception and preparation of cow milk.
- Operations to replace animal milk fat with vegetable oil.
- Preparation of a mixture of curd product enriched with ingredients from grape seeds and pollen.
- Mixing and homogenization of enriched mixture of curd product.
- Fermentation of enriched mixture of curd product.
- Self-pressing and pressing of curd clot.
- Cooling the curd clot.
- Packing of finished curd product.

## CONCLUSION

The results of experimental studies of physicochemical parameters of refined oils from flax seeds (RFSO) and sunflower seeds (RSSO) show the following: the acid number of oils is in the range of 0.25-0.5 mg KOH/g; the peroxide number of oils is in the range of 0.8-5.85 mmol of active oxygen/kg; color number, degree of transparency, mass fractions of moisture, volatile substances and the content of mycotoxins - the main indicator of microbiological safety - correspond to the normative ones. And the content of phosphorus-containing substances and aflatoxin B1 was not detected. However, in RFSO and RSSO, the acid number exceeded the norm, which indicates the presence of free fatty acids, which can lead to formation of glycidyl esters.

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## ECONOMIC ANALYSIS OF WORLD MILLET MARKET

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***Abstract***

*This review article examines the analysis of the global millet market, as well as the analysis of the production and harvest of millet in the Republic of Kazakhstan. Millet is one of the most popular cereals in the world. Along with buckwheat, millet starch has excellent nutritional value and good digestibility. Millet is especially popular in Asia and Africa because of its resistance to arid climates. The analysis of millet production volumes and millet yield was carried out. India, China and Mali have become the leaders in the production and harvest of millet worldwide. In these countries, there is an increase in production volumes and yields in the period under consideration. The production volumes and yield of millet in Kazakhstan were also reviewed.*

***Keywords:*** *millet, world market, millet market, world market of millet, millet production, millet harvesting, analysis of millet market*

### INTRODUCTION

Millet, alongside buckwheat, has consistently remained the favored food choice within our country's populace. Millet is derived from the grains of cultivated millet.

Ground millet contains an average of 12.6% protein, which is the most easily digested and fully assimilated by the human body, and therefore the most valuable in terms of nutrition. According to the amino acid composition, millet protein belongs to full-fledged proteins. Cereals contain 12.39% amino acids, of which 35.9% are essential amino acids. Millet proteins are characterized by a high content of such essential amino acids as leucine, isoleucine, valine, threonine, lysine, phenylalanine. As in other types of cereals, there is little tryptophan in millet, but despite this, 100 g of this cereal satisfies the daily human need for tryptophan by 18%. Millet starch, like buckwheat starch, has the best nutritional value. It is found in millet in the form of small grains, insoluble in water. In the human stomach, under the action of enzymes, it passes into a soluble state, which causes its good digestibility[1].

Millet holds the record for the content of molybdenum and magnesium. Low hygroscopicity and solubility, increased gelatinization temperature indicate dense packing of macromolecules in starch granules of millet. The remaining carbohydrates are represented by sugars (2.0%, of which monosaccharides – 0.2%); pentosans (3%) and fiber (1%) [2].

Currently, there is a large amount of millet polished by various brands on the market, the comparative evaluation of which by consumer properties is very relevant for consumers [3].

### RESULTS AND DISCUSSION

Of the global annual utilization of 30 Mt of millets about 90% is used in developing countries, and only a very small amount is used in developed countries outside the former USSR. Per caput millet consumption is greatest in Africa [4]. Millet play an especially important role in nutrition in parts of Africa and India, owing largely to their drought tolerance and other agronomic traits. Millets are especially drought tolerant and can perform well in areas receiving less than 350 mm rainfall (compared to about 700 mm minimum for maize). About 80% of millet production is used for human consumption [5].

The amount of millet produced by countries for 2011-2021 is shown in Table 1.

Table 1 – The amount of millet produced by countries 2011-2021, million tons.

| Years | | Manufacturing countries | | | | | | | | | | In total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | India | Niger | China | Mali | Nigeria | Sudan | Ethiopia | Burkina Faso | Kazakhstan | Other countries | |
| 2011 | mln t. | 12,7 | 2,7 | 1,5 | 1,46 | 1,27 | 1 | 0,65 | 0,83 | 0,04 | 5,48 | 27 |
| 2012 | mln t. | 10,7 | 3,8 | 1,8 | 1,68 | 1,28 | 0,37 | 0,74 | 1,08 | 0,02 | 4,61 | 26,8 |
| 2013 | mln t. | 10,9 | 2,9 | 1,74 | 1,85 | 0,9 | 1,09 | 0,84 | 1,08 | 0,05 | 4,9 | 26,4 |
| 2014 | mln t. | 11,4 | 3,3 | 2,3 | 1,71 | 1,84 | 1,24 | 0,91 | 0,97 | 0,03 | 5,56 | 28,5 |
| 2015 | mln t. | 11,6 | 3,4 | 1,96 | 1,86 | 1,8 | 0,48 | 1,03 | 0,95 | 0,03 | 5,63 | 28,8 |
| 2016 | mln t. | 10,3 | 3,9 | 1,39 | 1,8 | 1,5 | 1,44 | 1,01 | 0,90 | 0,06 | 5,72 | 27,7 |
| 2017 | mln t. | 11,5 | 3,79 | 2,54 | 1,49 | 1,52 | 0,87 | 1,03 | 0,83 | 0,03 | 3,53 | 28,9 |
| 2018 | mln t. | 10,6 | 3,85 | 2,34 | 1,84 | 1,87 | 2,64 | 1,03 | 1,18 | 0,04 | 8,32 | 31,4 |
| 2019 | mln t. | 10,2 | 3,27 | 2,3 | 1,87 | 1,92 | 1,13 | 1,12 | 0,97 | 0,04 | 5,99 | 28,2 |
| 2020 | mln t. | 12,5 | 3,5 | 2,8 | 1,92 | 1,9 | 0,42 | 1,21 | 0,95 | 0,03 | 4,44 | 30,8 |
| 2021 | mln t. | 13,21 | 2,1 | 2,7 | 1,5 | 1,92 | 1,50 | 1,00 | 0,72 | 0,04 | 6,44 | 30 |

Source: compiled by the authors based on data from the United Nations Food and Agriculture Organization [Official website of the United Nations Food and Agriculture Organization, 2020, https://www.fao.org/faostat/en/#data/QCL ].

The analysis of Table 1 showed that India by a margin is the leader in the production of millet in the whole world, covering 44% of the entire millet market. The production peak of millet for India occurred in 2021, amounting to 13.21 million tons, which is 7.8% higher than in 2011. The sharpest decline in the production of millet in India occurred in 2012, when the amount of raw materials produced decreased by 15.5%. By 2019, the production of millet in India decreased to 10.2 million tons, while in 2020 production volumes increased by 22%.

China ranks third in the world production of millet, occupying 8% of the total market. By 2021, the production of millet in China has increased by 80% compared to 2011, which in turn is the sharpest increase in production compared to the initial volume of production in the specified study period. A sharp increase in the production of millet in China began in 2017 when production volumes increased by 1.16 million tons compared to last year. Mali, Nigeria and Sudan occupy 17.4% of the total millet production market in the world. The volume of millet production in Mali did not show sharp jumps, while the sharpest increase in millet production in Nigeria occurred in the period from 2013 to 2014, during this period in Nigeria, millet production increased by 0.94 million tons. In Sudan, in the period 2017-2018, the volume of millet production increased by 1.87 million tons. In Ethiopia, since 2015, millet production ranges from 1 million tons to 1.21 million tons. In Kazakhstan, the volume of millet produced ranges from 0.02 to 0.06 million tons.

The area for harvesting millet by country for 2015-2021 is shown in Table 2.

Table 2. Area for harvesting millet by country for 2015-2021, million hectares.

| Years | | Manufacturing countries | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | India | Niger | Mali | Nigeria | Sudan | Burkina Faso | China | Ethiopia | Kazakhstan |
| 2015 | mln ha | 9,116 | 6,427 | 1,943 | 1,743 | 1,704 | 1,161 | 0,840 | 0,466 | 0,044 |
| 5016 | mln ha | 8,840 | 7,230 | 2,040 | 1,738 | 3,007 | 1,187 | 0,552 | 0,456 | 0,056 |
| 2017 | mln ha | 9,093 | 6,999 | 2,156 | 1,800 | 2,512 | 1,223 | 0,861 | 0,456 | 0,041 |
| 2018 | mln ha | 9,221 | 7,034 | 2,158 | 1,734 | 3,753 | 1,394 | 0,778 | 0,447 | 0,043 |
| 2019 | mln ha | 8,450 | 6,831 | 1,990 | 1,748 | 3,016 | 1,177 | 0,900 | 0,456 | 0,051 |
| 2020 | mln ha | 9,005 | 6,743 | 2,164 | 2,000 | 2,425 | 1,066 | 0,906 | 0,481 | 0,051 |
| 2021 | mln ha | 9,765 | 6,146 | 2,079 | 2,000 | 2,800 | 0,850 | 0,900 | 0,450 | 0,038 |

Source: compiled by the authors based on data from the United Nations Food and Agriculture Organization [Official website of the United Nations Food and Agriculture Organization, 2020, https://www.fao.org/faostat/en/#data/QCL ].

According to Table 2, India and Niger are the leaders in the yield of millet in the world in the period from 2015 to 2021, occupying 66% of the total yield of the countries under consideration. During the entire period under review in these countries, the yield of millet did not fall below a certain mark (8.4 million tons for India, 6.1 million tons for Niger).

Mali, Nigeria, Sudan and Burkina Faso occupy 28% of the total harvest of the countries under consideration. In 2021, Sudan saw a 64% increase in the millet harvest over this period compared to 2015, while in Burkina Faso, the harvest volume decreased by 36% compared to the initial period. In China, since 2018, there has been a gradual increase in the harvest up to the end of the period under review by 28.6%. In Kazakhstan, from 2017 to 2020, there was an increase in the harvest.

Figure 1 shows the volume of millet production in the Republic of Kazakhstan for the period from 2011 to 2021.

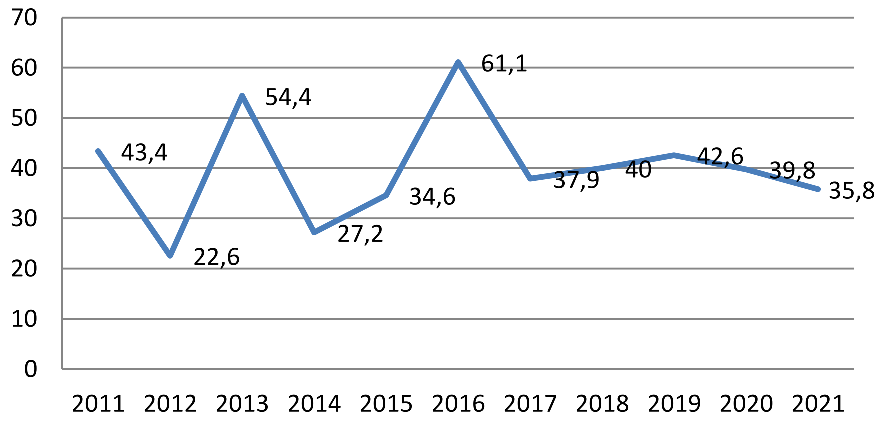


Fig.1. Millet production volumes in Kazakhstan for 2011-2021, 1000 tons

As can be seen from Figure 1, the volume of millet production in the Republic of Kazakhstan showed a sharp increase in 2013 (54.4 million tons) and in 2016 (61.1 million tons). Starting from 2017 and up to 2021, the volume of millet production in Kazakhstan did not rise above 42.6 million tons. In the period 2013-2014, there was a sharp decline in the production of millet, production volumes decreased by half. Since 2019, there has been a slow decline in the amount of grain produced by 18%. According to the figure, 2012 was the lowest year in terms of millet production. The lowest growth in production volumes occurred in the period up to 2017-2018.

Figure 2 shows the volume of millet harvest in the Republic of Kazakhstan for the period from 2011 to 2021.

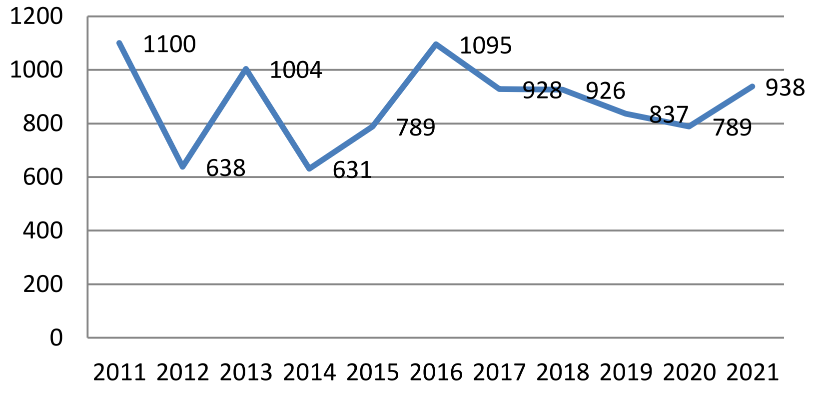


Fig.2. Millet harvest volumes in the Republic of Kazakhstan for 2011-2021, kg/ha

The analysis of Figure 2 shows significant fluctuations in crop volumes in the period from 2011 to 2016. The most productive year was 2011, followed by a sharp decline of 42%. A year later, there was a sharp increase in the harvest by 57%. By 2016, the yield of millet in Kazakhstan almost reached the indicators of 2011. After that, there was a slow decline in the millet millet harvest until 2020. By 2021, the yield of millet decreased by 14.7% compared to 2011.

**CONCLUSION**

Millet is a highly nutritious and versatile grain that has been a popular food product in many regions for a long time. It is not only rich in protein but also easily digestible, making it a valuable addition to a balanced diet.

In this article, the world market of produced and harvested milled were reviewed. The study showed an increase in millet production in many countries. It is also related with growth of the harvesting area in researched countries. India is a leader in both production and harvesting volume all around the world.

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# APPLICATION OF NON-TRADITIONAL PLANT RAW MATERIALS IN PRODUCTION OF MEAT AND VEGETABLE PATES


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***Abstract***

*This article discusses the use of non-traditional plant raw materials to obtain meat-and-vegetable pate. Duck meat and offal are used as the meat component. The vegetable ingredients used were flaxseed and lentil flour, onions, garlic, sesame oil, carrots, table salt, cloves, ground black pepper, paprika, broth and water. The broth is used after cooking duck meat. To create multicomponent meat products of improved quality, with good organoleptic characteristics, and also capable of compensating for the lack of specific nutrients and nutrients, it is necessary to take into account the criteria of biological value and the qualitative composition of the protein component. Quality assessment by organoleptic and physicochemical indicators was carried out using generally accepted methods. The results of a study of food safety and microbiological indicators of meat and vegetable pate are also presented. The conducted research established that the microbiological indicators and food safety of meat-and-vegetable pate with non-traditional additives fully complies with the requirements of regulatory documents. The creation of meat products, including pates, using food additives and ingredients of plant origin, which influence not only the technological properties of raw materials, but also contribute to the enrichment of products with essential substances, as well as the prevention of possible functional disorders in the human body, is one of the priorities of the modern meat industry.*



***Keywords:*** *pates, duck meat, non-traditional vegetable raw materials, by-products, flax meal, biological value, organoleptic characteristics*


## INTRODUCTION

Many scientists agree that combining meat and vegetable raw materials is the most promising way to solve the problem of healthy nutrition. The combination of raw materials allows obtaining high-quality products with different compositions, expands the assortment, and promotes the introduction of optimal customized recipes to ensure the best consistency and biological value of the finished product [1].

Functional and therapeutic-prophylactic food products should not only provide the body with food and energy, but also vitamins, dietary fibers and biologically important substances.

Also, the production of products of this group increases the range of manufactured goods, which affects the economic activity of processing enterprises - increasing net income and profitability.

Currently, meat products produced in meat processing plants consist of high-calorie homogenized canned food, the composition of which is dominated by meat or its byproducts. The expansion of the range of pâtés can be substantiated from the point of view of the rational use of available raw materials for the maximum production of high-quality edible meat products.

Pâtés are meat products whose production technology allows rational use of raw materials, as well as combining different types of raw materials. In addition to meat components, vegetable raw materials and other food components can be added to their composition [2].

The pâtés offered to the regional market are high in animal fat and low in protein, which does not correspond to the modern scientific concept of designing healthy food products. The development of new types of products involves the maximum use of various types of raw materials, using non-traditional resources of the Republic of Kazakhstan, in particular, secondary and by-products of the processing of protein-rich animals and poultry [3].

L. V. Antipova, I. N. Tolpygina and A. A. Mishchenko proposed method of preparation of low-calorie pate containing white poultry meat, mushrooms, tomatoes, herbs and lentils as meat components, and olive oil and spices as vegetable components. As a result, the authors get a product with a high biological value and a balanced amino acid composition, which helps to improve digestion and metabolism in the human body [4]. Currently, meat pâtés are a high-calorie product, regardless of their chemical composition balance; In addition to the rational use of raw materials, the production of mixed meat products allows to increase the volume of products with reduced calories, high protein content and high biological value.

In existing recipes for mixed meat pâtés, processed grain and soy products are often added as a vegetable component. Many scientists offer special recipes of mixed meat-vegetable pates with a guaranteed content of nutrients, and butter pie is popular among them. The recipe for canned goods includes: minced beef, pork or lamb's liver, chopped brain, unsalted butter, fried onions, table salt not less than first grade, sand sugar, spices [5].

The disadvantage of this method is that during the production of pate, long-term high-temperature processing is carried out, which leads to a significant loss of some biologically active substances, in particular, vitamins. In addition, the disadvantages of the method also include the use of butter in the pate recipe, which is characterized by a high content of saturated fatty acids, which leads to high cholesterol in the finished product. The pate obtained according to the given recipe has a high energy value.

Beef liver pate contains: beef liver, refined beef bone fat, full-fat soy flour, onion, red sweet pepper, bone broth, $CO_2$ extracts of nutmeg and black pepper, vegetable lecithin, vitamin E, beta-carotene, salt.

The disadvantage of this method is the use of soy flour in the pate recipe, since most consumers still have a negative attitude towards products containing soy due to the dominance of transgenic soybeans in the market.

The fatty acid composition of beef fat is dominated by saturated fatty acids, which does not correspond to the concept of healthy nutrition. In addition, the introduction of the gas-liquid processing stage of animal fats, which allows to improve their quality, as well as to use fats with low quality indicators before processing, complicates the pate production technology and decreases productivity and increases the number of cycles. Long-term use of temperatures from 70 to $80^0$C and high pressure in certain periods also leads to an increase in the energy capacity of the technology [6].

The authors proposed a recipe for meat-vegetable pate, which includes chopped beef liver, chopped cooked pre-soaked chickpeas, vegetable oil, fried onions, table salt, spices, carrageenan, cooking broth of by-products.

The disadvantage of this method is the use of boiled beans, because the protein is destroyed under the influence of high temperature, thereby reducing the nutritional value of the product [7].

Zhumagul M.S. proposed adding peas and carrots to the recipe of meat-vegetable pate based on lamb liver to obtain a functional product [8].

The introduction of different types of flour into the recipe of meat products allows not only to improve the consistency of the meat mass, but also to significantly change the taste and aromatic properties of the finished product. As a source of vegetable protein not only wheat flour can be used, but also other types of flour that are not inferior to wheat in terms of nutritional and biological value. For example, pea and bean sprout flour, wheat and barley sprout flour [9], as well as flax meal and lentil flour. Flax meal is a valuable source of vegetable protein. The protein composition of linen flour is characterized by a high content of amino acids such as arginine, valine, leucine, phenylalanine, tyrosine. Flax meal has the lowest energy value, which allows it to be used for the production of functional and dietary products. It is also known that flax meal has a high water (137.5%) and fat (123%) absorption capacity. In addition, at a concentration of 30% of linen flour and 70% of oil, the system has a high emulsifying capacity of oil [10].

Sesame oil is introduced into semi-finished products as a source of fatty acids to replace animal fats, whose consumption by humans is already excessive and leads to an increase in cardiovascular diseases in the population. Regular consumption of sesame oil has a positive effect on the cardiovascular system, restores the tone of the veins, increases their strength and elasticity. The product helps to eliminate "bad" cholesterol and normalize blood pressure. Moderate use of fatty liquid in the diet leads to an increase in the number of platelets in the blood [11].

The goal of our work is to expand the range of meat products and obtain a functional pate with a balanced chemical composition, high organoleptic properties, high nutritional value, and nutritional properties.

Poultry meat is a dietary product that is a source of useful and tasty quickly digestible proteins, vitamins and semi-fatty acids, and in terms of economic indicators, poultry meat is considered relatively affordable compared to other types of meat. Poultry meat and its processed products are products of social importance, and their production volume and sales volume are criteria for ensuring food safety.

One of the ways to eliminate the imbalance of trace elements and vitamins is to expand the range of food raw materials by using plant raw materials that are a source of proteins (flax, lentils), carbohydrates (pumpkin, carrots). Spices, medicinal herbs, plant raw materials are used as flavoring and aromatic mixtures [12]. Plant components can supplement biologically active substances that are missing or lacking in meat products.

## EXPERIMENTAL METHODS

The object of research is meat-vegetable pate, plant components - flax and lentil flour, onion, garlic, sesame oil, carrot, broth and water. The broth is used after cooking duck meat. In the process of preparing pate with herbal ingredients, the wheat flour used in the traditional pate recipe is replaced by flax and lentil flour. Crushed flour is added to the pate in the form of a protein-fat emulsion. To obtain a product with high organoleptic indicators, a protein-fat emulsion is prepared using sesame oil.

To prepare the pate, we used minced duck meat prepared from a fresh frozen poultry. The raw materials used for the preparation of pates meet the requirements of the technical documentation and TR TS 034/2013 "On the safety of meat and meat products" [13].

Evaluation of the quality of meat and vegetable pate was carried out according to generally accepted methods. Physico-chemical indicators of pate, such as mass fraction of moisture, ash content, total acidity, were determined by the arbitration method [14].

## RESULTS AND DISCUSSION

Organoleptic indicators are important for consumers in choosing a product. The main organoleptic parameters of pâtés are appearance, cut type, taste and smell, consistency. Organoleptic indicators of functional pate are presented in Table 1. Based on the results, it can be concluded that the studied samples meet the standard requirements in terms of organoleptic indicators.

Table 1 - Organoleptic parameters of meat-vegetable pate for functional purposes

| № | Indicator | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|---|---|---|---|---|---|
| 1 | Appearance | Light brown homogeneous mass | Homogeneous brown mass with inclusions | Light brown mass with inclusions | Thick, finely ground, paste-like mass, homogeneous, without extraneous impurities |
| 2 | Consistency | dense, not homogeneous | pasty with flexible inclusions | Homogenous, paste-like | Finely ground, spread, homogeneous, grainless |
| 3 | Colour | Too yellow | Uniform, light yellow | Pleasant yellow brown | Uniform, light brown |
| 4 | Smell | sweet, distinct aroma of spices | strong smell of spices | odor characteristic of this type of product | Normal, characteristic of meat, without foreign taste and smell |
| 5 | Taste | taste of oil and spices | taste of spices | pleasant aftertaste | Moderately pronounced meaty taste, without bitterness and foreign taste |

As a result of the research, we selected the 4th sample of the finished product, and based on these results, it is possible to create a functional additive and add it to poultry meat to produce a valuable product.

Physico-chemical indicators and energy value of functional meat-vegetable pate are shown in Table 2.

Table 2 - Physico-chemical indicators and energy value of functional meat-vegetable pate

| № | Indicator | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|---|---|---|---|---|---|
| 1 | Mass fraction of protein, %, кем емес | 14.5 | 15.3 | 15.7 | 16.7 |
| 2 | Mass fraction of fat, %, not less | 12.3 | 14.7 | 15.2 | 17.5 |
| 3 | Mass fraction of carbohydrates, %, not less | 1.35 | 1.47 | 1.55 | 1.65 |
| 4 | Mass fraction of sodium chloride (cooking salt), %, not more | 1.5 | 1.5 | 1.7 | 2.4 |
| 5 | Mass fraction of starch, %, not more | 2.0 | 3.7 | 5.0 | 5.0 |
| 6 | Calory content, kcal | 180.2 | 181.3 | 183.3 | 192.6 |

Based on the results obtained during the experiment, it can be concluded that samples with flax and lentil flour are more valuable in terms of protein content.

Pate prepared from duck meat and by-products complies with technical regulations on food safety and microbiology (Table 3). The amount of toxic elements such as lead and arsenic is 8-10 times less than the maximum allowable concentration (MAC), and no traces of cadmium and mercury were found in the samples.

Table 3 - Food safety indicators of meat-vegetable pate for functional purposes

| № | Indicator, measuring unit | Amount | MAC |
|---|---|---|---|
| 1 | Toxic elements, mg/kg, not more | | |
| | Lead | 0.058 | 0.5 |
| | Arsenic | 0.0092 | 0.1 |
| | Cadmium | Not identified | 0.05 |
| | Mercury | Not identified | 0.03 |
| 2 | Antibiotics, not more than mg/kg | | |
| | Levomycetin | Not identified | Not allowed |
| | Tetracycline groups | Not identified | |
| 3 | Pesticides, mg/kg, not more | | |
| | Hexachlorocyclohexane (α, β, γ-isomers) | Not identified | 0.1 |
| | DDT (dichlorodiphenyltrichloromethylmethane) and its metabolites | Not identified | 0.1 |
| 4 | Radionuclides, Bq/kg, no excess | | |
| | Cesium-137 | 8.3 | 200 |
| | Mass fraction of sodium chloride (table salt), %, not more | 2.4 | - |

Microbiological indicators of meat and vegetable pate are determined according to the Technical Regulation by introducing a protein-fat emulsion [11]. Microbiological indicators of functionally oriented meat-vegetable pate are given in Table 4.

Table 4 - Microbiological indicators of meat-vegetable pate for functional purposes

| Indicator, measuring unit | Composition of pate prepared from duck meat and by-products | Accepted norms according to regulatory documents |
|---|---|---|
| Bacterial group of Escherichia coli (coliforms) | 1.2±0.2 | 1.0 |
| Pathogenic, including salmonella | 23.5 | 25.0 |
| Sulfite-reducing clostridia | 0.11 | 0.1 |
| S. aureus | 1.3 | 1.0 |
| L. monocytogenes | 27±0.2 | 25.0 |

## CONCLUSION

Application of non-traditional types of raw materials in the production of meat-vegetable pate expands the possibility of obtaining balanced products that compensate for the lack of necessary substances (proteins, dietary fibers, vitamins, minerals, etc.), promotes achieveing a high chemical composition, nutritional and biological value. In addition, the use of non-traditional types of raw materials such as flax, lentils, dietary meat, and by-products in the production of pate allows for the rational use of meat raw materials and increases their nutritional properties, functional and organoleptic characteristics.

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## APPLICATION OF A RISK-BASED APPROACH IN UPDATING THE DOCUMENTATION OF THE QUALITY MANAGEMENT SYSTEM OF FOOD TESTING LABORATORIES

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***Abstract***

*Testing laboratories are the main subjects in the system of conformity assessment of the quality and safety of products, as they deal with the assessment of all the declared characteristics of products by their manufacturers. In case of confirmation, manufacturers are issued a certificate and/or declaration for a batch of products that can enter the commercial market. The requirements for the competence of testing laboratories in national certification systems are currently regulated by a number of international standards adopted by all countries, the implementation of which allows global and regional organizations in the field of quality and safety to recognize certificates issued to them on international markets. Currently, for testing laboratories, such a standard is ISO/IEC 17025, one of the conditions of which is the mandatory presence in the laboratory of a quality management system built and certified according to ISO 9001-2015. When passing the reaccreditation procedure, testing laboratories must work with up-to-date regulatory documents, the absence of which may affect the suspension or even revocation of the accreditation certificate. The article presents the results of research on updating the regulatory documentation of the quality management system of testing laboratories using a risk-based approach that reduces the risks of nonconformities during the assessment of conformity of product quality and safety.*

***Keyword*:** *testing laboratory, food products, conformity assessment, scope of accreditation, competence, international standards, certification tests, ISO 9001-2015 standard, ISO/IEC 17025 standard, quality management system, documentation, updating, risk-oriented approach.*

## INTRODUCTION

Testing laboratories are the main subjects in the system of conformity assessment of the quality and safety of products, as they deal with the assessment of all the declared characteristics of products by their manufacturers. In case of confirmation, manufacturers are issued a certificate and/or declaration for a batch of products that can enter the commercial market [1]. The requirements for the competence of testing laboratories in national certification systems are currently regulated by a number of international standards adopted by all countries, the implementation of which allows global and regional organizations in the field of quality and safety to recognize certificates issued to them on international markets. Currently, for testing laboratories, such a standard is the ISO/IEC 17025-2017 standard (GOST ISO/IEC 17025-2019) [2].

One of the main conditions is also the mandatory presence in the laboratory of a quality management system built and certified according to ISO 9001-2015[3]. Without such a system, the certificate of accreditation, which is the main document of the legitimate work of testing laboratories in the conformity assessment system of any country. The main task of the laboratory's quality system is to create and stable reproduction of the necessary conditions for obtaining reliable information about the values of product quality and safety indicators during testing by established methods and assessing the compliance of these indicators with the requirements [4].

The quality management system is an integral part (subsystem) of the laboratory management system. It has many internal and external connections, through which a large number of signals pass. The competence of the laboratory is the expressed ability to apply their knowledge and skills. The instrument for assessing the competence of laboratories is their accreditation, the main task of which is to ensure mutual trust in the results of the activities of accredited laboratories both domestically and internationally. To confirm competence, the laboratory conducts self-analysis, i.e. internal checks (internal audit) for compliance of the laboratory's activities with the requirements of ISO/IEC 17025.

The Republic of Kazakhstan, as a member of many organizations of technical regulation, standardization, certification and accreditation systems, strives to implement all the rules and requirements established by these organizations, as it supplies and expands the range of goods supplied to all parts of the world.

As one of the leading countries in the production of food products, Kazakhstan is interested both in increasing the number of testing laboratories, the scope of accreditation of which is declared by the conformity assessment of many food products, and improving their work by introducing the principles of independence, competence and reliability of certification tests[5].

The southern region of our country produces a wide range of food products, large, medium and small enterprises of the food and processing industry are concentrated here, which raises questions about the availability and testing laboratories that would assess the conformity of such products. One of such laboratories is the LLP «Certification Center. «Sapa Standard KZ»", organized in 2020 and received an accreditation certificate from the "National Center of Accreditation" of the Republic of Kazakhstan for the certification/declaration of food products. To obtain the certificate of accreditation, the testing laboratory developed, implemented and certified according to the ISO 9001 standard of the 2015 version[6]. However, the changes that are taking place in the legislation of our country, on the territory of the Eurasian Economic Union, on the world food markets dictate that the regulatory documentation on which the organization operates should be constantly updated.

In its activities, the testing laboratory should take into account all possible risks that may adversely affect the results of its activities, i.e. apply a risk-oriented approach in its work. The conducted analytical review showed that there is a lack of methodological and methodological recommendations in the field of applying a risk-based approach to updating the regulatory documents of the IL quality management system, and therefore, we believe that the relevance of our research for such IL as LLP «Certification Center. «Sapa Standard KZ» will provide practical and methodological assistance to solve emerging problems and tasks.

## EXPERIMENTAL METHODS

On the territory of the Republic of Kazakhstan, as a country belonging to the Eurasian Economic Union, the interstate standard GOST ISO/IEC 17025-2019 is applied, according to which, in relation to the QMS of the testing laboratory, its construction is possible in two variants: A – in full compliance with the requirements of GOST ISO/IEC 17025-2019; B – in accordance with the requirements of GOST ISO standards/IEC 17025-2019 (as part of sections 4-7) and ST RK ISO 9001-2016 [2,7].

If option B is chosen, the QMS becomes broader and covers all aspects of the organization's management that are aimed at its sustainable development. Therefore, we recommend using this option, which will take into account not only the specific industry requirements for testing laboratories, but also ensure the comprehensive effectiveness of the activity management system, as well as customer satisfaction and other stakeholders.

In this regard, we have developed a model for integrating the structures of GOST ISO/IEC 17025-2019 and ST RK ISO 9001-2016 standards in accordance with the PDCA cycle, which is the basis of the methodology for implementing and updating the quality management system, Figure 1.

Here there are requirements that are specific to testing laboratories and "expand" the requirements for QMS in accordance with the ST RK ISO 9001-2016. Clause 4.1.2 of GOST ISO/IEC 17025-2019 has been added to the "Leadership" block, which concerns the acceptance of obligations by the management of the impartiality laboratory. In the "Planning" section, clauses 5.1 and 5.2 on the mandatory legal status and definition of the laboratory management have been added. The block "Security tools and activities" has been "expanded" by the requirements of clauses 4.1.1 and 4.1.3 in terms of ensuring the impartiality of activities.

Considering the requirements for the QMS of the testing laboratory, it can be noted that, regardless of which of the options for building the QMS the testing laboratory chooses, each of them, in order to achieve its effectiveness, provides for the presence of risk-oriented thinking, which is aimed at the presence of processes related to risk management (identification, analysis, evaluation of measures to minimize or eliminate). At the same time, none of the standards requires any formalized risk management methods.

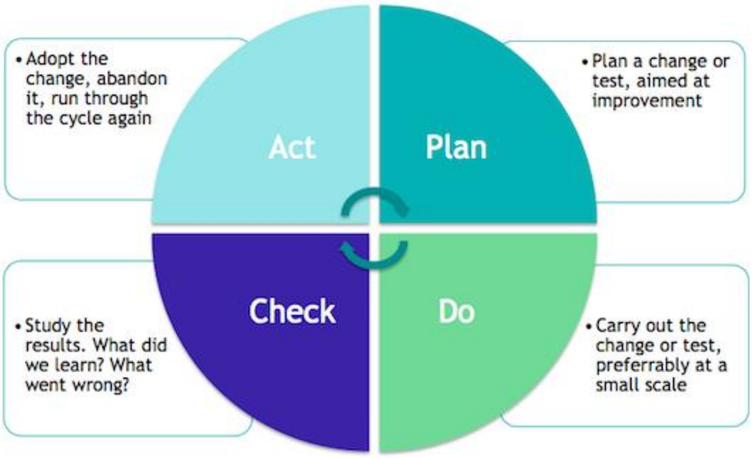


Fig. 1. PDCA cycle in management

But, despite this, some experts of the National Accreditation Center who go for inspections have different levels of competence, and quite often there are cases in which they require from the testing laboratory not only evidence of the measures taken in terms of preventing or eliminating risks, but also documenting activities in the field of risk management.

In this regard, in order to eliminate the inconsistency of opinions on this issue with experts and to facilitate the accreditation procedure, we recommend documenting activities in the field of risk management − the Quality Manual of the testing laboratory or any internal document (regulations, instructions, organization standard, etc.).

As part of this procedure, we offer the example of the testing laboratory of LLP "Certification Center. "Sapa Standard KZ" to consider the identification and assessment of risks. Due to the fact that the QMS in accordance with the requirements of the ST RK ISO 9001-2015 (option B chosen by us) is based on a process approach, which provides for considering activities as interrelated processes that must have inputs and outputs, a sequence of processes and more, we have developed a general model of the process "Acceptance of applications for research, handling samples, issuing research results" [8]. Using the model of this process, we have identified its stages and identified undesirable risks, which are listed in Table 1.

Table 1. Identification of undesirable events in the process of "Accepting applications for research, handling samples, issuing research results"

| Name of the process stages | Responsible | The result of the process | Event (risk) |
|---|---|---|---|
| 1. Registration of the application | Specialist of the reception department | Correctly completed application | 1. Error when filling out the application by the applicant |
| 2. Conclusion of the contract | Head of the Reception Department | Signed contract | 2. Application not signed by the applicant |
| 3. Approval of the application | Specialist of the reception department | Agreed or uncoordinated application | 3. Provision of an incomplete package of documents<br>1. Absence of a signed contract − absence of obligations<br>1. Approval in the absence of the possibility of carrying out the research data specified in the application<br>2. Approval in the absence of research in the field of accreditation<br>3. Coordination of incorrect research deadlines |
| 4.Invoicing for | Head of the | Invoice issued | 1.Incorrectly specified positions in the account |

| Name of the process stages | Responsible | The result of the process | Event (risk) |
|---|---|---|---|
| payment | Reception Department | | 2.Indication of non-current prices<br>3.Long billing |
| 5. Refusal of research and return of the sample to the customer | Technical Director | Return of the sample to the customer and the package of documents | 1. The safety of someone else's property<br>2. Waste of time<br>3. Customer dissatisfaction |
| 6. Acceptance of samples and transfer to departments for research | Specialist of the reception department | The accepted sample, registered with the entered information and transmitted to the departments | 1.Operator error when entering data<br>2. Exceeding the registration deadline<br>3.No depersonalization of the sample<br>4. Violation of requirements when dividing the sample<br>5.Non-compliance with the requirements when taking samples |
| 7. Examination of samples and their subsequent storage | Head of the research department | Studies of samples with the entered data | 1. Lack of necessary information for conducting research<br>2.Lack of necessary reagents and consumables<br>3. Research according to incorrect (irrelevant) regulatory documents<br>5. Violation of research deadlines |
| 8. Collecting research information and forming a research protocol | Specialist of the reception department | Signed protocol of laboratory tests | 1. Violation of the deadlines for the formation of the protocol<br>2.Adding erroneous data to the results |
| 9. Transfer of the research protocol to the customer | Specialist of the reception department | Signed research protocol from the customer | 1. Customer's dissatisfaction with the issued results |
| 10.Disposal of the decommissioned sample | Responsible specialist assigned in each department | Destroyed sample | 1.Disposal in the wrong way<br>2. Violation of the terms of disposal |

Based on table 1, the identified risks are assessed. Negative events are taken and the probability of its occurrence is determined, as well as the consequence that it may entail. On their basis, the amount of risk and its level are determined.

## RESULTS AND DISCUSSION

Analyzing Table 1, it can be seen that there are no critical risks in this process. There are risks of an acceptable and significant level that are worth paying attention to. In this regard, we have proposed preventive measures for risks of a significant level, as shown in Table 2.

Table 2- Measures to prevent undesirable events (risks)

| Event (risk) | Measures to prevent an undesirable event (risk) |
|---|---|
| Application not signed by the applicant | In the application form, enter the signature line of the specialist taking the sample next to the signature of the customer as confirmation of acceptance of the signed application |
| Providing an incomplete set of documents | Develop memos for clients with a list of the minimum necessary information and documents for taking samples for research |
| Absence of a signed contract | In the procedure (procedure) of the testing laboratory, prescribe a mandatory condition for accepting a sample application for research after the presence of a signed contract, or provide a letter of guarantee for its provision within a certain time, in case it is impossible to sign the contract on the spot |
| Approval in the absence of research in the field of accreditation | Integration of the approval process with the electronic version of the scope of accreditation. Checking each indicator for its presence in the field of accreditation |
| Coordination of incorrect research deadlines | Development of a document indicating the timing of all types of research according to the scope of accreditation |

| | |
|---|---|
| Incorrectly specified positions in the invoice | Implementation of an automated billing system in the testing laboratory |
| Indication of outdated prices | |
| Long billing | |
| No encryption of the sample | Prescribe in the procedure (procedure) for taking samples of the testing laboratory that the specialist of the department taking the sample for analysis is obliged to take the sample only in encrypted form |
| Lack of necessary reagents and consumables | Automated accounting of reagents and consumables. Weekly reporting in order to control the residues of necessary reagents and consumables |
| Research according to incorrect (irrelevant) regulatory documents | Updating the regulatory framework of the testing laboratory with the established frequency and as the document is canceled / replaced. As well as the use of regulatory documents with a note on its relevance and effectiveness |
| Disposal in the wrong way | Familiarization of responsible specialists about the responsibility and consequences of violations of disposal methods, under the signature |
| Violation of the terms of disposal | Familiarization of responsible specialists about the responsibility and consequences of untimely disposal of samples. |

## CONCLUSION

Thus, each organization has the right to decide how to manage risks and which methods to use for this. Competent risk management will allow the organization to eliminate or minimize the likelihood of an undesirable event, reduce losses and improve the QMS of the organization as a whole. And for this it is necessary to document and update all functioning processes in the testing laboratory.

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# DETERMINATION OF THE QUALITY AND SAFETY OF PASTA PRODUCTS IN THE ENTERPRISE

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***Abstract***

*This article shows the tendency of the complete decline in the quality of pasta products, identifies the causes of this problem and suggests ways to solve it. The results of our research allow us to conclude that the decrease in the quality of pasta products is connected with the transformation of state institutions in the field of technical regulation. Recently, one of the products included in the category of healthy nutrition - pasta products containing various vitamin supplements - has been widely used. The production of food products with curative and preventive properties, the complex use of food raw materials, and the improvement of the quality, nutritional and biological value of the produced products are important components of the "Concept of the State Policy of Nutrition of the People of the Republic of Kazakhstan". Therefore, research on finding a solution to these tasks is important. Fertilization of inexpensive food products, such as pasta, is an optimal solution due to the mass use of this product due to its availability. As a result, it is possible to prevent many different diseases and treat avitaminosis in pasta users.*

***Keywords:*** *Pasta products, wheat flour, evaluation, indicators, dough, moisture, carbohydrates.*

## INTRODUCTION

Pasta products have been known for the first time in Asian countries. In the Middle Ages, Neopolitan traders brought pasta from the USA to Italy. Since then, Italy has been called the Motherland of pasta. It can be called "Macaroni is a traditional food of Italians". 18th century In Italy and France, pasta products were produced with mechanical presses. Pasta production is a new industry for Kazakhstan. The recipe for pasta dough depends on the type of flour and types of mixture. Do not mix different types of flour to make pasta. The amount of water required for kneading pasta dough is taken depending on the moisture content of the dough, the quantity and quality of gum and the yield of flour. Depending on the type of product, the moisture content of the dough should be 25.0-32.5%. Pasta products keep well. They can prepare many dishes and side dishes. Pasta products have high nutritional value. Their composition includes proteins 9-11.8%, carbohydrates 70-75%, fats 0.9-2.7%, fiber, minerals. The energy value of 100g of the product is equal to 330-340 kcal.

Pasta products are characterized by their high value, good digestibility, quick and easy cooking. The pasta product contains digestible carbohydrates 70-79%, proteins 9-13%, fats 1.0%, minerals 0.5-0.9%, fiber 0.1-0.6%, moisture up to 10%.

It is impossible to determine exactly when and where macaroni appeared. Their path in history is probably a little later than when people began to grow wheat, when the dough accidentally dried up in the sun.

There is also a legend about spaghetti, which was invented in the cave of a Neapolitan witch in the 13th century. Emperor Federico II, who tried and admired its taste and simplicity, distributed this nutritious dish to the inhabitants of his kingdom.

There is a funny story about the origin of Bolognese noodles. It is said to have been specially invented by chef Alphonse Este and Lucrezia Borgia for their wedding. The chef dedicated the dish he made to the woman: he made the dough soft and shiny, added eggs and a little olive oil, then cut the dough into strips "as thin as Lucretia's long blond hair" and served them to his spouses and guests. [1].

Another legend says that the first noodles were invented by German chefs in the 13th century. They rolled out the dough to make shapes like swords, birds, and stars. This dough was used like regular bread and was far from the type of pasta common in our time.

## EXPERIMENTAL METHODS

According to GOST 31743-2017 "Pasta products are food products made from processed products of grain and non-grain crops using additional raw materials, mixed with water, further molded and dried in various ways"

Table 1 - Pasta products contain a large amount of carbohydrates; in addition, their nutritional value is determined by the presence of proteins, vitamins (thiamine, riboflavin, niacin), as well as macroelements (potassium, magnesium, phosphorus). In pasta products with eggs and dairy products, the protein content increases by 15-20%, 20%, 0% - methionine, lysine, tryptophan, vegetable additives (tomatoes, spinach, carrots) help not only to improve the color of the finished product, but also to improve the mineral composition[4].

Table 1. Nutritional and energy value of pasta made from durum wheat flour per 100 g of product [3]

| Product | Protein g | Oils | Carbohy drates, g | Energy value, kcal | K, mg | Mg, mg | P, mg | B1, mg | B2, mg | PP, mg |
|---|---|---|---|---|---|---|---|---|---|---|
| Varieties of high flour pasta | 11,0 | 1,3 | 70,5 | 338 | 123 | 16 | 87 | 0,17 | 0,04 | 1,2 |
| Egg pasta | 11,3 | 2,1 | 69,6 | 342 | 132 | 17 | 106 | 0,17 | 0,08 | 1,2 |
| Pasta products made from 1 type of flour | 11,2 | 1,6 | 68,4 | 333 | 178 | 45 | 116 | 0,25 | 0,08 | 2,2 |

GOST 31743-2017 also establishes the following characteristics based on the classification of pasta products. Division into groups is carried out according to the type used for the preparation of raw materials: for group A - hard wheat flour (MEMST 31463-2012), for group B - soft wheat flour for pasta products (MEMST 31491-2012), for group B - baking or general purpose flour wheat flour (MEMST 52189-2003).

Table 2- classification by class is based on the value of ash content. The ashiness of pasta products with additional raw materials (egg products, dry milk, vegetable powders) may vary depending on the ashiness of the mixture used. For pasta, if it is prepared using additional raw materials, the group and variety designation is supplemented with the name of the same raw material. For example, high-grade pasta products made from flour group A, using egg powder as an additional raw material, have the label "High-grade egg group A"[2].

Table 2. Classification of pasta products by groups and varieties according to GOST 31743-2017.

| Group A (wheat from durum flour) | Group B (wheat from soft flour) | Group B (wheat flour baking) |
|---|---|---|
| Upper class (ash content <0.9%) | Upper class (ash content <0.6%) | Upper class (ash content <0.56%) |
| First class (ash content < 1.2%) | First class (ash content <0.75%) | First class (ash content <0.75%) |
| Second grade (ash content < 1.9%) | - | - |

Depending on the method of forming, pasta products are classified into the following types:

- ➢ cut-out products made of dough tape, the type of which is compacted with a knife;
- ➢ Pushing the pressed products through the matrix;
- ➢ Type Stamped products formed from ribbons are sealed dough

Pasta is divided into types according to the following shape:

- ✓ bent or straight tubular products (horns, feathers and their analogues from Italian manufacturers - penne rigate (Penne rigate), cellentani (cellentani), etc.);
- ✓ thread-like products formed in the form of threads with a circular cross section (vermicelli, capellini);

All types of pasta are long (200 mm or more) or short (length less than 200 mm) is produced. Long pasta can be single (ie, no bend) or double bend and can also be coiled, bowed, and nested [2]. Table 3 - organoleptic indicators of pasta products.

Table 3 - Organoleptic indicators of pasta products

| The name of the indicator | Description |
|---|---|
| Color | Corresponds to the type of flour |
| Form | The color of products using additional raw materials varies depending on the type of these raw materials |
| Taste | According to the type of product |
| The smell | This product has no external taste |

## CONCLUSION

Thus, the standards for pasta products are considered and reflect the current trends in the development of the market for the production of this type of food products. Most domestic manufacturers use equipment based on modern, advanced technologies, which allows them to produce quality products that meet the requirements of global standards.

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# METHODOLOGICAL AND TECHNOLOGICAL ASPECTS OF OBTAINING A NATURAL SWEET REPLACEMENT BASED ON PLANT RAW MATERIALS STEVIA

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***Abstract***

*Proper nutrition ensures the normal functioning of the human body, helps prevent diseases and creates conditions for preventing premature aging. A successful solution to the problem of healthy nutrition depends on the development and implementation of the latest food technologies using natural plant materials with a high content of biologically active substances, functional ingredients and antioxidants. One of the basic elements in nutrition is sugar, which people consume both directly, adding it to tea, coffee, and to many products as a recipe ingredient. However, nutrition scientists, based on many studies, have proven that excess sugar causes irreparable harm to the body, since many people exceed the scientifically proven daily allowance tens and sometimes hundreds of times. Modern lifestyle and diet, which includes a large number of drinks, confectionery, etc. is direct evidence of such a statement. In particular, excess sugar is very harmful for a growing child's body, when a malfunction occurs in the body and sugar becomes the cause of many diseases, such as diabetes. Therefore, the issue of reducing sugar consumption, as well as replacing it with plant analogues, is an urgent task for researchers in this area. In Kazakhstan, as throughout the world, research by scientists in the field of food products is aimed at finding sugar substitutes and developing new recipes and technologies for the production of such products. The article contains the results of research on the development of methodological aspects of the formation of regulatory and technical documents for the production of biologically active mixtures based on stevia plant raw materials using scientific methods of standardization and certification.*

***Keyword*****:** *healthy nutrition, functional foods, sweeteners, plant raw materials stevia, regulatory and technical documentation, production of biologically active substances, stevia extract, disease prevention, new production.*

## INTRODUCTION

Human nutrition plays an important role in maintaining a high level of health, increasing life expectancy, and maintaining working capacity. Proper nutrition ensures the normal functioning of the human body, helps prevent diseases and creates conditions for preventing premature aging. A successful solution to the problem of healthy nutrition depends on the development and implementation of the latest food technologies using natural plant materials with a high content of biologically active substances, functional ingredients and antioxidants. The human attitude towards food as medicine has created a demand for foods known as functional.

One of the basic elements in nutrition is sugar, which people consume both directly, adding it to tea, coffee, and to many products as a recipe ingredient. Sugar is an ideal source of energy; it is necessary for the normal functioning of the brain and muscles. Without sugar, blood supply to the brain and spinal cord deteriorates. Lack of sugar in the diet can lead to weakness, dizziness, drowsiness, and decreased intellectual abilities. However, nutrition scientists, based on many studies, have proven that excess sugar causes irreparable harm to the body, since many people exceed the scientifically proven daily allowance tens and sometimes hundreds of times. Modern lifestyle and diet, which includes a large number of drinks, confectionery, etc. is direct evidence of such a statement. In particular, excess sugar is very harmful for a growing child's body, when a malfunction occurs in the body and sugar becomes the cause of many diseases, such as diabetes. Therefore, the issues of reducing sugar consumption, as well as replacing it with plant analogues, are an urgent task for researchers in this area [1,2,3].

Currently, many countries are actively replacing sugar in the formulations of various products, which is due to the need to optimize human nutrition, as well as the possibility of solving issues of rational nutrition for people with certain diseases. In Kazakhstan, as throughout the world, research by scientists in the field of food products is aimed at finding sugar substitutes and developing new recipes and technologies for the production of such products[4]. As part of our master's thesis research, we selected as an object a plant raw material - stevia, which is native to South America, but is already cultivated in countries such as Japan, Korea, Taiwan, etc. [5,6]. The creation of conditions for its cultivation in Shymkent also allows us to obtain its extract in industrial volumes, which can be used as a sweetener in many food products, as well as to produce dietary supplements from it.

I would like to note that any production must be accompanied by the development of various types and categories of regulatory documents, which include both standards for technology and standards for finished products, since its future implementation must be accompanied by certification of finished products for safety and quality indicators with obtaining certificate of conformity, without which access to trade counters is prohibited.

## EXPERIMENTAL METHODS

Among the most promising and effective modern natural sweeteners, attention is drawn to sweet diterpene glycosides that accumulate in the aboveground part of Bertoni (stevia) in a sufficiently large amount – up to 20% in terms of dry weight and have a pronounced sweet taste. Stevia leaves are 10-15 times sweeter than ordinary sugar, extract – 30-40 times, the main biologically active substance - stevioside – 200-300 times, but the advantage of using them, unlike sugar, is that stevia diterpene glycosides contain very few calories and do not they increase the level of glucose in the blood. Currently, stevioside is considered excellent for sufferers of various diseases. Stevia extracts are widely used in the food industry. Their use in the production of dietary products is especially valuable.

Based on pharmacological studies, stevia dry extract has been proposed as an immunostimulating, antioxidant, anti-inflammatory, antisclerotic and antidiabetic agent. Study of the chemical composition of stevia as a raw material, as well as biologically active additives (hereinafter – dietary supplements) containing stevia plays an important role for its industrial processing, which in turn facilitates the treatment of the above-mentioned diseases. The stevia plant contains more than 100 phytochemicals, the content of which, the main substances, is given in Table 1 [7]

Table 1 – Chemical composition of stevia

| Components | Content in the plant |
|---|---|
| Plant polyphenols (flavonoids) | 30-45% |
| Plant pigments | 10-15% |
| Glycosides | 18-20% |
| Free sugars | 3-5% |
| Oxycoric acids | 2-3% |
| Amino Acids | 1,5-3% |
| Trace elements (zinc, potassium, magnesium, iodine, selenium, etc.) | 0,18-1% |
| Vitamins of group B, also A, C, D, E, K, P | 0,1% |

The plant is especially rich in terpenes and flavonoids. In addition to the substances presented in the table 1, stevia contains: apigenin, austroinulin, avicularin, beta-sitosterol, caffeic acid, campesterol, caryophyllene, centaureidin, chlorogenic acid, cosmosiin, cinaroside, dauxosterol, dulcoside AB, foeniculin, formic acid, humic acids, gibberellin, indole-3-acetonitrile, isocuercitrin, isosteviol, kaempferol, kaurin, lupeol, luteolin, polystachoside, quercetin, cuercitrin, scopoletin, sterebin AG, steviolbioside, steviomonoside, stevioside-3, stigmasterol, umbelliferon and xanthophyll [8].

An extensive group consists of essential sugars. Some compounds are extremely bitter, while others, on the contrary, are very sweet. The leaves of stevia accumulate glycosides of 11 species, which have a sweet taste, but with the presence of a bitter note [9].

This fact causes the bitter taste of fresh and dried leaves, licorice taste. The dry and liquid extracts obtained as a result of deep processing are spared from such a disadvantage. Table 2 shows the composition of stevia glycosides.

Table 2. Characteristics of stevia glycosides

| Glycosid | Content in the plant, % | The sweetness coefficient (by so many times the glycoside is sweeter than ordinary sugar) |
|---|---|---|
| Stevioside | 60 | 150-300 |
| Rebaudioside A | 30 | 200-400 |
| Rebaudoside B | 4 | 300-350 |
| Rebaudoside C | 0,5 | 50-120 |
| Rebaudoside D | 0,5 | 200-300 |
| Rebaudoside E | 4 | 250-300 |
| Rebaudoside F | 0,5 | No data available |
| Rubusoside | <1 | 110 |
| Stviolmonoside | <1 | No data available |

| | | |
|---|---|---|
| Steviolbioside H | <1 | 100-125 |
| Steviolbioside b - Gic | <1 | 50-120 |

The data in Table 2 indicate that the bulk of glycosides account for stevioside and rebaudioside A. These components are the basis for the production of dry concentrated extracts. Studies of domestic and foreign scientists indicate the harmlessness of stevia glycosides when administered orally.

Thus, according to the indicator of acute toxicity, stevioside belongs to hazard class IV – low-hazard substances, and since December 2008, according to the FDA (Food and Drug Administration translated from the English "Food and Drug Administration"), purified glycosides from stevia can be considered recognized as safe (IM the GRAS (Generally recognized as safe) category has been assigned, which translates from English as "recognized as completely safe".

Indeed, it has been shown that the use of steviol glycosides does not have a harmful effect on the liver. At the same time, some authors believe that it is necessary to further study the effect of these diterpene glycosides on the blood-brain barrier and their careful use during pregnancy. Nevertheless, currently the production of sweeteners based on stevia glycosides continues to grow. Nevertheless, currently the production of sweeteners based on stevia glycosides continues to grow.

*Methods for determining the main physical and chemical parameters of stevia plant raw materials.* To solve the tasks set within the framework of the dissertation research, a set of modern methods of physico-chemical analysis were used, which are based on the fundamental principles of organic chemistry, modern chemical and physico-chemical research methods: chromatographic (liquid and gas-liquid chromatography, chromatography in a thin layer), spectrometry (infrared spectrometry, nuclear magnetic resonance), gravmetric and electrochemical research methods, as well as standard titrometric methods [10,11,12]. Methods of differential and integral calculus with the involvement of modern software were used to process the results.

*Determination of the acid number*. The determination of the acid number (KCH) was carried out according to DSTU 4350:2004. The essence of the method consists in dissolving a certain mass of vegetable oil in a solvent or a mixture of solvents, followed by titration of free fatty acids with an alcoholic solution of potassium hydroxide.

Calculation of KCH (mg KOH / g) is performed according to the formula 1 and 2.

$$T_{KOH} = \frac{B \cdot T_{HCl/KOH}}{10} \tag{1}$$

where, B is the amount of HCl that went into titration of 10 cm3 0.1 N KOH solution, cm3.

$$KЧ = \frac{a \cdot T_{KOH}}{H} \cdot 1000 \tag{2}$$

where, a is the amount of 0.1 N KOH, which went to the titration of the sample, cm3;

H – hitch, g.

*Determination of saponification number*. Determination of saponification number (CHO) was carried out according to DSTU ISO 3657:2004. The essence of the method consists in dissolving a certain mass of vegetable oil, saponifying it and titrating the excess alkali with a solution of hydrochloric acid.

The calculation of CHO is made according to formula 3.

$$ЧО = (a - b)\, T_{HCl/KOH} / H\ 1000,\ \text{мг KOH/г} \tag{3}$$

where, THCl/KOH is the HCl titer by KOH;
a is the amount of hydrochloric acid used for titration
of the control sample, cm3;
b is the amount of hydrochloric acid used for titration of the working
sample, cm3.

Determination of the peroxide number. The determination of the peroxide number (IF) was carried out according to the DSTU ISO 3960:2001. The method is based on the reaction of the oxidation products of vegetable oils and animal fats with potassium iodide in a solution of acetic acid and chloroform, followed by the quantitative determination of iodine, which was released as a result of the reaction, with a solution of sodium thiosulfate by titration. The calculation of the IF is performed according to the formula 4.

$$ПЧ = (V_1 - V_2) \cdot T_{Na2S2O3/I2} / H \cdot 100,\ \%\ \text{масс. иода} \tag{4}$$

where, V1 is the amount of 0.01 N Na2S2O3 solution that went for titration in the control sample, cm3;
V2 – the amount of 0.01 N Na2S2O3 solution that went to titration
in the working sample, cm3;
TNa2S2O3/I2 is the titer of disodium trioxothiosulfate by iodine.

Determination of moisture content. The determination of the moisture content (B) was carried out according to DSTU ISO 662:2004 [46]. The method is based on heating a certain mass of vegetable oil at 103 ± 2 ° C until complete removal of moisture and determination of mass loss.

The calculation in is made according to the formula 5.

$$B = 100 \cdot (m_1 - m_2) / m, \text{ \% масс.} \qquad (5)$$

where, B is the moisture content, % by weight;

m is the weight of the suspension, g;

m1 is the mass of the cup with oil before drying, g;

m2 is the mass of the cup with oil after drying, g.

*Determination of odor and transparency.* The determination of odor and transparency was carried out in accordance with GOST 5472-50. The essence of the method consists in organoleptic determination of odor and determination of transparency of raw materials at a temperature of 20 ° C.

*Determination of the color of raw materials.* The determination of the color of raw

materials was carried out according to GOST 5477-93. The method is designed to determine the color number of all unrefined and refined vegetable oils (except cotton).

The method for determining the color number on the scale of standard iodine solutions is based on comparing the intensity of staining of the analyzed oil with the color of standard iodine solutions. The color number of the oil is expressed by the number of grams of free iodine, which is contained in 100 cm3 (% wt.) a standard solution of iodine, which has, with the same layer thickness of 1 cm with the oil, the same intensity of staining as the one being applied.

*Determination of non-fat impurities in raw materials.* Determination of non-fat impurities was carried out according to GOST5481-89. The method is based on the separation of non-fatty impurities that are not soluble in petroleum ether or low-boiling gasoline (nefras) from oil and subsequent determination after drying of the mass fraction of these impurities by weighing.

The mass fraction of non-fatty impurities (X) is calculated by the formula 6:

$$X = (m_2 - m_1) \cdot 100 / m, \text{ \% масс.} \qquad (6)$$

where, m is the mass of the analyzed oil sample, g;

m1 is the mass of the cup with a clean filter, g;

m2 is the mass of the cup with a clean filter and non–fatty impurities, g.

*Determination of the fatty acid composition of raw materials.* Determination of the fatty acid composition of raw materials was carried out according to GOST30418-96. The method is based on the conversion of triglycerides of fatty acids into methyl esters of fatty acids and gas chromatographic analysis of the latter on a chromatograph according to the instructions.

*Determination of the iodine number.* Determination of the iodine number was carried out according to GOST 5475-69 "Vegetable oils. Methods for determining the iodine number".

*Assessment of the composition of the selected clay.* The method is based on obtaining a diffractogram according to the instructions for the Dron-3 diffractometer.

## RESULTS AND DISCUSSION

After checking the raw materials for compliance with the standards, permission is given for its admission to production. Standardization and quality control of products is a means that significantly simplifies the production process and increases the level of uniqueness of the product. At this stage, the quality control specialist tests all the raw materials used, and equipment, and the technological process itself, and all intermediate results, including the final one. The quality of raw materials and ingredients, the material for the manufacture of capsules, tubes and jars for packaging, the quality of packaging are the components that work for the manufacturer and its products, and mistakes are excluded here. During the working process, up to 3 hundred analyses are performed by a group of professional researchers on quality control equipment. They allow you to track the compliance of the manufacturing process of the means and the serviceability of the equipment. Along with the control over the production process carried out in a working manner, there is also departmental quality control of bioactive additives and products produced. It is produced by the bodies of the department, directors of related enterprises, teams of supervisors, laboratories, craftsmen and specialists directly involved in production. Departmental control is another evidence of a strict approach to the quality of products, an interest in their safety and in compliance with high standards.

## CONCLUSION

Thus, the main rule of the manufacturer of food additives and products is to check the finished products for compliance with microbiological standards. To do this, samples are taken from each series of products for final testing. The products are checked for the correctness of labeling, organoleptic properties, microbiology, physico-chemical parameters, disintegration and solubility. Output quality control is only a link in the chain of measures aimed at obtaining products of ideal quality. And it is not final. Samples selected for testing are stored until the expiration date in the control department. This allows you to perform the necessary quality analysis of the product at any time.

This approach brings confidence to both the manufacturer, the customer, and the buyer in compliance with the standards of products, in perfect cleanliness and environmental safety.

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# DEVELOPMENT OF PRODUCTION TECHNOLOGY OF NEW TYPES OF MEAT BREAD WITH THE ADDITION OF TALKAN POWDER


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***Abstract***

*Currently, increasing attention is being paid to fortified foods. These include edible food products that contain the addition of one or more essential food ingredients to support the food product. Meat and meat products are among the most famous food products that are of great importance in the diet of modern people. Meat bread can be considered as the basis for creating products that have functional and technological principles that provide the human body not only with complete protein, but also with vitamins, minerals, and dietary fiber through the use of plant raw materials. In this regard, the work explored the possibility of developing a technology for the production of meat bread with the introduction of talkan (tary) powder into their recipe. Using the developed technology, several samples of meat loaves were experimentally processed: a control sample - without plant components and samples - with the addition of lentil powder, buckwheat powder and tary powder (talkan).*



***Keywords****: meat bread, beef, functionality, food, vegetable supplement*

## INTRODUCTION

Human health is closely related to proper and healthy nutrition. Therefore, the problem of providing the population with the necessary components contained in food, their proper use to maintain health and longevity, is currently an urgent problem. It is known that meat and meat products are biologically complete food products. However, in modern conditions, consumer demand has increased for food products with high nutritional value and preventive effect. To create food products that contain essential ingredients that are beneficial to human health and increase resistance to diseases, the search and use of various functional additives from local raw materials of animal and plant origin is required. A review of the literature confirmed the feasibility of improving the recipe for meat bread by adding plant materials. In this regard, one of the important areas of the meat industry is the development of meat products using herbal additives.

Domestic plant crops such as talkan (tars) are of interest as plant raw materials.

In recent years, consumers have been advocating for new foods that can provide health benefits. One of these products is millet processing products. Millet is one of the oldest grain crops in the CIS countries. Millet and flour are mainly produced from millet. Tarys are millet, which is prepared from specially roasted millet. And finely crushed tarys are called talkan. Tary obtained from millet have high nutritional value and good taste qualities. They do not contain gluten, and it has been determined that they play an important role in the regulation of glucose and cholesterol in the blood [1]. Tarys do not contain gluten, which makes it possible to use it in the diet of people with celiac disease. Millet is considered one of the most nutritious and least allergenic grain crops [2]. Tary are a source of some vitamins (especially group B), starch, amino acids, mineral elements and fiber [3]. In particular, it contains biotin, thiamine, nicotinic acid, folic acid, vitamins B6, B2 and B3 [4]. In terms of the amount of methionine and cystine in its composition, tarys nutritionally surpasses many cultures [4]. Tary can be used as an alternative product to control weight and reduce the risk of developing chronic diseases, such as diabetes mellitus [3]. Millet is easily absorbed by the body, helps to remove toxins, antibiotics and fat cells from it, and also helps to strengthen damaged bones and wound healing.

The purpose of the study is to develop a technology for meat bread made from 2nd grade beef with the addition of a plant component in the form of talkan (tary) powder and to assess the quality of the resulting product

## EXPERIMENTAL METHODS

Method of organoleptic analysis of meat bread. Organoleptic analysis is carried out according to GOST 33609-2015 meat and meat products. Organoleptic analysis. Determination and selection of descriptors for determining organoleptic properties in a multilateral way, GOST 9959-2015 meat and meat products.

## RESULTS AND DISCUSSION

Organoleptic analysis is characterized by a rating assessment of quality, which is carried out through taste, sight, smell, touch. The method consists of a verbal description of the properties of the product and an assessment on a certain scale.

The assessment of compliance of indicators in appearance, consistency, smell and taste is determined according to table 1 on a 5–point scale:

- 5 points-excellent quality, full compliance with the requirements;
- 4 points-good quality, minor inconsistencies;
- 3 points-satisfactory quality, significant inconsistencies;
- 2 points-unsatisfactory quality, some inconsistencies;
- 1 point-very poor quality, obvious inconsistencies (gross);
- 0-not subject to evaluation.

Table 1 - Meat bread quality indicators (sample)

| Point | Organoleptic indicators | | | | | | Overall quality assessment |
|---|---|---|---|---|---|---|---|
| | Appearance | Color in section | Smell | Taste | Consistency (soft, hard) | Juiciness | |
| 5 | Attractive | Attractive | Fragrant | Tasty | Soft | Juicy | Excellent |
| 4 | Good | Good | Quite fragrant | Delicious enough | Softish | Juicy enough | Good |
| 3 | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Medium | Medium | Satisfactory |
| 2 | Unattractive | Unattractive | Unpleasant | Unpleasant | Slightly firm | Dry | Unsatisfactory |
| 1 | Very bad | Very bad | Very bad | Very bad | Very hard | Very dry | Very bad |

The evaluation of the quality of the meat product of experimental and control samples was carried out according to generally accepted methods. The organoleptic evaluation, the results of which are shown in the figure, was carried out in accordance with GOST 9959-2015 "Meat and meat products. General conditions for organoleptic evaluation". Based on Figure 1, a meat bread containing 25% powder additives from talkan had the best results in points. The results of studies of organoleptic indicators are presented in Table 2.

Teachers of the Department of Food Engineering, in accordance with Table 1, tasted control and experimental samples of meat bread. Five samples were prepared with a different ratio of meat raw materials and vegetable additives, namely, with the addition of powder obtained by grinding tary (talkan). The results of an organoleptic study of a new type of meat bread are shown in Figure 1.

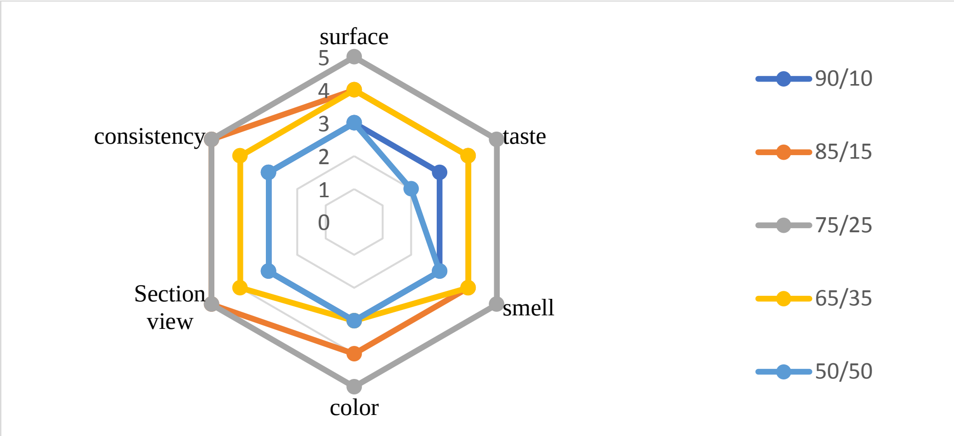


Fig.1. Sensory evaluation of a meat product with the addition of talkan powder

Table 2 - Organoleptic indicators of meat loaves

| Indicator name | The norm according to GOST 23670-2019 | Meat bread without vegetable additives (control) | Meat bread from talkan |
|---|---|---|---|
| Vnesnic species | With a clean, smooth, dry, evenly fried surface | Clean, smooth, dry, evenly fried surface | Evenly fried surface without cracks and tears |
| Consistency | Elastic | Elastic | Elastic, well baked, not sticky to the touch, without lumps |
| Color and type of incision | Pink or light pink minced meat is evenly mixed and contains pieces of raw beef fat with sides no larger than 6 mm | Pink minced meat, evenly colored and mixed | Light pink minced meat, finely chopped, homogeneous, evenly mixed, pieces of fat are visible on the cut |
| Smell and taste | Characteristic of this type of product, without extraneous taste and smell, with the aroma of spices, moderately salty | Characteristic of this type of product, with the aroma of spices, without extraneous tastes and odors, moderately salty. | Characteristic of this type of product, moderately salty with the aroma of spices, a pleasant taste and the smell of packaging |
| Form | Rectangular, trapezoidal, oval | A regular trapezoidal shape with smooth side, bottom and top surfaces, corresponding to the bread form in which the baking was made | |

Table 3 - Physico-chemical indicators of a meat product

| The name of the indicator | Pate samples | |
|---|---|---|
| | control With talkan (tarys) | control With talkan (tarys) |
| | 61,8 | 60,1 |
| humidity,% | 18,1 | 18,4 |
| protein,% | 20,03 | 18,7 |
| fat content,% | 7,4 | 12,6 |
| carbohydrates,% | 1,15 | 1,22 |
| Mass fraction of chlorides, % | 6,55 | 6,65 |

Based on the table, it follows that the humidity in the pate samples with the addition of vegetable additives, talkan (tarys) -60.1%, slightly decreases compared to the control sample (61.8%). The amount of proteins varied from 18.1% in the control sample to 18.4% in the sample with 18.4% from talkan (tarys). The decrease in fat content in new types of pates, compared with the control sample, is explained significantly lower in plant raw materials. Thus, the fat content decreased in samples from talkan (tarys) 18.7%, compared to the control-20.03%. The amount of carbohydrates increased from 7.4% in the control sample to 12.6% in the buckwheat sample, respectively.

With the help of an 18M-6390 electron microscope, studies of the (elemental) mineral composition of the meat loaves developed by us were carried out. As is known, minerals are involved in all mass exchange processes (proteins, fats, carbohydrates, vitamins, etc.), especially phosphorus and calcium play an important role in the formation of bone tissues. For example, phosphorus is a building element. In the tissues of a living organism. Phosphoric compounds play a particularly important role in the actions of the brain, in the heart muscles. Calcium is necessary for the proper formation of bone tissues. Magnesium contributes to vasodilation, stimulation of intestinal walling and bile secretion. If we take into account that mineral substances make up the main structural and functional properties of the body, participate in cardinal synthesis reactions, in enzymatic and catalytic reactions, then the resulting product can be used for therapeutic and preventive purposes

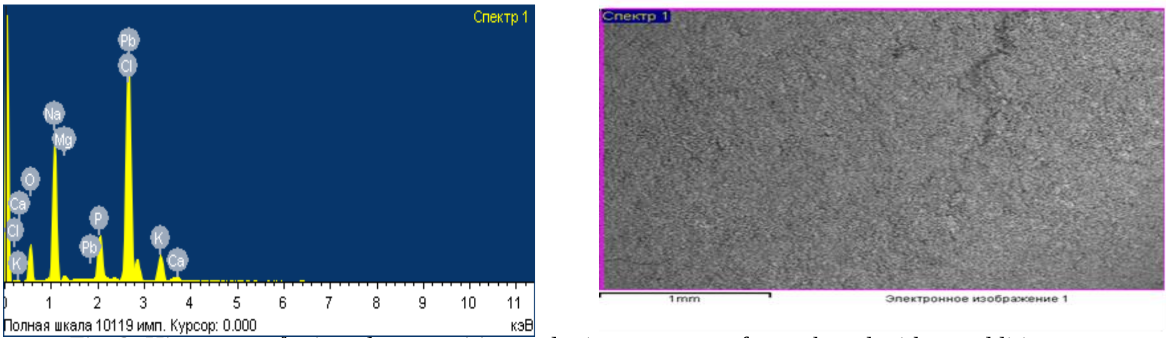


Fig. 2. Histogram of mineral composition and microstructure of meat bread without additives

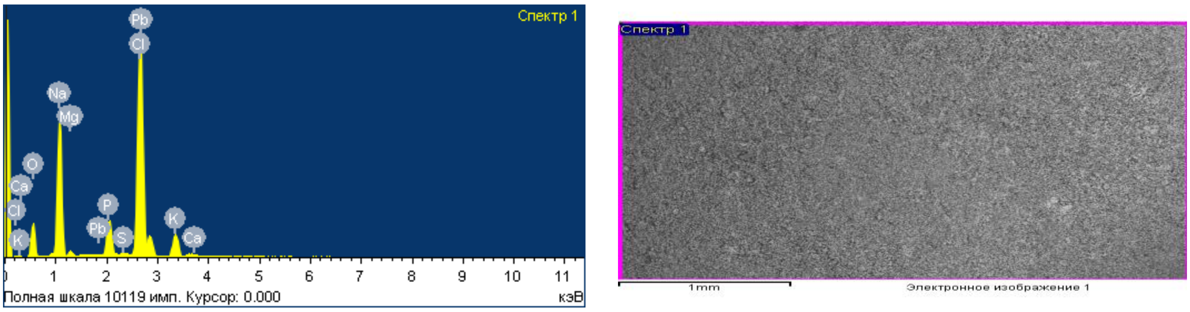


Fig. 3. Histogram of mineral composition and microstructure of meat bread with the addition of talkan powder

The technology of cooking meat bread with the addition of powders from tary (talkan) has been developed (Figure 4).

As a basis, the technology of meat bread production was used, in which, during the preparation of meat loaves, minced meat obtained on a batch fine-grinding cutter was mixed in stirrers with coarsely ground structural components. In our case, the preparation of raw materials consisted in the release of grade 2 beef meat from veins, then it was cut into large pieces. After veining, the meat was subjected to preliminary grinding in a meat grinder with a 16-25 mm grate and salted with table food and nitrite salt. Salted meat was kept for 12 hours at a temperature of 0-4oC in a refrigerator for maturation.

Salted and aged beef meat was crushed and processed on a cutter for 3-5 minutes with the addition of spices, hydrated vegetable powders, ice water and starch. Starch was dissolved in ice water until homogeneous (without lumps).

In parallel, the pre-sifted powder of tary was placed in a cutter, then, when the bowl was rotated, drinking water (3:1) was introduced at a temperature of 15-20 ° C, in a given ratio. The duration of the cutting was 3-4 minutes until a dense viscous mass with a glossy sheen was obtained. The resulting hydrated flour was kept for 10 to 15 minutes to swell the proteins and ensure an even distribution of moisture in the resulting mass. The prepared hydrated powder of tary was added to the minced meat. The dosage of adding a vegetable additive to minced meat was calculated experimentally.

The resulting minced meat from ground beef meat with spices and additives of vegetable ingredients specified in the recipe was mixed with finely ground fat. Then the resulting minced meat was filled with special aluminum baking molds, pre-greased with fat, preventing the presence of pores and air voids.

Baking was carried out in the oven for the first hour at a temperature of 110 ° C, the second hour at a temperature of 150-160 ° C. The baking process is considered finished if the temperature inside the meat bread has reached 70 ° C. Meat bread were taken out of the molds and cooled first at room temperature, and then at 10 ° C in the refrigerator for 10-12 hours.

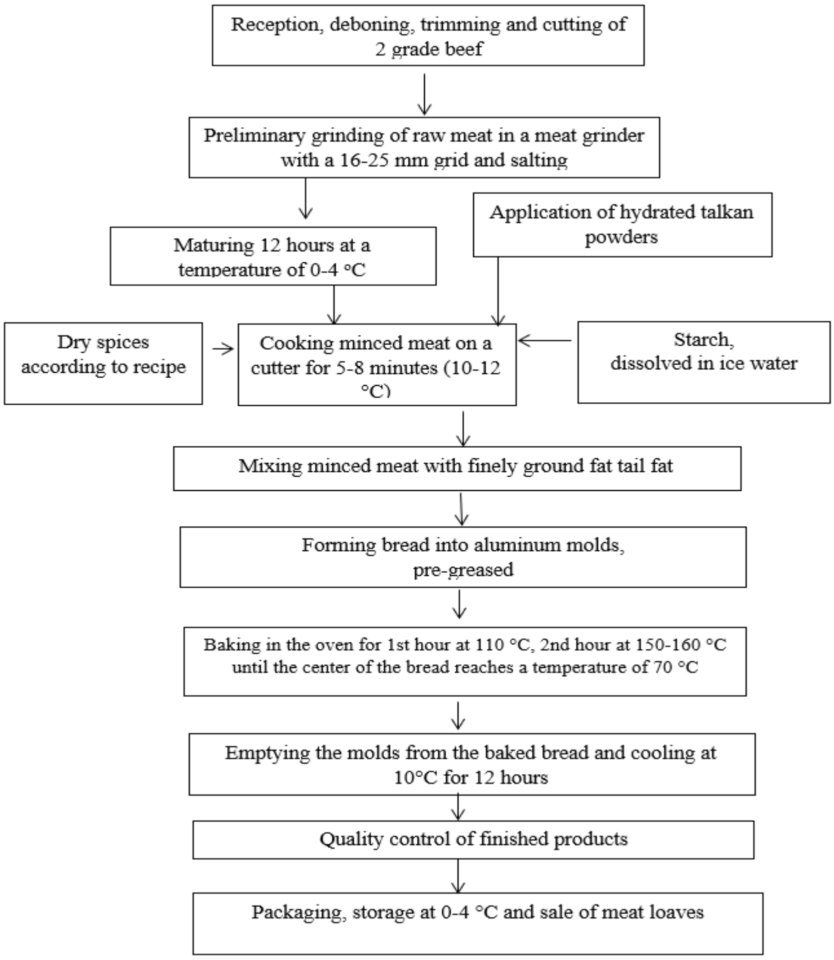


Fig. 4. Technological diagram for the production of new types of meat bread with the addition of talkan powder

## CONCLUSION

Thus, plant components contribute to an increase in the chemical and biological parameters of meat products, having a beneficial effect on the final quality of products, increasing their nutritional and biological value against the background of existing, classic versions of these products. Enriched meat loaves have a positive effect, and their use is spreading in the dietary and medical fields. Therefore, such meat products will be in great demand among consumers who value their own health.

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# RESEARCH RESULTS ON ENRICHMENT OF WHEAT FLOUR WITH VINAMINE-MINERAL COMPLEXES AND SELENIUM

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***Abstract***

*Fortification of flour, including wheat, is a preventive method aimed at improving the nutrition of the population by increasing the amount of micronutrients and vitamins in products that are widespread in the structure of food consumption. To improve the quality of nutrition of the population, Kazakhstan actively accepts international recommendations in the field of prevention of various diseases that are associated with a lack of certain microelements caused by natural and climatic factors. In recent years, it has been possible to solve such problems as iodine and iron deficiency by legislating the mandatory presence, for example, of iodine in table salt and iron in flour produced in the territory of the Republic of Kazakhstan. The next step is to provide zinc and selenium at recommended levels through basic foods. The article presents the results of studies on the selection of optimal ratios of these microelements during the fortification of different types of wheat flour. It has been established that to replenish the daily requirement of an adult, 0.0015 mg of selenium per 100 g of flour is needed. It has been established that it is possible to use ready-made vitamin and mineral premixes from Kazakhstani manufacturers, which are available on the market and contain elemental iron, zinc oxide, tamine mononitrate, riboflamin, niacin, folic acid, tricalcium phosphate.*

***Keyword*****:** *vitamin and mineral premixes, selenium, wheat flour, fortification, choice, disease prevention, effectiveness.*

## INTRODUCTION

The current problem associated with the lack of some vital micro- and macroelements, vitamins, which the human body should receive daily, but does not receive, occurs in almost many countries, regardless of whether it is a developed or developing country, but, of course, in developing countries In countries with low incomes, this problem is more acute, since not everyone can afford the entire line of food products that contain certain nutrients. Taking into account these realities, WHO in its recommendations provides ways to solve such problems through the enrichment of some products, in the basics, which include flour and its processed products with the most important elements for the body, such as iodine, iron, zinc, selenium, etc. The Republic of Kazakhstan, by its territorial location, belongs to countries with iodine deficiency, both in soil and in water, the results of such studies were carried out back in 1979 by scientist M.E. Zeltser, when it turned out that the prevalence of goiter endemicity among the adult population reaches 50-60%, it is especially common in the south and east of Kazakhstan [1]. In this regard, back in 2001, the Government of the Republic of Kazakhstan developed and implemented the Program “On the prevention of iodine deficiency disorders among the population of the Republic of Kazakhstan for 2001-2005” [2,3]. This made it possible to reduce diseases associated with iodine deficiency by almost half, since fortified table salt produced in Kazakhstan is all iodized, and it is used daily by the population of the country, both in cooking and comes with all food products that contain such salt.

However, scientists are faced with the task of preventing other diseases associated with a lack of other microelements, such as zinc, iron, B vitamins, etc. [4]. Research on elements such as iron and zinc is already yielding results, since in Kazakhstan, flour milling enterprises are actively enriching flour with such elements, as well as its processed products [5].

By us, as part of dissertation research. Work is being carried out to study and use ready-made vitamin-mineral complexes, which contain a number of microelements and vitamins, as well as a separate microelement such as selenium. Selenium is one of the essential trace elements for humans. It is one of the trace elements involved in the metabolic, biophysical and energy reactions of the body, ensuring the viability and function of cells, tissues, organs and the human body as a whole. The role of selenium is especially important for the functional activity of organs such as the heart, liver, kidneys, etc. Selenium is one of the key microelements that ensure the normal functioning of the body's enzymatic antioxidant system [6]. In combination with vitamins E and A, it significantly protects the body from radiation exposure. Selenium reduces the risk of developing certain chronic diseases, heart disease, the development of malignant and benign tumors, regulates the functioning of the thyroid gland and strengthens the immune system. Selenium deficiency leads to Kashin-Beck disease (osteoarthritis with multiple deformities of the joints, spine and limbs), Keshan disease (endemic myocardiopathy), hereditary thrombasthenia [7]. In this regard, adequate supply of selenium is very important for human health.

Daily intake of selenium from food sources varies significantly in different parts of the world and varies widely: 8-11 mcg in some provinces of China, 400-500 mcg in Canada, 500-600 mcg in some US states. In Kazakhstan, in most regions, this figure is in the range of 20-67 mcg/day. According to the norms of physiological needs for energy and nutrients for various groups of the population of the Republic of Kazakhstan, the body of a healthy adult should receive 50-75 mcg of selenium daily. Kazakhstan has low levels of selenium in soils, water and food products. In everyday life, selenium enters the human body in organic form as part of food of plant and animal origin. However, according to epidemiological studies, more than 80% of the population has less than optimal levels of selenium. This necessitates the correction of selenium status in many regions of our country. Therefore, the task of increasing the content in food products, incl. flour and its processed products, to rationalize nutrition and deliver missing nutrients to the body, incl. selenium.

## EXPERIMENTAL METHODS

To select the most significant ones for improving the nutritional and biological value of flour, a review of the vitamin and mineral complexes available on the market was carried out. The selection was made based on composition and manufacturer. We consider Kazakhstani manufacturers to be the most optimal, since logistics, i.e. delivery to enterprises, would be more efficient. Such a vitamin and mineral complex is a premix of the KAZvit 28190 brand, produced by the Kazakh manufacturer Deutsch Standatd LLP, produced according to the organization standard STO LLP 15M1101. KAZvit 28190 contains elemental iron, zinc oxide, tamine mononitrate, riboflamin, niacin, folic acid, tricalcium phosphate. According to the STO, the dosage of the vitamin-mineral complex KAZvit 28190 is 100-150g per ton of flour.

Also, as part of the research, a source of selenium was selected in a form that ensures its safety for use for the human body in the form of L-Selenomethionine. Selenium dietary supplement was purchased, in which the content of L-Selenomethionine was 20 mg. We conducted experiments on the enrichment of premium, first and second grade wheat flour of the Mayakum-Astyk brand of Erasyl 2030 LLP. In the original flour, physicochemical indicators were determined - moisture, protein, ash content, starch, damage, greenness index. The results of the analysis showed their correspondence to the type of wheat flour. L-Selenomethionine was added to the prepared samples of the original flour of several varieties in a ratio of 0.0010 - 0.0015 mg per 100 g of flour, depending on the daily intake into the human body. Sample No. 1 - 0.0015 mg, sample No. 2 - 0.0001 mg, sample No. 3 - 0.00005 mg. This ratio is due to the fact that, according to processing technology, premium flour is considered, in terms of the presence of the initial content of various minerals and vitamins, to be less enriched than 1st grade flour, and even more so 2nd grade flour. The preparation of samples was carried out on the basis of the laboratory of the Department of Standardization and Certification of SKU named after. M. Auezova. Samples of selenium-enriched flour were submitted for analysis for mineral composition to the certified regional engineering testing laboratory "IRLIP" of SKU named after. M. Auezova, based on application No. 163, dated October 10, 2023. The samples were burned in a muffle furnace to produce ash, in which the mineral composition was determined by X-ray spectral method using a scanning electron microscope.

## RESULTS AND DISCUSSION

The results of the mineral composition of wheat flour of various varieties are presented in Figures 1-3.

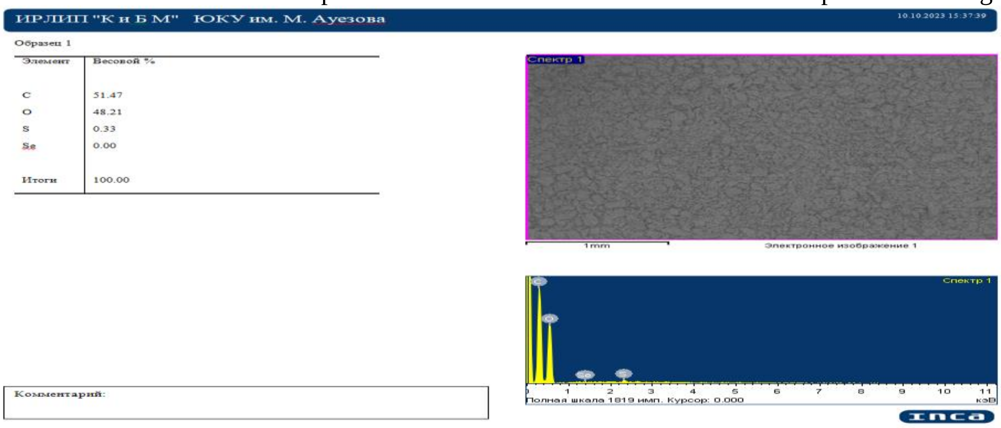



Fig.1. Mineral composition of premium wheat flour

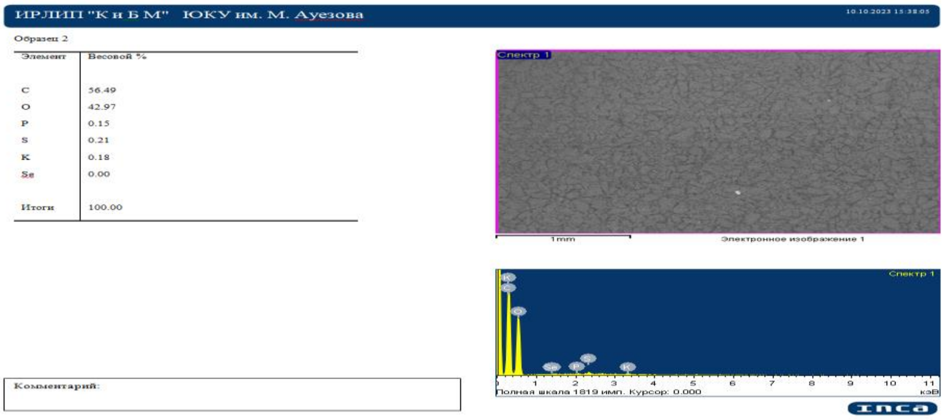



Fig.2. Mineral composition of 1st grade wheat flour

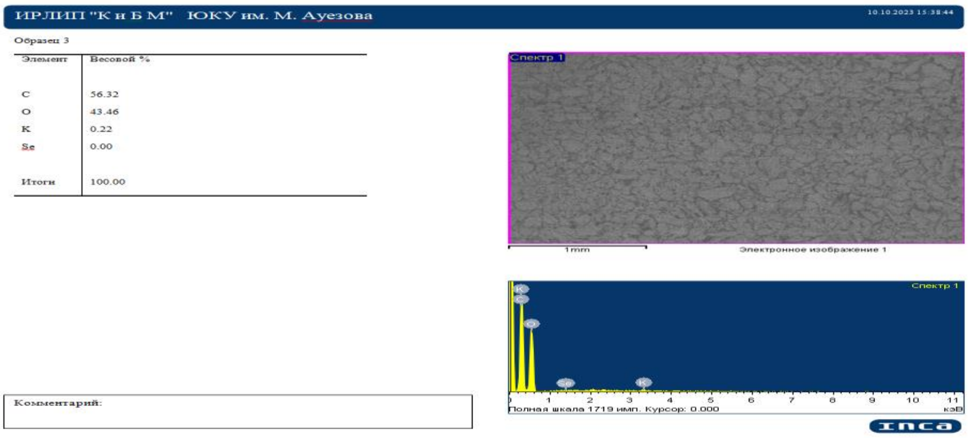
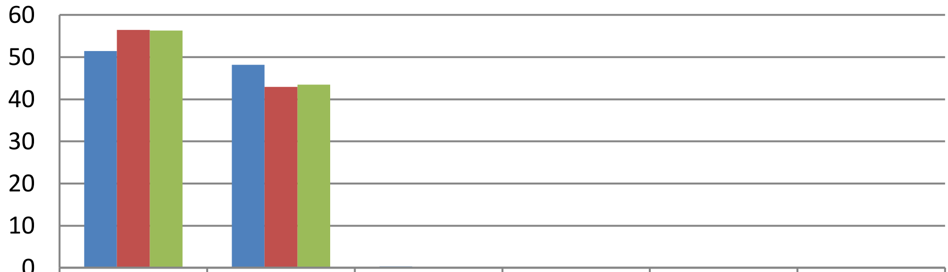



Fig.3. Mineral composition of wheat flour 2 grades

The results of the analyzes were summarized in the form of diagrams presented in Figure 4.

**Mineral composition of the product under study**




| | C | O | S | Se | P | K |
|---|---|---|---|---|---|---|
| Sample 1 | 51,47 | 48,21 | 0,33 | 0,0015 | 0 | 0 |
| Sample 2 | 56,49 | 42,97 | 0,21 | 0,0001 | 0,15 | 0,18 |
| Sample 3 | 56,32 | 43,46 | 0 | 0,00005 | 0 | |

Fig. 4 - Mineral composition of various types of wheat flour enriched with selenium

As can be seen from Figure 4, the X-ray spectral method showed the presence of selenium in the samples, however, due to the low selenium content, there is a need to use the atomic adsorption method, which will confirm the selenium content in the doses with which it is necessary to enrich the flour.

## CONCLUSION

Thus, the studies have shown that when enriching with ready-made vitamin-mineral premixes, we consider the choice of Kazakh manufacturers to be the most optimal, since logistics, i.e. delivery to enterprises, is more efficient. Such a vitamin and mineral complex is a premix of the KAZvit 28190 brand, produced by the Kazakh manufacturer Deutsch Standatd LLP, produced according to the organization standard STO LLP 15M1101. KAZvit

28190 contains elemental iron, zinc oxide, tamine mononitrate, riboflamin, niacin, folic acid, tricalcium phosphate. When enriching with selenium, it is necessary to select it in a manner that ensures the safety of its use for the human body. This form includes L-Selenomethionine. Such work helps Kazakh enterprises comply with international recommendations, which take into account and expand the use of elements such as selenium, which will undoubtedly help replenish the nutrition of the Kazakh population.

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UDC 687.1

# CAPILLARY-POROUS STRUCTURE OF THREAD CONNECTING SEAMS. THE MECHANISM OF MOISTURE TRANSFER TO THE INSIDE OF CLOTHING MADE OF GENUINE LEATHER AND COMPOSITE MATERIALS

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***Abstract***

*The article considers that the main criteria characterizing the level of quality of the joints of clothing parts made of leather and composite materials are the strength and moisture permeability of the seams. Theoretically, it has been established that thread joints in products made of natural and artificial leather are a heteroporous body and contain three groups of pores and capillaries in their structure, which affect the penetration of moisture through the seams to varying degrees. For the first time, the mechanism of moisture transfer through the seams of various structures was revealed. Thread connections are always filled with water when interacting with atmospheric moisture. Filling of voids occurs due to absorption, as well as capillary condensation of steam in micro- and macro-capillaries. The reason for the transfer of moisture to the inside of the product is the difference in capillary potentials that occurs in the picket. On the basis of theoretical analysis and experimental studies of the stress-strain region of joints, the relationship between mechanical loads on parts and the shape of materials at the junction boundary has been established. Based on experimental studies and theoretical generalization, it has been established that the capillary-porous structure of thread compounds changes when interacting with atmospheric moisture.*

***Keywords:*** *genuine leather, composite materials, thread connections, capillary absorption, atmospheric moisture, capillary-porous body.*

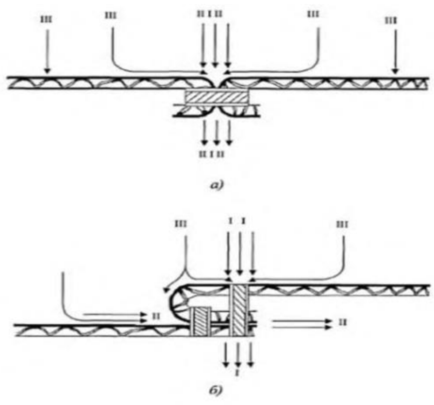
## INTRODUCTION

During operation, clothing made of genuine leather and composite materials may be exposed to droplet - liquid or vaporous atmospheric moisture. The small size of the pores and capillaries contained in the structure of the thread seam eliminates the direct ingress of raindrops into the undercover space, therefore, the main type of moisture transfer to the inside of clothing will be capillary absorption. The hydrostatic effect and kinetic energy of raindrops can enhance capillary mass transfer.

The experience of sewing enterprises has shown that the most common when connecting parts of clothing made of genuine leather and composite materials, received stitched and customized seams. A detailed analysis of the design of the adjustment seam in clothing made of these materials allows us to establish that the seam structure contains various voids that allow moisture to penetrate to the wrong side of the product [1].

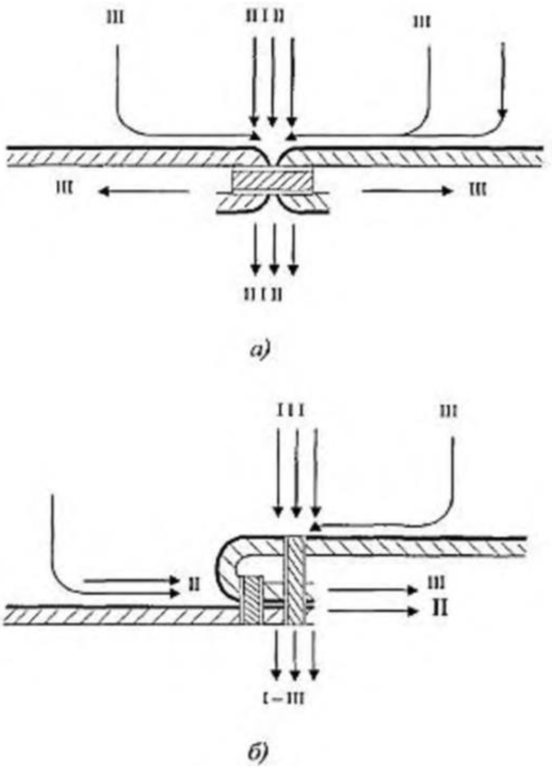
## MATERIALS AND METHODS

Figures 1 and 2 show schematic images of the connecting seams used in the stitching of clothing parts made of genuine leather and composite materials.



a) stitch seam;
b) adjustment seam

Fig.1. Ways of moisture penetration through seams in genuine leather products




a) stitch seam;
6) adjustment seam

Fig. 2. Ways of moisture penetration through seams in products made of composite materials

The ways of penetration of atmospheric moisture on the inside of clothing are:

- holes formed in the material by a sewing machine needle and capillaries of sewing threads (the first group of pores and capillaries (I));
- pores formed at the joints due to loose fit of parts in each stitch of the thread stitch (second group of pores (II));
- capillaries of genuine leather or textile (knitted) basis of composite materials (the third group of holes and capillaries (Ш)).

Thus, possible ways of penetration of moisture on the inner side of the products are voids contained in the structure of the seam. All voids according to [2] can be divided into microcapillaries, macrocapillaries and macropores, while the body in which these voids are located is called capillary-porous.

We will analyze the behavior of liquid (moisture) in capillary-porous bodies, representing the capillary in the form of a cylindrical tube with a limited amount of liquid, which has the shape of menisci with radii r. In such capillaries, the shape of the meniscus does not depend on gravity, but is determined only by the interaction of the liquid with the walls of the capillary. If the tube is not small enough in radius, the shape of the meniscus depends on the action of gravity, i.e. on the amount of fluid in the tube. The hydrostatic pressure of a column of liquid with a height in a vertical cylindrical tube of radius r is balanced by the difference in capillary pressures of the upper and lower menisci. The relationship between the curvature of the lower and upper meniscus can be expressed [2]:

$$\frac{1}{r_2'} = \frac{1}{r_1'}\left(1 - \frac{\ell}{h_1}\right), \qquad (1)$$

where $r^1_1$ and $r^2_2$ - are, respectively, the radii of the upper and lower menisci, m;
$h_1$ - is the maximum height of liquid lifting in a cylindrical tube, m;
$l$ - is the height of the liquid column, m.

It can be seen from the relation (1) that as the height of the liquid rise $l$ increases, the radius of curvature $r^1_1$ of the lower meniscus increases (the curvature decreases). When $l > 0$, the radius of curvature becomes equal to infinity (the surface of the meniscus is flat), with a further increase in $l$, the curvature of the lower meniscus $\left(\frac{1}{r_2'}\right)$ becomes positive, and the surface is convex. Thus, as the height of the liquid column increases, the lower meniscus becomes convex from the curved one with a gradually decreasing radius of curvature, up to the separation of the drop from the lower end of the tube.

The pores of the body can be considered capillaries [2] if the value $\frac{l}{h1} \leq 1$, i.e. the curvature of the upper and lower meniscus is the same. For example, at $l = 100$ *mm*, the value $\frac{l}{h1}$ can be neglected (with an accuracy of 6%) if the radius of the tube is $r \leq 103$ *cm* and the condition of complete wetting is met ($Cos\ \theta = 1$).

Thus, for a porous body with a size $l = 100$ *mm*, the pores can be considered capillary if their radius is less than *0.01 mm*, and the body itself can be called capillary-porous. As can be seen from the relation (1), the concept of capillary pores of a given body depends on its size [2].

Consequently, the voids contained in the structure of the thread seam can be attributed to pores or capillaries, depending on the value of $\frac{l}{h}$, i.e., depending on their size.

Guided by the ideas outlined above about the forms and types of connection of moisture with natural leather and composite materials, as well as by examining the capillary-porous structure of thread seams and fluid movement in capillaries and pores, the mechanism of moisture transfer in the structure of seams and through them to the inside of clothing can be described as follows.

In conditions of high humidity (rain, fog, snow), a dry capillary-porous body tends to balance with the environment by adsorbing water molecules from the air. As a result, the walls of the pores and capillaries will be covered with a layer of water about $10^{-3}$ cm thick. In hapillaries with a radius $r \leq 10^{-3}$ *cm* and closed capillaries, these layers will merge, and menisci of water with a curved surface will form. Immediately after that, there is a difference in the partial pressure of steam in the atmosphere (equation (2)) and capillary condensation occurs above the surface of the menisci.

$$p = p_s \exp\left(-\frac{2\sigma V_{мол}}{rRT}\right) \qquad (2)$$

where

$p$ - is the saturated vapor pressure above the meniscus, Pa;

$p_s$ - the pressure of the inflated vapor above the flat surface of the liquid, Pa;

$\sigma$ - is the surface tension of the liquid, N/m;

$V_{mol}$ - is the molar volume of the liquid;

$r$ - is the radius of curvature of the liquid surface, m;

$R$ - is the gas constant;

$T$ - is the absolute temperature, K.

As a result of capillary condensation of steam on the walls of the capillary, the narrowest capillaries are filled first, and then the wide micro- and macropores that are contained in the structure of fastening sewing threads, i.e. capillaries of group I and III. The amount of moisture that has filled the capillaries depends on the hygroscopic absorbency of the sewing threads and the material itself.

When the seam comes into direct contact with moisture, the wide pores of group II are filled first, and then the narrower ones. Moreover, the filling of narrow pores and capillaries will occur not only due to direct contact with the liquid medium, but also due to the transfer of moisture from wide pores and capillaries, which in this case play the role of transport pores, into narrow ones. This will happen because the wetting liquid will mix from the lowest potential to the highest potential: a narrow capillary sucks liquid from a wide capillary. It should be noted that the non-wetting liquid moves, on the contrary, the exhaust gas of the highest potential to the lowest [2].

After a certain period of time, as a result of direct contact of atmospheric moisture with the thread seams, the capillaries of groups I, II and III will be filled with water. At the same time, the capillary-porous structure of the thread seams will change. At 100% humidity, natural leather swells, and the threads that hold the seam together, depending on their fibrous composition, undergo anisotropic swelling. As a result, the puncture hole of the leather fabric with a sewing needle is reduced, and further penetration of moisture into the structure of the thread seam is limited. It is also known [3] that there is no mixing of water in a capillary already filled with water.

The described mechanism of atmospheric moisture penetration into the structure of thread seams is characteristic of the operation of clothing when exposed to it first with vaporous, and then with droplet-like moisture. In the case when clothing from conditions with low relative humidity gets into the air and is immediately exposed to rain, the mechanism of moisture penetration into the seam structure will differ in that the processes of adsorption, capillary condensation and hydrostatic absorption will leak simultaneously.

Thus, from all of the above it follows that the thread connecting seams of clothing made of genuine leather and composite materials will be filled with moisture. The maximum amount of water that can be contained in the seam depends on its porosity and the type of exposure to atmospheric moisture.

Seams containing water can pass it to the inside of the garment. The reason for this penetration is the difference in capillary potentials, which occurs when dry and wet materials come into contact (Figure 3).

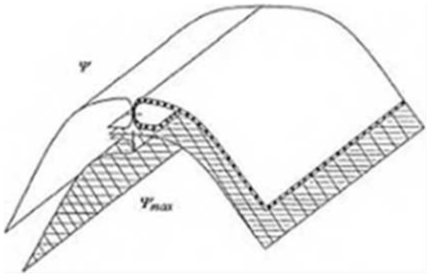


Fig. 3. Distribution of potentials in the shoulder seam area

The capillary potential of ψ dry ice is maximal [3]:

$$\Psi_{\max} = \frac{2\sigma Cos\theta}{r\rho_{ж}}, \qquad (3)$$

where $p_{жс}$ - is the density of the liquid, kg/m$^3$.

As the capillary is filled with water (Figure 4), regardless of how this filling occurs (capillary absorption or condensation), the capillary potential decreases:

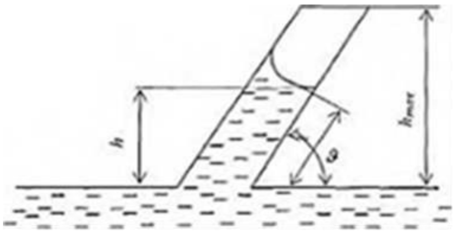


Fig. 4. The height of the liquid rise in an inclined cylindrical capillary

The potential of the suture capillary. completely filled with water, equal to zero. Based on studies [3], it can be assumed that in the capillaries of the seam, as the hc is filled with water, the movement of water to the inside of the garment from the influence of excessive capillary potential will stop. Such phenomena will occur in the connecting seams of the top of the product. When the wet seams of the top and the dry lining of the product come into close contact, a package of clothes with a certain potential difference is formed. As a result, moisture, striving to move from a lower capillary potential to a higher one, will fill the pores and capillaries of the lining in contact with the seams of the upper garment. That is, the lining will get wet through the connecting seams of the top located on the supporting surface of the human body.

The rate of water penetration to the inner side of the product will depend on which group of pores and capillaries this capillary will belong to, on the radius of the puncture hole, on the angles of inclination of the punctures to the horizon g0, as well as on the length of the capillaries *l* [4].

$$\frac{d\ell}{d\tau} = \frac{\Psi}{\ell}\,\frac{r^2\rho_{ж}}{8\eta}, \qquad (5)$$

where

*r* - is the absorption time, with;

*η* - is the viscosity of the liquid, with.

From the mechanism of atmospheric moisture transfer described above through the connecting seams to the inner side of the product, it follows that the rate of absorption of the rod is directly proportional to the square of the radius g, which in turn depends on the technological parameters of the formation of the connecting seam. In particular, to reduce the radius of group I capillaries, it is necessary to choose a sewing needle (number and sharpening of the tip) that would reduce the capillary absorbency of the connecting thread seam [5].

## RESULTS AND DISCUSSION

To reduce the radius of perforation of the skin with a needle, it is necessary to use a thin needle, which, in turn, requires the use of sewing threads with a low linear density. As is known, such threads have a breaking load less than threads with a higher linear density. Consequently, a compound made with a thin needle will have low strength properties.

## CONCLUSION

In order to obtain a compound with good moisture-proof and strength properties, it is necessary to select such technological parameters that, with a decrease in the opening of the puncture, would not worsen the strength of the joint both in the newly manufactured product and during operation.

As is known, during the period of operation, the product is exposed to liquid, droplet-liquid and vaporous moisture. Under the action of this moisture, the fibers of the thread and the swelling skin, can close the perforation hole. This assumption needs to be tested experimentally.

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# CLASSIFICATION OF FIBROUS WASTE


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***Abstract***

*In the technological process of primary processing of cotton, in addition to the main products - cotton fiber, cotton seeds and linters, a large amount of fibrous waste is obtained from which, as a result of processing, fibrous materials are extracted, suitable as raw materials for textile and other industries.*


***Keywords:*** *fiber, lint, quarrel, raw cotton, variety, seeds, regeneration.*

## INTRODUCTION

Fibrous waste from the cotton ginning industry is divided into three types

- fibrous lint;
- regenerated cotton fiber;
- cotton fluff.

Fibrous ooze includes purified fibrous waste from gins, fiber purifiers before the first linting of regenerators when processing fibrous waste of 1st and 1st grades of raw cotton and cotton fiber condensers, fibrous lint in appearance is a mass of underdeveloped puny seeds / lint / cotton with varying degrees of drooping, with an admixture of fiber adhered together with the lint in a free state and fibrous defects and litter.

## EXPERIMENTAL PROCEDURE

Fibrous lint depending on the type of raw cotton, pure mass fraction fibrous part and color and are divided into two types:

1st - obtained by processing 1st and n varieties of raw cotton;

2nd – obtained by processing w and 1 from raw cotton varieties.

Fibrous lint must meet the requirements specified in Table 1.

Table 1. Nominal values of fiber lint

| The name of indicators | Characteristics and standards by type | |
|---|---|---|
| | I | II |
| Total mass color | White to pale to creamy yellow | Yellow to light brown |
| Mass fraction of pure fibrous part, % no less | 40 | 30 |
| Standard moisture content | 14 | 20 |
| Nut/underdeveloped seeds and seed skin without fibers | Not standardized | |

The mass fraction of pure fibrous part includes:

- underdeveloped seeds covered with fiber / fibrous lint /;
- fibrous defects / flagella, shiny plastic of immature fiber, skin with fiber and fluff, nodules /;
- free fiber.

Regenerated fiber includes fiber obtained at cotton mills after processing of fibrous lint of the 1st and 2nd types on a regeneration machine. Regenerated fiber is characterized by a large mass fraction of defects and impurities, as well as non-standardized length, an increased proportion of short fiber //fluff/ and a reduced staple length of cotton fiber of a given cotton variety. The regenerated fiber is divided depending on the breaking load For two grades: I and II. Regenerated fiber must comply with the standards specified in Table 2

Table 2. Regenerated Fiber Ratings

| № | The name of indicators | Standards for varieties | |
|---|---|---|---|
| | | I | II |
| 1. | Breaking load, cN / gf / | 3,8 / 3,9 / - 3,7 / 3,8/ | |
| | | and more | or less |
| 2. | Mass fraction of defects and impurities, % | 10,0 | 20,0 |
| 3. | Standard humidity,% | 9,0 | 12,0 |

Cotton fluff includes clogged and dusty fluff collected by cyclones after cotton linter battery condensers and seed cleaners before the second and third linting. Cotton fluff has the appearance of short fibers rolled into lumps and, depending on the type of raw cotton, is divided into two groups:

1 – obtained by processing raw cotton of grades 1 and 2;

2 - obtained by processing and 1 in varieties.

The type of fiber wool and the group of cotton fluff are determined by appearance by comparison with samples in a prescribed manner.

Lint is obtained by exposing the seeds on the linters after ginning. Depending on the variety of seeds and maturity of the lint.

Depending on the length of the staple, linters are divided into three types:

Type I – staple length from 13 – 14 mm or more:

Type II - staple length from 7 – 8 and 12 – 13 mm:

Type III - staple length less than 6 - 7 mm.

**RESULTS AND DISCUSSION**

Comparing the quality indicators of fibrous waste from textile and cotton ginning industry, it can be concluded that they can be used to produce carded yarn after appropriate cleaning to achieve standardized clogging. To study the composition of fibrous lint at the Kasansay cotton plant, a series of experiments was carried out with the processing of raw cotton of grades 1, 2, 3 and 4. The analysis was carried out by manual analysis, the results of which are shown in Table. 3.

Table 3**.** Composition of fibrous lint by fractions

| Variety cotton raw | Variety fibers | Fibrous lint from fiber gins dragged | | | | Fibrous fiber-cleaner hives | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | fibers, % | Lint nut,, % | rubbish, % | Broken seed peel with fiber % | fibers, % | Lint nut,, % | rubbish, % | Broken seed peel with fiber % |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | I | 38,6 | 27,2 | 32,0 | 2,2 | 61,6 | 21,1 | 14,5 | 2,8 |
| 2 | II | 33,2 | 29,3 | 34,1 | 3,4 | 46,7 | 23,7 | 16,2 | 5,4 |
| 3 | III | 29,0 | 30,4 | 37,0 | 3,6 | 42,4 | 34,3 | 25,5 | 2,8 |
| 4 | IV | 20,0 | 32,4 | 43,3 | 4,3 | 43,3 | 30,8 | 20,8 | 5,1 |

Research has shown that the composition of fibrous lint includes fiber, large and small debris of organic and mineral origin, lint with matted fibers and nuts, crushed seeds, skin with fiber, nodules, and combined defects. Fibrous waste from fiber scourers is highly fibrous and a larger quantity of fibered skins and broken seeds than gin waste. Studies of fibrous lint from hand-picked raw cotton, first grade, Namangan-77 selection, determined the main components and their quantity, the results of which are given in Table 4.

Table 4**.** Main components of fiber lint

| № | Name of components | Number of components, % |
|---|---|---|
| 1. | Free fiber | 37,0 |
| 2. | Lint nut | 30,1 |
| 3. | Lint covered with fiber | 4,5 |
| 4. | Broken seed | 2,2 |
| 5. | Peel with fiber | 3,3 |
| 6. | Large and small litter | 10,4 |
| 7. | Combined defects | 0,6 |
| 8. | Cotton fluff | 11,3 |
| 9. | Foreign impurities | 0,6 |

As can be seen from Table 4. the sum of the shares of fibrous components of lint makes up the majority of it /86.8%/, which is the basis for the feasibility of extracting spinnable fibers and their regeneration.

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# THE MAIN ADVANTAGES OF THE AUTOMATIC TEMPERATURE MEASUREMENT AND CONTROL SYSTEM IN RIOTS


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***Abstract***

*SCADA is a separate dispatcher system. This system is designed to collect, process and manage information on the current state of a process. The main advantages of the SCADA system project are that all processes can be viewed on a computer monitor or monitored on a mobile phone. Another advantage of the system is that it can receive data from different points of the inspected object in real time and transmit it to the required place.*



***Keywords:*** *interface, SCADA, cotton, temperature, graphics, network, raw materials, physical and mechanical.*


## INTRODUCTION

The main advantages of the SCADA system project are that all processes can be observed on a computer monitor or monitored using a mobile phone. Another advantage of the system is that it can receive data from different points of the object being checked in real time and transmit it to the desired location. This allows optimal control of the inspected object.

As a result of the experiments, the temperature of cotton in the chamber was measured in two directions: horizontal and vertical. In both cases, the measurement results were obtained in four thermocouples at adistance of one meter. The results are shown in Table 2.

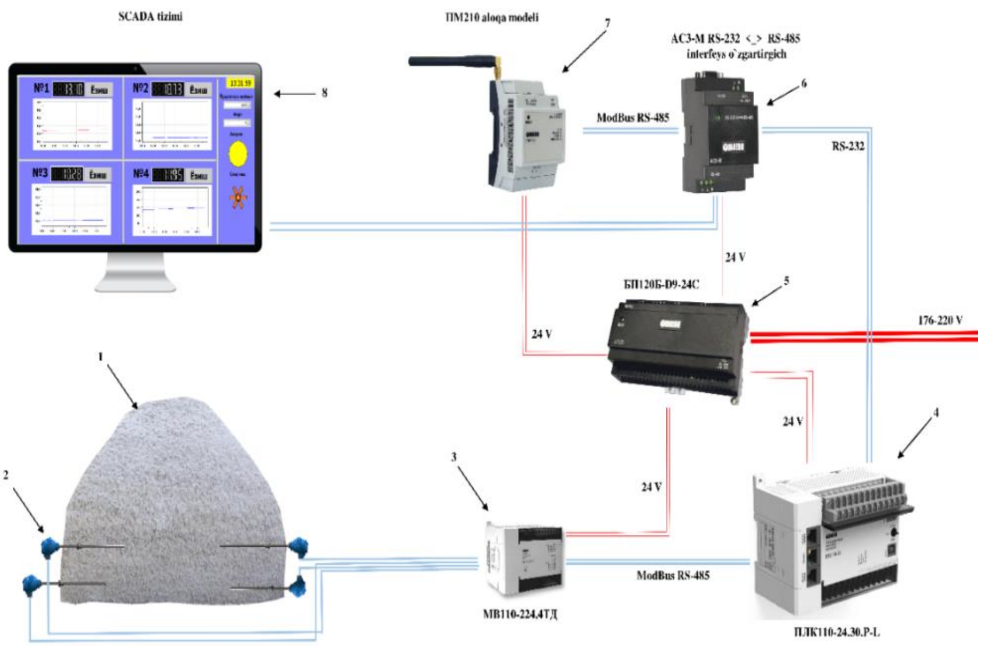
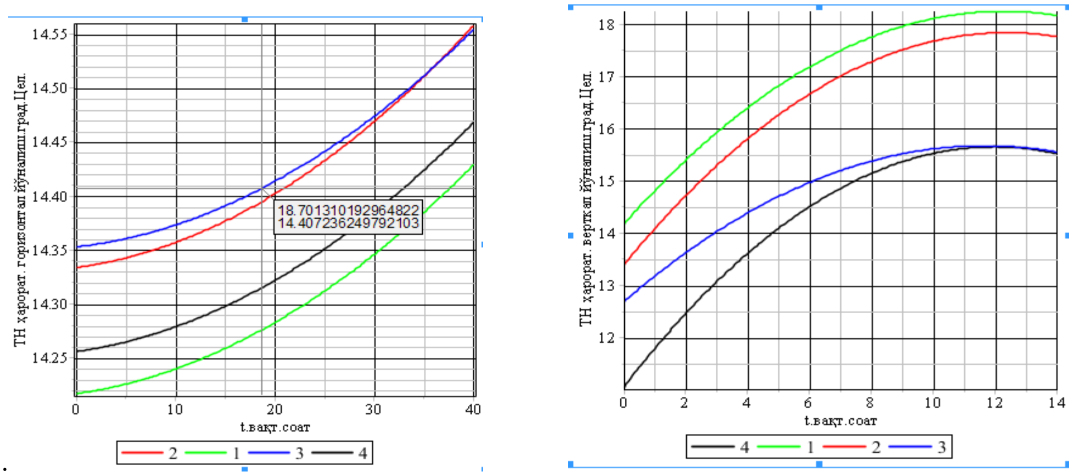



Fig 1. The scheme of measuring the temperature of one cotton bunt based on the SCADA system.

1-buntah cotton, 2-DTS015M-temperature sensors for temperature measurement. 3-MB110 transmits the temperature measured by the thermal sensors to the signal display.4-PLC-110-signal logic controller. 5-BP is a single-channel block source. Converter device 6-AC3–M-interface. 7-PM210-network gateway. Operating window of the 8-SCADA system




(a) (б)

Table 2. The regularity of changes in the temperature of raw cotton in the horizontal (a) and vertical (b) directions.

Temperature change at point No. 1; Temperature change at point No. 2; Temperature change at point No. 3; Temperature change at point No. 4.

2a-It can be seen from the graphs in the horizontal direction in the figure that the temperature of raw cotton changes more slowly at the left and right extreme points compared to the middle points. The temperature change is mostly linear in time. It can be seen from the graphs that the heating of raw cotton is mainly observed in the middle part of the lower layer.

Table 2  the graphs taken in the vertical direction in the figure, we see that the temperature of raw cotton increases from top to bottom, and the heating process of the lower layer takes its maximum value near the center. At the same time, we can observe that the temperature varies from 17 to 26 according to the nonlinear law of the parabola. Therefore, it is necessary to take measures to reduce the temperature by opening tunnels from such places of the mine

## CONCLUSION

When the system of the front section of the sleeve is P5H10, points P4H2 and P4H3 are directly attached. Their intersection with horizontal L is marked with the letters L8 and L4, respectively.

With the older age groups, the semi-introduction system for youth clothing is created in exactly the same way as this system is created for adult clothing. In the rest, the structure is implemented according to the methodology given below.

a) data exchange in the system is carried out through special drivers in real time;

b) all data coming from the system is analyzed and processed in a timely manner;

c) the operation of the human-machine interface is very convenient;

g) a database of all processes at the inspected facility is maintained (raw cotton temperature);

e) this system has a high chance of preventing an accident;

k) the process report is always available on the computer monitor;

l) based on the data obtained, it is quite possible to compile reports in graphical, tabular or textual form;

m) The SCADA system can be used to control and measure the temperature of raw cotton, as well as its humidity, density and other physical and mechanical parameters.

In the SCADA system, all processes can be viewed on a computer monitor or monitored using a mobile phone.

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## DEVELOPMENT OF DESIGN AND TECHNOLOGICAL DOCUMENTATION FOR THE MANUFACTURE OF CLASSIC STYLE TROUSERS FOR MEN

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***Abstract***

*The trousers appeal with their variety - wide, flared, from the buttocks or knees, classic straight or semi-fitted, short breeches with an extra cut. It is particularly suited to youthful tastes. Social demands are determined by the appropriateness of the product range. The role of social factors increases as a result of the filling of the market with goods and the improvement in the welfare of the population. Functional requirements take into account the main functional purpose of men's trousers and the compatibility of the garment with the appearance of the consumer. Social requirements are therefore determined by the appropriateness of the product range. The role of social factors increases as a result of market saturation and improvements in the welfare of the population. Purpose determines the requirements for pattern, design and material. The variety of consumption conditions determines the wide range of clothing. Ways of altering the basic silhouette are created by widening and narrowing in various details, parallel and tapered forms at different levels. This type of simple change is made by maintaining the contour lines of the product design, ie copying folds in different directions, gathering folds, additional details. yuks appeal to its variety - wide, flared, from the buttocks or knees, classic straight or semi-fitted, short pants-bridges with an extra neckline. It is particularly suited to youthful tastes.*

***Keywords:*** *design, trousers, parallel and constructive extension, patterns, modelling*

### INTRODUCTION

Pants attract a variety of styles - wide, flared, from the butt or knee, classic straight or semi-constricted, as in the 70s. Short breeches are not forgotten. Especially for the taste of young people.

All requirements for clothing quality are divided into consumer and technical-economic. Consumer requirements are classified into functional, social, aesthetic, ergonomic, operational requirements.

Consumer requirements include social requirements that ensure compliance of products with public demands, their suitability for production and liquidation purposes. Therefore, social requirements are determined by the appropriateness of product assortments. The role of social factors increases as a result of the market being filled with goods and the improvement of people's well-being.

Functional requirements take into account the main functional purpose of men's trousers and the compatibility of the garment with the consumer's appearance. The designation defines the model, construction and material requirements. The variety of consumer conditions determines a wide range of clothing.

**Description of the technical sketch and appearance of the received model** Pants for boys made of semi-wool fabric, which can be worn in the spring, autumn and winter months of the year**.** Pants are made in classic style. The front consists of two parts. Has two side pockets.

The back consists of two parts. There is a pleat from the waist line. The right part has a framed leaf pocket. This product is recommended for sizes 170-100-88.

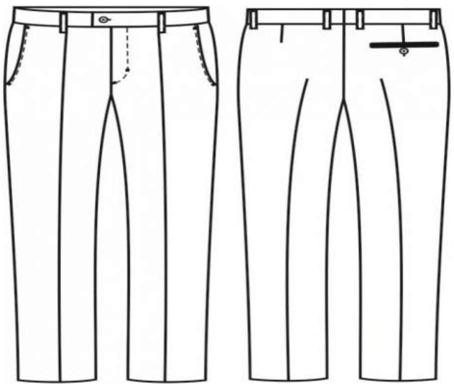

Fig 1: Picture of Shaalbar

Compilation of the main drawing is carried out by various methods, the most common of which is the graphic calculation method.

In the production of many garments, an accounting graphic system is used. This method is based on calculating the size of the human body and making a drawing.

Table 1. Measurements needed to construct pants

| № | Size indicators | Dimension names | Size, cm |
|---|---|---|---|
| 1 | $S_t$ | Half rotation of the waist | 44,0 |
| 2 | $S_б$ | Half rotation of the buttocks | 49,5 |
| 3 | Vs | Sitting height | 21 |
| 4 | $D_{tk}$ | Length from waist to knee | 52 |
| 5 | $D_{pants}$ | Pants length | 100,0 |

This unified methodology was adopted as a basis for the first time, it separated the big problem for tailors - the construction of the model form of the product from the main construction, and gave complete freedom to experts to quickly master the proposal of a new form. [1] The calculation formula reveals the compatibility of clothes with a certain part of the body. A number of calculation formulas are replaced by body measurements. All this did not make it difficult to change the typical and non-typical research forms. The calculation of the width of the grid is the main factor for the construction of the grid, and the calculation of the front height, back height and also the armpit groove are collected in the vertical lines.

Table 3.Calculation of pants construction drawing

| № | Cut off | Calculation formula, calculation | Cut off apparently, cm |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Build the base grid of the drawing | | | |
| 1 | $Т_оН_о$ | $Т_оН_о$= $Д_{брюк}$ | 100,0 |
| 2 | $Т_оК_о$ | $Т_оК_о$= $Д_{тк}$ | 52,0 |
| 3 | $Т_оЯ_1$ | $Т_оЯ_1$= 0,5$С_б$ – 1,0…2,0-0,7=0,5*49,5-1,0 | 23,8 |
| 4 | $Я_1Б_1$ | $Я_1Б_1$=1/3$Т_оЯ_1$= 1/3*23,8 | 7,9 |
| 5 | $Т_оТ_{01}$ | $Т_оТ_{01}$=0,1($С_б$-$С_т$)=0,1(49,5-44)=0,1*5,5 | 0,55 |
| 6 | $Б_1Б_2$ | $Б_1Б_2$=0,5 ($С_б$+$П_б$)= 0,5 (49,5+1,5)=0,5*51 | 25,5 |
| 7 | $Б_2Б_{21}$ | $Б_2Б_{21}$=0,5…0,7 | 0,5 |
| 8 | $Я_2Я_{21}$ | $Я_2Я_{21}$=0,1 ($С_б$+$П_б$)= 0,1 (49,5+1,5)=0,1*51 | 5,1 |
| 9 | $Я_1Я$ | $Я_1Я$=$ЯЯ_3$=$Я_1Я_3$/2=30,2/2 | 15,1 |
| 10 | $НН_1$, $НН_2$ | $НН_1$= $НН_2$=Н1Н2/2=(Шн-2,0)/2=(24,0-2,0)/2=22/2 | 11,0 |
| 11 | $НН_3$, $НН_4$ | $НН_3$=$НН_4$=$НН_1$+2,0=11,0+2,0 | 13,0 |
| 12 | $Б_1Б_3$ | $Б_1Б_3$=0,1($С_б$+$П_б$)-2,0=0,1(49,5+1,5)-2,0=0,1*51,0-2,0=5,1-2,0 | 3,1 |
| 13 | $Б_3Б_4$ | $Б_3Б_4$=( $С_б$+$П_б$)- $Б_1Б_{21}$=(49,5+1,5)-26,0=51,0-26,0 | 25,0 |
| 14 | $Б_4Б_5$ | $Б_4Б_5$=0,05($С_б$+$Т_0$ $Я_1$)-0,3...0,5=0,05(49,5 +23,8)-0,5=0,05*73,3-0,5=3,665-0,5 | 3,2 |
| 15 | $Я_2Я_{21}$ | $Я_2Я_{21}$=0,03*$С_б$=0,03*49,5 | 1,5 |
| Build up the front of the pants | | | |
| 16 | $Я_{21}1$ | $Я_{21}1$=0,4$Я_2Б_2$=0,4*7,9 | 3,2 |
| 17 | $Т_2Т_4$ | $Т_2Т_4$=0,5($С_т$+$П_т$)+2,0...2,5=0,5(44,0+1,0)+2,0=0,5*45, 0+2,0=22,5+2,0 | 24,5 |
| 18 | $К_3К_1$ | $К_3К_1$=1,0...1,5 | 1,0 |
| 19 | $КК_2$ | $КК_2$=$КК_1$ | From the drawing |
| 20 | $НН_5$ | $НН_5$=0....1,0 | 0,5 |
| Build up the back of the pants | | | |
| 21 | $Я_{21}Я_5$ | $Я_{21}Я_5$=0,25( $С_б$+$П_б$)-1,5=0,25(49,5+1,5)-1,5=0,25*51-1,5=12,75-1,5 | 11,3 |

Continuation of table 3

| | | | |
|---|---|---|---|
| 22 | $Я_3Я_{32}$ | $Я_3Я_{32}$=1,0 | 1,0 |
| 23 | $Я_{21}2$ | $Я_{21}2$=2,0...3,0 | 2,5 |
| 24 | $КК_4$, $КК_5$ | $КК_4$=$КК_5$= $КК_2$+2,0=12,5+2,0 | 14,5 |
| 25 | $Т_5Т_7$ | $Т_5Т_7$=0,5($С_т$ +П)+1,5=0,5(44,0+1,0+1,5) =0,5*45,0+1,5=22,5+1,5 | 24,0 |
| 26 | $НН_6$ | $НН_6$=0,5...1,0 | 0,5 |

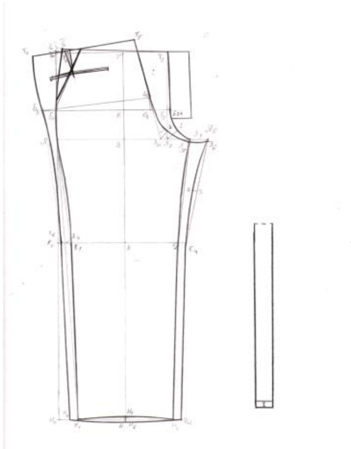

Fig. 2: Pants pattern

The method of legal technical modeling, its selection and capture of model features in the construction of justification. Modeling is a creative, artistic process of creating a new model.

Constructive modeling is an engineering process for drawing a new model drawing and models using the drawings and models of the corresponding basic structure [2].

- The process of creating a new construction of clothes goes through the following stages:
- Model study;
- Choose the main design according to it;
- Changing the main design and specifying its model features;
- Checking that the main design of the model is done correctly.

1. There are three main types of constructive modeling methods.
2. 1st type of constructive modeling methods
3. This type of simple modification is done by keeping the image of the contour lines of the design of the product, that is, moving the folds in different directions, assembling folds, additional parts.

- A simple copy of the fold is obtained by covering the folds on the template and cutting the fold in the new direction, and then unfolding it. This operation can be done without cutting the frame, for that:
- Mark the outer edge of the new fold on the contour of the sheet and circle the section of the sheet from the beginning of the new fold to the old fold;
- Turn the lekal around from the center of the fold, completely cover the old fold, and draw the remaining part of the lekal around to the mark of the new fold;

Decorating the contour lines of the new fold.

- The following condition must be met when copying the fold:
- The point taken as the center of the fold should be in the middle of the convex part;
- - Determines the seam line 1.5-2.5 cm from the center point of the fold to create a cone-like shape.

4. Due to the change in the direction of the fold, the beauty of the clothes and the area of the parts changes. A beautiful shape is found if the angle between the direction of the fold and the base thread is equal to 45 degrees.
5. 2nd type of constructive modeling methods.
6. Ways to change the main silhouette are made in different parts, at different levels, by expanding and narrowing in the form of a parallel and cone shape [3].

## CONCLUSIONS

Parallel expansion is often used to design folds and fine folds in parts. Here, the part to be changed is cut into several slices and moved along the designed volume. Depending on the model, the parts may expand evenly or unevenly. When making folds, not only the horizontal size of the part changes, but also the longitudinal direction [4]. Part parallel expansion is often used in conjunction with conical expansion. Cone expansion can begin at different levels depending on the silhouette of the model: shoulders, chest, waist, buttocks, knees and hem. The shape of the conical expansion of the particles is used when designing a trapezoidal form. The expanded edge of the part may contract, creating a shape called a "convex trapezium". The modification method is similar to the parallel expansion method mentioned above, the difference is only in the form of moving fractional slices. It is moved in the form of a cone, the expansion can also be parallel-conical. In order to expand parts with a fold, its edge is made so that it passes through the end of the fold. Here, after moving the incisions, the fold is completely or partially closed [5].

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# DEVELOPMENT OF DESIGN TECHNOLOGICAL DOCUMENTS WITH THE STUDY OF THE SPECIFICS OF THE DESIGN OF CHILDREN'S OUTERWEAR

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***Abstract***
*The range of children's clothes is the most varied in form, format, colour, processing, etc. This is due to the particular physical, psychological and physiological development of children of different ages. However, as noted above, throughout the growth of children there is an exchange of posture and body balance, external grace and character of movement, goals, habits and activities. The child is therefore individually designed for each of the five growing groups. Built with a selection of basic assembly techniques which have significantly improved the construction of the selected designs. The design of the base pattern begins with a structural pre-calculation. First of all, two widths are calculated; based on this, the other parameters of the sleeve are calculated.Since the design of the presented sample is taken from a prefabricated base frame, the structural and technological applications are taken into account here. These applications are determined by the amount of difference between the dimensions of the product and the child itself*

***Keywords****: children's outerwear, design, assembly techniques, product dimensions, calculation*

## INTRODUCTION

Types of children's clothing assortment structure. It is very diverse in terms of form, shape, color solution, processing and others. This is due to the physical, psychological and physiological development features of children of different ages. At the same time, as mentioned above, during the entire growth of children, body structure and body balance, external gracefulness and character of movement, goals and interests, habits and busy behavior alternate. In this regard, children's clothes are designed individually for each of the five age groups. Fashionable coat for girls, made of semi-wool fabric, with a loose design. The coat fastens with four buttons. The coat has ash. The front part consists of two parts: the upper part and the lower part. The upper part is made of yellow fabric. The lower part has a pocket with a label. A decorative fabric and a decorative border were used for the hem of the coat.The back consists of two parts: lower and upper. Theproduct is lined. The sleeve is single-stitched, fitted. A decorative heart is attached to the pocket, and fan ribbon is sewn to the edge. Recommended size: 122-60.

Fig. 1. Technical sketch of the model

It is necessary to select and justify the main construction methodology in order to select and justify the initial data necessary for construction drawing.

Selection and justification of construction methodology. The construction of the selected model is built by choosing one of the main and significantly improved construction methods. There are many methods of construction, they are TsNISHP, EMKOSEV, MTILP.

Among them, the peculiarity of the TSNHP method is that the design of the base plan begins with a structural pre-calculation. First of all, calculate the width of both; based on that, calculates other parameters of the sleeve.

And the feature of the MTILP method is ease of graphic construction and calculation, radiograph and perspective discimencant methods are often used to construct curved contours of particles.

Unlike the methods mentioned above, the EMKOSEV method is considered a universal method for all types of clothing and gender and age groups.

Table 1. Initial information for obtaining a ready-made base

| № P/P | Size name | Conditional signs | Size, cm |
|---|---|---|---|
| 1 | Chest circumference | O2 | 56 |
| 2 | Waist circumference | $О_т$ | 52 |
| 3 | Buttock circumference | $О_б$ | 58 |
| 4 | Back length | Dsp | 23 |
| 5 | Sleeve length | $Д_{рук}$ | 31 |
| 6 | Neck circumference | $О_м$ | 27 |

In order to obtain the dimensions shown in the table, the dimensions of the person were measured and compared, the most accurate dimensions were taken, the construction of the finished drawing was determined, and it was drawn correctly and accurately. We compared the details to each other to get the desired construction.

Selection and justification of supplements. Since the construction of the proposed model is based on a ready-made base, the gap, package thickness, that is, constructive and technological additions are taken into account here.These additions are determined by the difference of the child's own measurements from the dimensions of the product. [3]

These values for free movement, fit, and movement of children's clothing are shown in Table 2.

Table 2. Selection and justification of supplements

| Naming of attachments | Apparently, cm |
|---|---|
| On the chest | 3-4 |
| At the waist | 2-3 |
| On the buttocks | 1,5-2 |
| To the width of the sleeve | 5,0 |

A typical design scheme of a children's clothing drawing

Shruk = 0.90i+Po.i+1.7 in products for nursery and preschool children:

Shruk=Oi+Po.i in products for children under school age and teenagers:

Shruk=1.20p Po.i - 4.6 in products for children older than school age:

Closed groove height ЕВпр=dв.р+Пс.пр+1

The height of the bottom of the sleeve Vok=Vpr(1+H)+Pv.ok

The length of the bottom of the sleeve Dok=1.5(0.5Shruk+Wok)

Groove length Dpr=Dok(1+P)

Groove width Shpr=0.6 (Dpr-Pd.i) –Vpr

The width of the rear longitudinal Shsi=Shs+Ps1-0...0.5+Pdr where 0......0.5 is a free term.

It takes into account the compensation of the reduction of the rear longitudinal width during the formation of the central system of the rear longitudinal.

The width of the region in products for children of the nursery group.

Shpol=Shg+Pi+Pur

In other cases, the Shpol is determined by the following formula:

Shpol=Shg+0.8(Gr P-Gr1)+Pi+Pur

The creation of the drawing grid begins with the creation of a rectangle at the top of point A (Fig. 100). Sections below point A are placed: AU=0.3Dr.s AT=Dr.s Pdts; TB=0.5Dt.s ;AN=Dizd +Pur.

Points UTB and H are connected by horizontal straight lines.

Sections are placed to the right of point A: Aa=Шс; aa1=Spr; a1a2=Spol

Verticals are drawn through points a, a1, a2. Their intersections with the horizontal drawn from the point T are marked with the corresponding letters T2, T3 and T4. The intersection of the vertical drawn from point A2 with the horizontal drawn from point B is denoted by the letter B2.

To create a neck groove of the back length, a section AA0 is placed vertically from point A. AA0=0.2...0.4 cm; Horizontally drawn from point AA1=1/3N + Ш.г.с , vertically drawn from point A1 - section A1A2=Дт.сП-Дт.с.

The creation of the system of the shoulder section of the back length is based on the determination of the position of the point P6. When it is continued with the point A2, the system of the shoulder section appears. To determine the position of the point, perform calculations according to the following formula [23]

$A_1A_{21}=В_{т.о,ш}$- $В_{и.т}$+$П_{д.т.с}$-$П_{и.с}$+0,5$П_{у\ и}$

The section is placed vertically down, and horizontally to the right through point A

A2P0=Sp-1

The cut is placed horizontally to the right of point A2 until it intersects with the horizontal drawn from point A21. P0P5 will be placed in continuation of A2P0 system. P0P5= 1+Psut, where Psut=0.7 cm

Increase the shoulder point for ironing the groove П5П6=0...0.7 cm

Section A2P6 is the shoulder section of the back length if the shoulder placement is planned. If a fence is designed, then it is necessary to perform a number of additional calculations related to determining the location and spacing of the fence.

Ui=0.4 Shs; A2П4=0.25A2П5.и .и4 points are directly connected. To the right side of i4 point and on the left side, the offset difference is placed from 0.5. The difference of the slide i1i2=1.5.....2.5cm.

i3i4=5....6cm points i1i2 are continued with point i3. Then the right side of the slide is aligned with the left side, and the point found is continued with point P6. The final system of the shoulder section of the back longitudinal is formed during closed sliding.

Above the T04 point T04G0=Vs.1 – Vl 1 section is placed. A horizontal line is drawn through point G0 and the following segment is placed on it:

A straight line is drawn through the points T04.G01 to the hem of the product, and a perpendicular T4T6 is drawn to it. A section equal to P1 is placed on it:

T4G= D g i- B + 0.5Pd t i +Pur

The cut is placed above the T4 point along the line passing through the T04G01 points. From point G, a perpendicular is drawn to this straight line and a section ГГ1=П2 is placed on it. Through point G1, a horizontal line is drawn from point T to cross section T04Г01 until it intersects at point G3. Points Г and Г3 are directly connected. Point Г2 is drawn perpendicular to ГГ3 from point Г1 and placed at its intersection.

ГГ1=Г1Г2+Pur where Pur=0.....1cm[4]

Section TГ4 is placed along the line ГT04 above point Г, and points Г1 and Г4 are connected. A perpendicular drawn to point G4 on the straight line Г1Г4 is drawn and point G2 is placed at its intersection.

ГГ4=Г1Г2+Pur where Pur=0....1cm.

To create a neck groove in the region, the T4G4A4 size is placed according to the system above the point.

T4G4A4 =Dt i P Id t s+Pur

On the perpendicular to the left side of point A4, the width of the neck groove in the region, and the depth of the hem are placed on the segment G4A4 drawn from the left side of point A4.

A3A4=AA1; A4A5=0.45Sh

Points A3 A5 are connected by a smooth curve.

The calculation and structure of the shoulder section of the region prompts to determine the position of point P1. Continuing it with point A3, the shoulder section system is obtained.

A3A31=W.o.sh - Vp.t+Pd.t.p - Pp.i -0.5Pu.i

The resulting section is placed vertically below point A3, and drawn horizontally to the left of this point A3:. So A3P01=Shi-1cm section is placed. The points A3 and P01 are directly connected and the section A3P1=Shi is placed in their extension.

The calculation and structure of the groove system depends on the determination of auxiliary points through which this system itself passes.

T2P2=15.....25cm.

Through the point P2, a horizontal line is drawn until it intersects at the point P3 on the straight line T3G3.

P2P2G5=0.56Dir-0.5Shir+M

Here M=0.5(P2P5+P3P1).

A horizontal line is made through point G5 until it intersects with the straight line P3T3 at point G6. G5G8=0.5Shir

Sections G5-1, G6-2 are placed on the bisectors of the angles П2Г5Г8 and Г3Г6Г8.

G6P4+3.5...5 cm section is placed according to the G6P3 system above point G6. Points P1 and P4 are directly connected.

П – 3=0.5П1П4; 3-4=0.5.....1cm

The groove system is formed by a uniform curve and the points П6 П2 1 Г8 2 П4 4 and П1 are continued. Side sections of vertical silhouette products along the rear length of the region are formed in the form of a straight line drawn from the top of point G8. Lateral sections of the rear longitudinal are made parallel to the central system of the rear longitudinal below point G8. Its intersection with the lumbar system and the intersection with the buttock system of T8 are marked with the letters H1 and the skirt of B3.

The width of the buttock system is placed on the perpendicular erected from the point B2 to the half-penetration system.

B21B5=C6+H6-BB3

G8j2 is drawn straight through points B5, and at its intersection with the waist system, point Ti is placed at the intersection with the hem system, point P2. G8P2 system is a system of the side section of the region of products that are not drawn to the belly.[5]

The structure of the slide for the belly button begins with the definition of its location.

T6K4= 0.2Dt s -2

This incision is placed below the T6 node in a system that is parallel to the partial insertion system. Through the K4 point, a partial injection to the left side is carried out horizontally and perpendicularly. In both systems, the lateral section of the region is carried out until it intersects with the system at points K10 and K11. Both sides of the slide are aligned along its larger side. The system of the side section of the region is finalized during closed sliding. At the same time, the side section of the region is extended by the amount of the cross section:

H2H21=K10K11

The bottom edge of a region in a partial input system

T4H5=T1H+1.5+Pur

Points H5 and H21 are connected by a convex curve.

To create a sleeve drawing, a rectangle is created with the vertex at point O. From there, OR=Vok; OL=Dr.lok+Pok+Pur; ON=Druk-1.5+Pur sections are placed.

Horizontal lines are drawn through the found P, L, H points.

Creating a sleeve bottom system begins with determining its width and the position of a number of auxiliary points.

Sleeve width OO1=0.5Shruk. From point O1 downwards, a vertical line is drawn from point P until it intersects at point Pl.[26]

PP1=PлP2=Pл P3=0.5(Shruk-Shir)

P1P2P with the points perpendicular to the horizontal drawn from point P, the following sections are placed on them:

$P_1P_4$=0.25$Ш_{рук}$; $PP_5=PP_4$; $P_лP_6=P_л\ P_5$; $P_6P_7$= 0.5$Ш_{рук}$; $P_лP_{12}=P_лP_7$.

O2 and P4 points O2 and P6 are directly connected to each other. Their intersection with the vertical created from the point P1 is denoted by O3, and the intersection of P1O1-P8 with the vertical is denoted by letters P8. Through the point P3, a horizontal line is drawn from the point Ri until it intersects at the point P10. The P10P12 line determines the direction of the sleeve bottom system to the lower part of the sleeve. Point P8 is continued with point P9, and point O9 is placed at the intersection with PO vertical. O2O4= 0.5 O2O3; O4O5=2cm,

A segment O1O2=2...3cm is placed on the bisector of the angle PlO1O2.

The sleeve bottom system is made through points P25, P10, O2, O6, O5, O3, P9, P4.

The construction of the sleeve ends begins with determining the width of the sleeve ends.

Shruk.vi=0.5 Shruk +10 cm The width of products for children of nursery age is determined by the following formula.

Shruk.vi=Ovai+PO.I-1

HH1=1.5cm H1H2=2cm. A straight line is drawn through points H and H2 and the following sections are placed on it. HH3=0.5 Shruk; HH14=1.5HH3; HH11=0.5HH3; HH10=0.5HH3; H11H12=H0H10;

## CONCLUSIONS

When the system of the front section of the sleeve is P5H10, points P4H2 and P4H3 are directly attached. Their intersection with horizontal L is marked with the letters L8 and L4, respectively.

The position of the elbow flexor of the sleeve in the elbow system is determined by the following section: Л4Л5=0.5cm Point Л5 continues with points P1 and H3. From point Л8, P is drawn perpendicular to points Л5 and Л5H3. Thus, corresponding points L10 and L11 appear. In order to get the elbow seam, L10 and L15 are directly continued and both sides of the seam are equalized: L10Л16=Л10Л14;

The system of the elbow section of the sleeve: P25, L14 passes through the points L16L14. The sleeve end system is carried out through the points H14, H3, H0, H1, H12

With the older age groups, the semi-introduction system for youth clothing is created in exactly the same way as this system is created for adult clothing. In the rest, the structure is implemented according to the methodology given below.

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# DEVELOPMENT OF DESIGN AND TECHNOLOGICAL DOCUMENTATION FOR WOMEN'S EVENING DRESS OF ASYMMETRIC FORM

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***Abstract***
*Symmetry provides a balance of weight, shape, colour and hue for the right and left side of a composition, and the mutual harmony of the elements within it. Symmetry is often used in the depiction of ornamentation. Symmetrical division in paintings creates conditions for equal distribution of sizes, number of scenes, colours of colours, even if it is not clearly visible. Dimensionality is brought closer to equilibrium through the possibilities of fullness of colour dimensions etc. The asymmetric arrangement of the images in the composition does not create the impression of a painting being divided into two parts equal in weight, form, background, the images in it are ruthless, intertwined, deflected to the side of the balance, but the general equilibrium in the work is kept as a result of the harmonious transfer of the compositional rhythm. An anthropometric measure of the range of external contours of the human body is used to develop the design of the piece, primarily taking into account data on human appearance.*

***Keywords:*** *design, women's evening dress, symmetry, asymmetry, fashion*

## INTRODUCTION

The possibilities that reveal the importance of the composition are divided into four: they are rhythm, the plot environment of the composition, symmetry and asymmetry, the placement of the main character in the second place. Rhythm is the alternating location of the image in the composition, their repetition in a certain order, as well as repetitions in the movement of the people and animals depicted in it and their dynamic features.

The regularity of the plot center is the main part of the picture that draws special attention to itself and reveals the compositional idea content. A scene of a character or an object, a scene of nature, representing an idea can be given in the plot interval. In addition to the main scenes that reveal the compositional idea, the painting also contains secondary elements.

Law of symmetry. The name of symmetry ensures the balance of weight, shape, color and tone of the right and left parts of the composition, the harmony of its elements.

Although symmetrical division is not clearly visible in the paintings, the dimensions, number, and color of the scenes create conditions for equal distribution. The size is determined by the saturation of the color dimensions, etc. will be brought closer to equilibrium through capabilities. The asymmetric arrangement of the image in the composition does not create the impression that the painting is divided into two equal parts in terms of weight, shape, and tone, the images in it do not clash, mix with each other and deviate from the balance, but the overall balance in the work is preserved as a result of the harmonious presentation of the compositional rhythm.

Asymmetry - compositing, in which the balance of vision is disturbed and the two halves of the object do not match From the solution, in an asymmetric composition, one thing should be dominant, making the elementssubordinate to one environment.

To develop the design of the product, first of all, the anthropometric measurement of the range of external contours of the human body is used, taking into account the data about the appearance of the person.

The lower values of anthropometric clothing for drawing the main base structure are given in the table.

Table 1- Measurement characteristics of typical and head sizes of women (170-88-92)

| p\c | Dimension name | Conventional sign | Unit of measure (magnitude) |
|---|---|---|---|
| 1 | Height | Р | 164 |
| 2 | Half a turn of the neck | $С_{Ш}$ | 17,7 |
| 3 | The first semicirculation of the chest | $С_{Г1}$ | 42,9 |
| 4 | The second half-turn of the chest | $С_{Г2}$ | 44,3 |
| 5 | The third semicirculation of the chest | $С_{Г3}$ | 44 |
| 6 | Semi-rotation of the waist | $С_{Т}$ | 33,8 |
| 7 | Half rotation of the buttocks | $С_{Б}$ | 46 |
| 8 | Shoulder rotation | Оп | 27,5 |
| 9 | Shoulder width | Шп | 13,1 |
| 10 | Chest height | $В_{Г}$ | 25,4 |

Table 1. Continued

| | | | |
|---|---|---|---|
| 11 | The length of the waist from the front | Дтп | 43,2 |
| 12 | Armpit height from back | $В_{ПРЗ}$ | 20,9 |
| 13 | Back to waist length | $Д_{ТС}$ | 42,7 |
| 14 | Shoulder height | $В_{ПК}$ | 42,8 |
| 15 | Chest width | Шг | 16,5 |
| 16 | Chest center | $Ц_{Г}$ | 9,6 |
| 17 | Back width | $Ш_{С}$ | 17,3 |
| 18 | Arm length to elbow | Дрлок | 24,2 |
| 19 | Length from shoulder point to palm | Дрзап | 43,3 |
| 20 | The length of the back of the waist | Дтс | 42,2 |
| 21 | Product length | Диз. | 120 |

Addition - the amount added to the body measurements to obtain the drawing of the clothing details (not the drawing of the outer surface of the human body) consists of several additional parts: the main ones are those that have a slight potential for completeness of the package, body dynamics, shaping and beauty [1].

A supplement with a small capacity ensures the smooth functioning of the body (respiratory, blood circulation, movement, etc.). Its size is constant, equal to 2 cm.

Package thickness supplement is an supplement that takes into account the thickness of the lining of clothing materials[2].

For single and double-layered clothes (dresses-skirts), no additional consideration is given, because the materials used for these types of clothes are rather thin, and the outer dimensions of the clothes are practically the same. It is only intended for three and four layer (jackets, shirts, coats, etc.) clothes.

The addition of freedom of movement is reflected in static measurements and relative dynamic body measurement changes, resulting from garment construction and materials..

When determining the addition, data on changes in body dimensions should be related to the ability of the clothing material to stretch under the influence of forces exerted by the human body (the more the material stretches, the smaller the addition). At the same time, it should be remembered that the size increases at such a moment when the clothes are easily transferred from a unique part of the body to other parts. The above-mentioned factors make it possible to reduce the dynamic application somewhat. As a result of research, effective applications of freedom of movement of the shirt have been established. They vary from 3 cm to 6 cm [3].

An allowance for freedom of movement is not usually given to the longitudinal dimensions of the garment, as this itself can lead to spoiling the appearance of the garment. At the same time, the design of many types of clothing allows it to be easily located along the body. In addition, it is given only if this possibility is not available, so to speak, when the ends of the sleeves are thin or the product is tightly tied with a belt at the waist. In this case, the sleeves are extended by 6-8 cm, and the chest circumference by 8-10 cm.

In the construction practice, the sum of the first three that make up the application is called a technical application. The technical supplement for the width of the product is constant for uniform types of clothing, so it is not taken into account. At the same time, a technical supplement is given to the width and length of the half region and length of the breast, the length of the waist and the whole region, the length of the sleeve, the width of the groove. Anthropological measurements of a typical person in the design of clothes are carried out in the same way as measurements in a certain part of the clothes. The external dimensions of each product are usually decorated with decorative additions on any constructive lines. Therefore, when drawing a drawing, the conditions for decorative additions must be met to add layers of freedom of movement to the heat distribution of the body.

Technical additions to the chest line, as well as fashionable and constructive additions, are of great importance.

It differs from technical applications in that it has a particularly important meaning in the design and design of the product. The size of fashion-constructive additions depends on many factors. Therefore, it is not always clearly defined for products with a complex outline or body structure without preparing a model or model [4].

Fashionable - the amount of constructive addition depends on the main fabric used. For such thin but very dense fabrics, the fashion-constructive applications are often greater than for thick, soft, loose fabrics.

In the process of assembling products with a complex outline, fashion-constructive accessories are divided into the main parts: back length, arm length and front length width.

Thus, the size of the fashionable-constructive accessory varies within a large range (0-10 cm) and depends on the type of product, its use, the outline format and pattern, the thickness and properties of the main fabric used, the length and features of the human body, and the directions of modeling and the artistic opinion of the designer and modeler. [5]. Analyzing the shape of the silhouette and taking into account the properties of the fabric, the values of the technical applications are filled in 2 tables.

Table 2. Appendices

| № | Appendices conventional signs of | Name of attachments | Size (cm) |
|---|---|---|---|
| 1 | 2 | 3 | 2 |
| 1 | Пг | Supplement given on the third line of the chest | 1 |
| 2 | Пб | Half a round of the buttocks | 2 |
| 3 | Пшгор | To the width of the neck player | 1 |
| 4 | Пдтс | The length of the back to the waist | 0,7 |
| 5 | Пшп | Shoulder width in the back | 1,2 |

As the basis of the construction of clothing, appropriate constructions of the front and back of its main parts, which are made every 3-4 years, taking into account the size typology of consumers and the compatible additions to the free fit, agreed with the direction of future fashion, are determined. The base shape defines the typical location and types of the main elements, and shows the type of technological processing that gives the voluminous shape in women's and men's outerwear. The basic basis of clothing is created separately depending on the type of fabric, according to the requirements of the silhouette, shape, gender, age and dimensional completeness. The silhouette and shape determine the general characteristics of the garment's construction and volume. The construction of the product is offered in two stages. First, the main structure of the products and model features are drawn on the drawing using the calculation formulas and drawing constructions using the dimensions of the person and the dimensions given in the appendices.

Table 3 - Calculation of plotting

| № | Constructive place | Designation | Formula | Measurements (cm) |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 1 | Grid width | $A_0a_1\rightarrow$ | $Cg_2+P_2$ | 48+6=54 |
| 2 | Product length | $A_0H\downarrow$ | $D_{izd}$ | 90 |
| 3 | The sad part | $A_0У\downarrow$ | $0,4\cdot D_{ts}$ | 0,4·42,9=17,1 |
| 4 | Chest line | $A_0Г\downarrow$ | $B_{прз}+P_{спр}$ | 21,5+2,5=24 |
| 5 | Waist line | $A_0T\downarrow$ | $D_{тс}+P_{дтс}$ | 42,9+0,5=43,3 |
| 6 | Butt line | $TB\downarrow$ | $D_{ts}/2-2$ | 42,9/2-2=19,4 |
| 7 | Back width | $A_0a\rightarrow$ | $SH_s+P_{шс}$ | 18,3+1,2=19,5 |
| 8 | Front width | $a_2a_1\leftarrow$ | $SH_g+(S_{t2}-S_{t1})+P_{ш}$ | 17,3+(48-45,9)+ +1=20 |
| 9 | Armpit width<br>Armpit width check | $aa_2$<br>$aa_2$ | $A_0a_1-(A_0a+a_2a_1)$<br>$O_p+P_{оп}/3$ | 54-(19,5+20,4)= 14,1<br>30,3+6/3=12,1 |
| 10 | Side line | $G_1G_2=G_2G_4$ | $G_1G_4/2$ | 14,1/2=7,05 |
| Calculation of the drawing of the back | | | | |
| 11 | $A_0A\rightarrow$ | | | 0,5 |
| 12 | A0 The points are connected with a smooth curve. | $TT_1\rightarrow$<br>$T_1U$ points $T_1N$ points are drawn with a straight line | | 1 |
| 13 | The width of the neck | $A_0\ A\rightarrow$ | $S_ш/3$+Pшгор | 18,5/3+1=7,1 |
| 14 | Neck depth | $A_0\ A_1\downarrow$ | $A_0\ A\ /3$ | 7,1/3=2,5 |
| 15 | The shoulder blade | $A\ P\downarrow$ | 1- arc A P = $SH_П$ + do not fold<br>2- do not fold | 13,3+2=15,3<br>43,6+0,5 =44,1 |

| | | | | |
|---|---|---|---|---|
| | | | $T_1P = B_{пк} + P_{дтс}$ | |

Continuation of table 3

| | | | | |
|---|---|---|---|---|
| 16 | Finding the shoulder crease<br>Fold position<br>Length<br>Place of worship<br>Connects points I, B on the line<br>Fold width | <br>AB→<br>$BB_1$↓<br>УИ→<br>← B→ | <br>А П/3<br>6 n/e 7см<br>$0,4 \cdot Ш_с$ | <br>15,3/3=5,1<br>7<br>0,4·18=7,2 n/e<br>10cm<br>2cm |
| 17 | Arm game<br>Adds P, P3, 3, G2(•) and completes the arm game | $G_1P_1$↑ ;<br>$G_1 P_3$<br><br>$Г_1$ 3 | P(·)$G_1$a=$P_1$(.)<br>$G_1P_1$/3+2<br><br>0,2·$G_1G_4$+0,5 | from the drawing<br>19,6/3+2=6,5+2=8,5<br>0,2·14,2+0,5=3,3 |

## CONCLUSIONS

The method of legal technical modeling, its selection and capture of model features in the construction of justification After developing the drawing of the main structure of the product, work is carried out in parallel with this drawing. These checks are to determine the features and differences in the condition of the fabric of the drawing. This method is defined by the surface coordinate given the name Chevyshev grid.

Three different conditions are implemented. According to the first condition: changes in angles are determined by connecting the cross-sections of clothing parts to each other. According to the second condition: a layout is created as a result of the change of this angle. Determines the maximum change in the angles of the warp and base threads of the fabric. According to the third condition: it can be observed that the smaller the intersection of the corners of the mock-up, the more effective it will be. The model is made of plain fabrics or loose fabrics [6].

By testing the product on the mock-up, we can observe the product's shortcomings, defects, and advantages in practical work.

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UDC 671.01/3

# NEW METHODS OF DYEING TEXTILE MATERIALS

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***Abstract***

*The textile industry is constantly evolving, with ongoing efforts to find more sustainable, efficient, and environmentally friendly methods for dyeing textile materials. New methods of dyeing have become a focal point for researchers and industry professionals in this field. This abstract provides an overview of some of the latest innovative methods for dyeing textile materials. Research and development in this area encompass the use of nanotechnology to create more durable dyes, alternative dyeing methods such as pigmentation, injection dyeing, and inkjet printing, as well as the development of environmentally sustainable processes with minimal water and energy consumption. These new dyeing methods have the potential to significantly reduce the negative environmental impact of the textile industry, enhance product quality, and increase the industry's competitiveness. This abstract presents an overview of these innovations and their potential advantages, emphasizing the importance of further research in this field.*

***Keywords:****genuine injection dyeing, textile industry, development, water, energy consumption, abstract, further*

## INTRODUCTION

The textile industry is the second most polluting industry in the world. Synthetic dyes contribute to a major part of this pollution, with nearly 20 percent of global water pollution being linked to the textile dyeing processes. The main contributors to this problem are the use of non-biodegradable petroleum-based colorants to dye textiles, the use of toxic agents to fix colorants on the textiles, and the release of large proportions of these colorants and fixation agents into the surrounding ecosystem. The contaminated wastewater discharged out after dyeing process contains huge amount of chemical substances which has negative impact on environment. Conservation of water resources and the environment have become key issues of concern in textile manufacturing. Sustainable dyeing innovations can help reduce water usage, replace wasteful practices with efficient and cost-effective ones, and minimize the impact on our ecosystems. New sustainable advancements that enhance the dye ability are ultrasound, ozone, plasma, ultraviolet, gamma illumination, laser, microwave, particle implantation, air-dye and other waterless technologies.

## EXPERIMENTAL METHODS

**Exhaust Dyeing.** Exhaust dyeing process is also termed as batch, discontinuous, direct or coordinate dyeing. Direct dyeing involves the direct application of dye to fabric without the help of any fixing agents. This process is so called exhaust because the dye molecules slowly get transferred from a comparatively large volume dye bath to the substrate or material that is to be dyed. The exhaust dyeing process is used for staple fiber dyeing. Yarn and fabric could be dyed by exhaust dyeing method. Dye solution or dye bath is produced by dissolving the dyestuff according to required liquor ratio. Then textile material is immersed in to the dye first solution. Initially the surface of the fiber is dyed when dyes contact with the fiber, then the dyes are entered in the core of fiber. Proper temperature and time are maintained for diffusion and penetration of dyes molecule in the fibers core.

**Steps involve with exhaust dyeing:**

1. First stage (dissolving and dispersion of the dye)
2. Second stage (adsorption)
3. Third stage (Diffusion)
4. Fourth stage (migration)

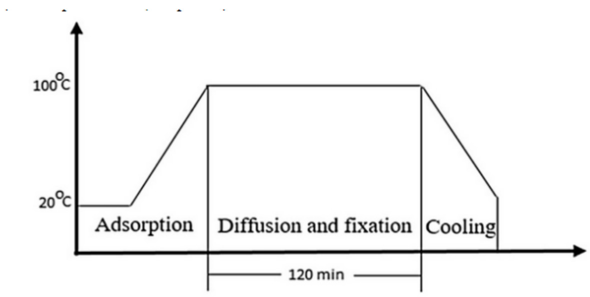


Fig. 1. Line diagram of exhaust dyeing

Continuous Dyeing. Continuous dyeing process typically consists the following. Dye application, dye fixation with heat or chemicals and finally washing. Various sequential operations are used for the continuous dyeing of fabric. An initial padding stage is common to all sequences. It involves immersion of the fabric in the dye liquor contained in a trough of minimal volume, which is kept constantly replenished from a stock tank. A liquor ratio is as low as 1:1 may be used; in general, low-substantivity dyes are used in continuous dyeing process. Next, the fabric passes in open width through a 'nip'. The nips are the padding mangle, in which heavy rollers (called bowls), pressed closely together along their length, and are rotated in opposite directions to carry the fabric through the system at a constant speed, squeezing out the superfluous dye liquor. Heavier fabrics are passed through two consecutive troughs and a second nip, using a three-bowl mangle.

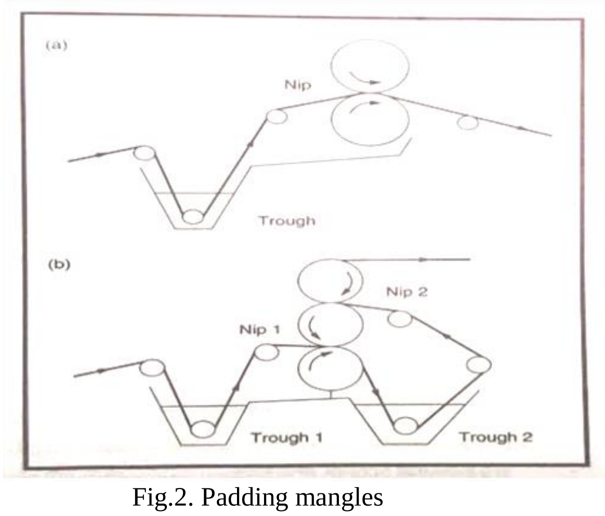


Fig.2. Padding mangles

Continuous dyeing has been found to be most suitable for woven fabrics. Mostly continuous dye ranges are designed for dyeing blends of polyester and cotton. Sometimes Nylon carpets are also dyed in continuous processes, but the design ranges for them is unlike that for flat fabrics. Warps are also dyed in continuous process. Very good examples of such warp dyeing are long chain warp dyeing and slasher dyeing using indigo.

Few continuous dyeing processes includes pad-stream process, pad-dry process and thermosol process.

**Semi-continuous Dyeing.** In the process of semi-continuous dyeing that consists of pad-batch, pad-jig, pad-roll the fabric is first impregnated with the dye-liquor in, what is called a padding machine. Then it is subjected to batch wise treatment in a jigger. It could also be stored with a slow rotation for many hours. In the pad-batch this treatment is done at room temperature while in pad-roll it is done at increased temperature by employing a heating chamber. This helps in fixation of the dyes on to the fiber. After this fixation process, the material in full width is thoroughly cleansed and rinsed in continuous washing machines. There is only one point of difference between Continuous and semi-continuous dyeing process is that in semi-continuous dyeing, the dye is applied continuously by a padding. The fixation and washing remaining discontinuous. Liquor ratio in semi-continuous dyeing is not of much importance and is not taken as a parameter. Some of semi-continuous dyeing processes include pad-roll process, pad-jig process and pad-batch process. One of the widely used techniques for semi-continuous dyeing process is the Pad Batch Dyeing a schematic diagram is given here for the semi-continuous dyeing process.

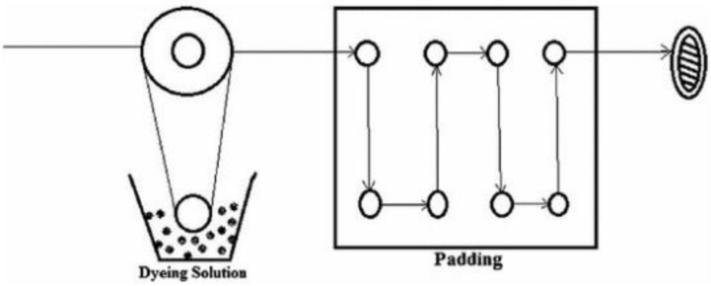


Fig. 3. Pad batch dyeing.

Electrochemical Dyeing. The main ecological impact of vat dyeing today is the use of dyeing auxiliaries and reducing agents, which end up in the waste water after their use in the dyeing process. Electrochemical dyeing is one alternative to overcome these problems and increase the attractiveness of vat dyeing. In principle for this process the reducing agent is replaced by electrons from the mains helping to achieve a wastewater-free process. Additionally, the vat dyeing process can be monitored and steered by measuring the redox potential in the liquor. This positively influences the quality and cost of the process. There are two techniques by which electrochemical dyeing can be done: direct or coordinate electrochemical coloring and indirect electrochemical coloring.

Foam Dyeing. Foam dyeing is an attractive alternative to traditional dyeing methods due to the potential environmental benefits and supply chain savings. The main dyeing element in this process is foam, using air instead of water to carry the chemistry or dye onto the fabric. Foam is the key factor in foam dyeing process. Foams are formed using foaming agents and usually foam is mainly obtained from aqueous solution which is then spread on the textile material. These agents must produce foam instantly, should not get affected by temperature, quick wetting process and ability to stabilize itself. Foam may be of dispersion foam or condensation foam. Dispersion foam is mixing of gas with the liquid while condensation foam is producing gas within the liquid physically or chemically.

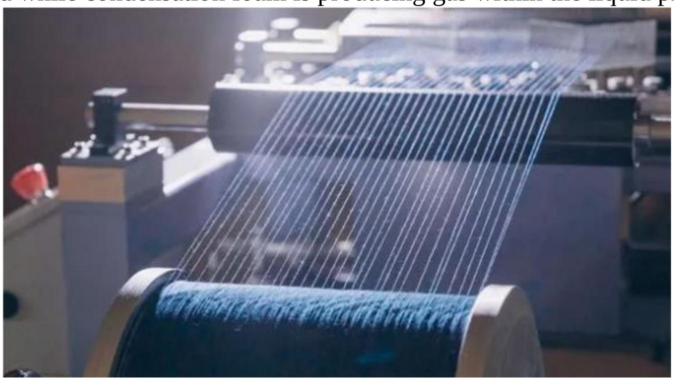

Fig. 4. Foam dyeing technology.

**The continuous methods of foam dyeing have the following steps:**

a. Foam generation.

b. Foam application to the substrate.

c. Foam distribution with simultaneous drainage and diffusion of the liquid into the substrate Foam collapse and release of active substance.

d. Fixation of the active substance.

**Advantages**

- Fixation of dye into fiber can be improved.
- Diffusion of dye into fiber can be enhanced.
- Stability of the fiber dyed obtained is high.
- Outcome is more in short time duration.
- Waste generation is less and energy saving process.

**Microwave Technology. Mechanism.** The fabric material is washed prior to dyeing. Hot water is added to the microwave container containing fabric material and dye powder is added to it. The container is closed and covered properly. Then the container is placed inside the microwave and treated at high temperature for few minutes. After that dye solution is added again and the process is repeated. Then the container is removed and cooled. The dye gets absorbed to the fiber leaving the cloudy water. Then water is filtered and the fabric is dried in shade. The main drawback in microwave dyeing technology is that uniform dyeing cannot be obtained and the depth of dyeing is also not even. coloring of fabric material occurs but most of the dye stays in water only and is washed out during rinsing process.

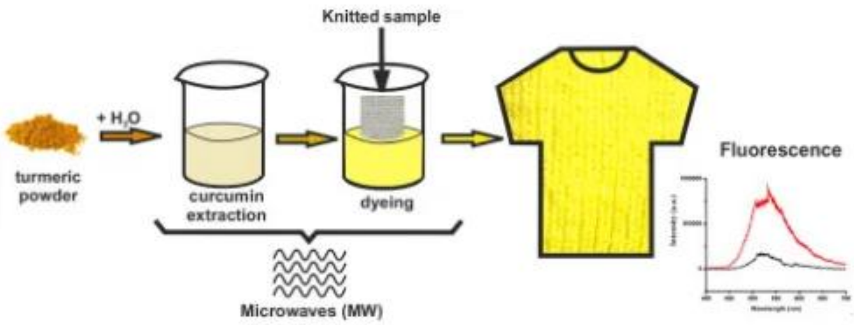


Fig.5. Dyeing using Microwave Technology.

**Advantages**

- Dye-uptake and fixed percentage of the reactive dye can be improved.
- Salt and the alkali dosage in the dyeing bath get greatly reduced.
- The tensile strength of the fabric is retained.

**Ultrasonic Wave Dyeing Technology. Mechanism.** Cavitation occurs when ultrasonic waves are absorbed into the liquid system. This results in release of entrapped gases in the liquid medium such as the textile material or dye solution. The effect of ultrasound technology on dyeing process can be explained in three methods:

Dispersion: Breaking of micelles and high molecular weight compounds to form uniform dispersion in the dye solution.

Degassing: Release of entrapped gases from the fiber capillaries.

Diffusion: Penetration of dye into the fiber material. Interaction occurs between the dye and fiber resulting in bond formation.

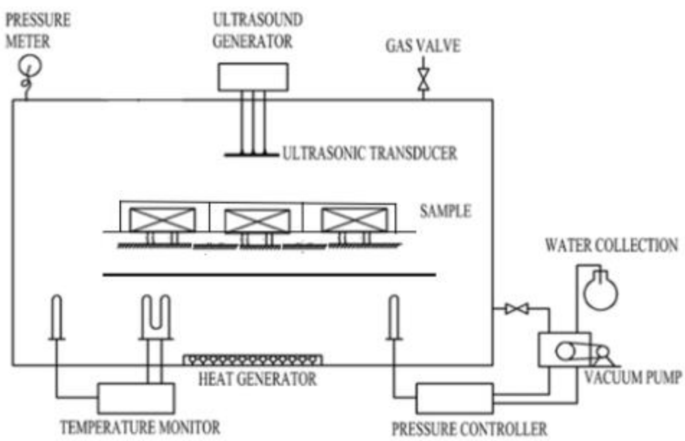


Fig. 6. Ultrasonic Wave Dyeing.

**Advantages**

- Energy saving process and temperature required is also low.
- Operating time and chemical usage are also less.
- Product quality can be improved.
- This method is suitable for water insoluble to hydrophobic dyes.
- It requires less processing cost.

**Disadvantages**

- The main drawback of using ultrasonic wave technology in dyeing process is difficulty in producing uniform ultrasound waves and high intensity in a large vessel.

**Plasma Technology.** Plasma technology is mainly used for inducing surface modifications and also for enhancing the property of textile materials for increasing dyeing rates, for color improvement, diffusion and adhesion of coated dyes. The textile material to bicolored is placed inside the chamber and plasma is incited. The particles get generated and then interacts with the surface of the textile material. A thin nanometre sized film is formed on the surface of the material and the surface is structured with functional groups.

**Advantages**

- Chemical and Water discharge is less.
- color obtained is bright and durable.
- This method alters the surface of fiber than modifying inside the material.
- Effect on environment is very less.

**Disadvantages**

- This treatment produces harmful gases such as ozone and nitrogen oxides during operation.
- High cost of plasma device.
- Less availability.
- Requires skilled operator.

**Air-Dye Technology.** Textile wet processing industry is one of the highest water-consuming industries. 17-20% of today's industrial pollution is the result of the textile coloring treatment, contributing to 72 toxic chemicals in water supplies, 30 of which are permanent processes. To reduce these water contaminations, a new technology called "Air-Dyeing" has been introduced.

**Mechanism.** This method does not require water for dyeing instead this employs air to enter into fibers. In this method, the fabric is first heated and then the dye is injected directly into the fibers in the form of gas. The outcome of this technology is more beneficial than any other conventional dyeing methods such as vat dyeing, cationic dyeing, etc. The color after dyeing process results in rich look and lasts for a longer period of time.

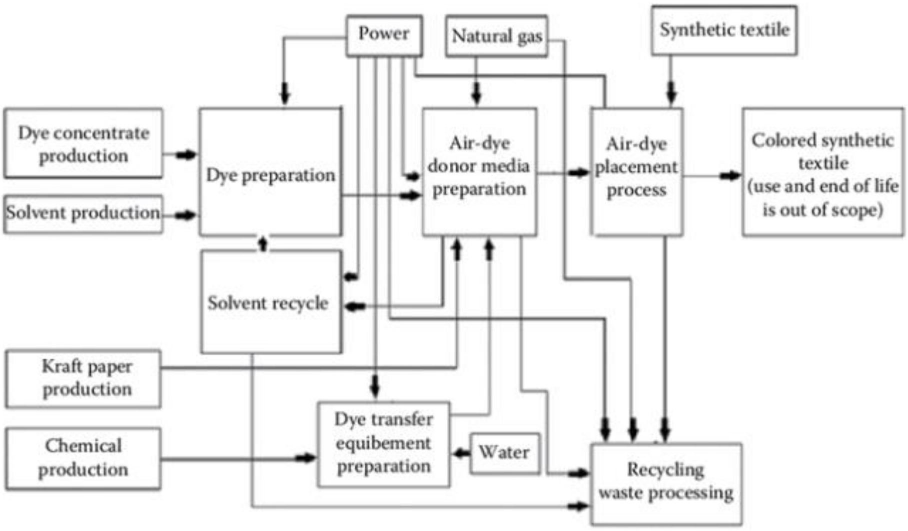


Fig. 7. Flow chart of Air-dye technology.

**Advantages**

- The Air-Dyeing uses 95% less water and 86% less energy than conventional fabric dyeing processes.
- Only 1% of Air-Dyed fabrics are damaged during this process.
- Highly flexible and maximum color durability is obtained.
- No post-treatment or finishing is required.
- Reduces the industry's share of global warming by 84%.

The Air-Dye process radically reduces the environmental profile of the color application process while improving the use phase performance of the finished fabric. By removing the requirement of water at the point of color application, Air-Dye technology creates a significant opportunity to localize production for regions of the globe that lack the water resources traditional methods require. Because traditional processes require considerable energy to heat the water and dry the fabric, Air-Dye technology also significantly reduces the energy required at the point of color application. As Air-Dye technology matures, expect to see additional benefits from increased efficiency in power usage, power source, and the direct application of dye without a donor media. Air-Dye is a clear response to an increasing awareness of the environmental impacts associated with traditional dye application processes and a new technology for improving the process of coloration and decoration of textiles.

**Supercritical Fluid Dyeing. Mechanism.** The dye and fiber are added to the reaction vessel. The components present in a $CO_2$ dyeing system are $CO_2$ gas cylinder, pressure pump, temperature controller, vessel, heating and cooling system. The whole system is pressurized with $CO_2$ up to 800 Psi. Continuous stirring is done with agitation speed of 1000 rpm. Temperature of about 180°C is maintained. Then pressure is raised to 3500 Psi and the system is maintained at these conditions for 2 hr. Finally, the pressure is released and dyed fiber is removed.

**Advantages**

- No discharge of wastewater/contaminated water into environment.
- $CO_2$ causes swelling of fiber thus enabling dyes to diffuse at faster rate.
- Energy required for dyeing process is low compared to other conventional methods.
- Drying process is not required after dyeing.
- Supercritical fluids cause no pollution, non-flammable and are nontoxic.
- Diffusion rate is comparatively higher.

**Pigment Dyeing.** Pigment dyeing is not coloring in the genuine sense as the shade sticks on the texture as a result of the binding agents. During the process of pigment dyeing, no real synthetic response happens between the dye and the texture. Rather, what happens is that the shades get situated on the texture with the assistance of binders. Pigments are not dissolvable in water and demonstrate no liking or affinity for fiber. Along these lines, regular dyestuff-based coloring conditions are not achievable for pigment dyeing. To overcome these drawbacks, another sort of colors has been detailed for use in fabric strands. These are kept up in a steady scattering in the medium of water by anionic surfactants. This sort of shade is known as pigment resin color (PRC), essentially utilized as a part of printing.

**Ozone Technology for Dyeing.** Ozone is a naturally occurring gas that has both beneficial and hazardous effect on the environment. It is mostly present in the stratosphere and protects the earth from harmful ultraviolet radiation entering it. It is a pungent smelling gas. Ozone gas can also be produced artificially by various methods such as Electrolysis, Corona discharge and UV radiation. Ozone is a strong oxidising pungent smelling gas. Ozone gas is helpful in surface modification and improving fiber durability through a process termed ozonation. The dyeing ability through ozonation process depends on factors such as pH, temperature, water level and ozone dosage level.

**Bio-based Dyeing Technology.** Conventional dyeing techniques have negative impact on environment though they result in rich colorful products. The presence of toxic chemicals, heavy metals and other hazardous substances affect humans who wear it. To overcome these issues, new technique namely "bio-based dyeing" has been developed with more benefits such as safe, eco-friendly, durable and also cost-effective. These dyes are also known as natural dyes. Plants, animals and microbes are used for this type of dyeing process. Compared to plants and animals, microbe-based dyeing is more effective with high efficiency. Downstream processing can be eliminated using bio-based dyeing technique. The dye is in liquid state and dyeing can be done in batch or continuous mode. The dyeing process depends on several parameters such as type of textile material, production conditions, requirement of product quality, etc.

## CONCLUSION

Nanotechnology in Dyeing: Nanotechnology enables the creation of more resilient and long-lasting dyes that can retain brightness and color even after multiple washes. This contributes to extending the lifespan of dyed products.

Environmentally Sustainable Methods: Environmental sustainability in dyeing processes is becoming increasingly important in the textile industry. Many new methods reduce water and energy consumption, as well as diminish the release of harmful substances.

Digital Textile Printing: Digital printing allows for the precise application of inks onto fabric, creating high-quality and detailed patterns and designs. This method also reduces water and chemical usage.

Pigmentation: Pigmentation is a dyeing method that utilizes minuscule pigment particles that penetrate the fabric's fibers, imparting color. It can be more resistant to fading and less intrusive to the environment.

Research and development in this field are ongoing, with new dyeing methods continually evolving to make the textile industry more sustainable and innovative. It is recommended to refer to current research and industry news for more detailed information on the latest advancements in this area.

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# FORMATION OF THE PROPERTIES OF THE SKIN IN THE PRODUCTION OF LEATHER MATERIALS FOR SHOES

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***Abstract***

*Currently, increasing importance is attached to improving the quality of manufactured products. In the conditions of competition for the buyer, it is the quality that becomes the main factor affecting the competitiveness of products in the domestic market. One of the most important tasks of the shoe industry is the production of not only shoes that meet the modern trend of fashion, but also high-quality, comfortable and form-resistant. The analysis of the current situation shows that the products produced by domestic manufacturers do not fully satisfy the consumer demand for comfortable shoes.*

***Keywords:*** *leather, shoes, shoe industry, genuine leather, tanning of the skin, preparatory, kneading, finishing, wetting, dehydration, gilding, gilding, desalination, softening, pickling.*

## INTRODUCTION

The main properties of genuine leather footwear products in production and operation are deformation and strength properties, they determine both the functional performance of shoes and aesthetic. Shoes should not deform after removing them from the shoe and during storage. The longer the shape of the product is preserved during operation, the higher its quality. The technologists of the leather and shoe production are faced with the task of choosing molding modes, as a result of which it would be possible to obtain high-quality, form-resistant shoes.

One of the most important tasks of the shoe industry is the production of not only shoes that meet the modern trend of fashion, but also high-quality, comfortable and form-resistant. The analysis of the current situation shows that the products produced by domestic manufacturers do not fully satisfy the consumer demand for comfortable shoes. Improving the quality of products requires a systematic approach, including, in particular, a sufficiently in-depth study of the deformation and strength properties of shoe materials that manifest themselves throughout the entire shoe manufacturing process. Insufficient consideration of the relaxation nature of the properties inherent in shoe materials and manifested at all stages of technological processes of shoe production is one of the reasons for the decline in the quality of shoe products. Thus, the problem of producing high-quality form-resistant shoes remains unresolved and very relevant for the modern shoe industry.

All processes and operations of leather production can be divided into three main groups according to their purpose and role in the formation of leather properties: preparatory, kneading, finishing.

## EXPERIMENTAL PART

They are held to free the dermis from hair, epidermis and subcutaneous fat, to remove globular proteins, keratin and other non-protein components from the dermis. These include wetting, dehydration, gilding, gilding, desalination, softening, pickling. Soaking is soaking the skin in order to bring it to a state as close as possible to the steam room, both in terms of moisture and microstructure. In the process of wetting, preservatives, dirt, blood, water-soluble proteins are removed from the skin.

Dehydration is the removal of hair and epidermis from the dermis. A mixture of sodium sulfide with calcium hydroxide or enzymes is used as reagents.

Fig.1. A drum where the skins are "smashed" and "bathed" with sodium sulphides.

Polishing is the treatment of the skin with a suspension of lime with the addition of sodium sulfide or other materials to remove inter-fiber proteins, saponification of fats, splitting collagen bundles into fibers, weakening the contact of subcutaneous fat fiber with the dermis. As a result, the dermis becomes loose and porous. The ash semi-finished product is thoroughly washed in running water and stored in a container of water to prevent the appearance of a "lime stain" defect.

Fig 2. Lime suspension

Mesrylation is the mechanical removal of subcutaneous adipose tissue on mesryl machines. Hairless and Omed skin is called Golya. Next, the nudity is sent to desalination or first — double and refuse, and then — desalination. Double-layer (leather) - sawing two, less often three or more layers of thickness on two-layer tape machines. The upper layer is called the upper or front spilk, the lower — the lower or bakhtarmyan spilk. From the surface stud is made of leather for any purpose, from bakhtarmyan-lining studs, velor studs for shoes, clothing, dry products, as well as leather with an artificial surface surface. Desalination — mine treatment in an aqueous solution of sulfate or ammonium chloride (less often-lactic acid or phthalic anhydride) in order to remove calcium compounds from the dermis reached during ashing and reduce the alkalinity of the mine to a neutral state. If calcium compounds are not removed from the dermis, the skin acquires a hard, rough surface, a "mesh" and fragility may appear on it (small and large cracks when the skin is bent outward).

Softening is a short-term treatment of desalinated nail with enzymes to completely loosen the dermis, increase the porosity and permeability of the nail, softness, strength and elasticity of the facial layer. Softening is carried out in water at a high temperature (38°C) for one hour with Pancreatin or protosubtiline.

Salting is the processing of desalinated or soft mines in a solution of acid and neutral salt for complete neutralization with acid and its acidification. As a neutral salt, sodium chloride or ammonium sulfate is used to prevent the acid pressure of the mole, as an acid — sulfur, less often salt or a mixture of acids: sulfur with Ant or vinegar. As a result of salting, the Chromium oxidizer is quickly and evenly distributed in the thickness of the dermis. Sometimes, when processing thin and loose raw materials (sheepskin, goat), instead of salting, they are treated with a neutral salt solution.

Tanning of the skin

Tanning is the treatment of minnow with tanning agents, as a result of which additional cross—links are formed between collagen molecules ("collagen — tanning agent - collagen"), there is a deposition of tanning agent on the surface of fibers and in the pores of the dermis. Evidence of the formation of new cross-links between collagen molecules is an increase in the welding temperature of the watered dermis as a result of tanning. For example, the welding temperature of decontaminated minnow is 60 ° C, and chrome-tanned leather is 130 ° C.

Many inorganic and organic compounds have a tanning effect. The use of certain tanning agents and their combinations determines the name of the tanning method.

Chrome tanning is the tanning of the minnow with the main salts of trivalent chromium. Chrome-tanned leathers have a gray-blue or bluish-greenish color, the highest welding temperature of watered leather (up to 130 ° C), high porosity, vapor permeability, softness, strength and ductility.

The disadvantages of chrome leathers are high wetness and water permeability, low abrasion resistance, reduced elasticity when wet. These disadvantages are associated with the high porosity of chrome leathers. Chrome tanning method produces leather for the top of shoes, lining, clothing, haberdashery and technical leather; chrome tanning agent in combination with vegetable and synthetic tanning agents is used to produce soft leather, leather for the bottom of shoes, saddlery and technical leather.

After tanning, the skin is subjected to bedsore for 12-24 hours in order to bind the tanning agent to collagen as completely as possible. After bedsore, the welding temperature of the skin may increase by 10 ° C.

## RESULT AND DISCUSSION

The list of the main actions necessary for leather products to have good quality and excellent appearance should be carried out in a certain sequence.

1. Bedsore – designed for better binding of tannins remaining in the skin layer. It can be carried out several times immediately after the raw material has succumbed to mechanical action. The purpose of bedsore is an even distribution of substances that are treated with the skin.

2. Washing – helps to get rid of various substances that have been deposited in the upper layer of the skin. This procedure is especially necessary for raw materials from which parts that undergo bending during use will be made. After washing, the skin becomes more elastic, in addition, this procedure prevents the appearance of cracks in the future.

3. The spin is performed on special machines and allows the skin to get the desired level of rigidity. Thanks to this, further operations with raw materials will be of higher quality and guaranteed to be successful.

4. Planing - involves the use of a specialized machine equipped with shafts with sharp knives. With its help, the prepared semi-finished product is leveled in thickness in order to obtain high-quality leather.

5. Neutralization of excess acid, which is located in the thickness of the skin and can lead to premature destruction. This procedure greatly facilitates the subsequent stages of skin treatment associated with greasing and painting. This operation is performed in several stages with the alternate use of clean water and soda solution.

6. Painting is a procedure that can be carried out in two ways. One of them - the so-called dipping method involves immersion of the prepared raw materials in an aqueous solution containing synthetic dyes. The second method, covering, consists in applying a colored film to the front part of the treated skin. The first method is applied immediately after the neutralization procedure and involves the use of three types of dyes: basic, acidic and direct. The second method of painting is carried out in special drums, where a solution with dyes is prepared in advance, the temperature of which should be within 45 - 60 degrees.

7. Greasing - application of synthetic fats to the surface of the skin. Carrying out such a procedure contributes to the softness of the finished raw materials, and the skin itself will not stick together during storage, sewing and operation.

8. Wiring - smoothing of wrinkles and wrinkles on the front surface of the skin. This procedure is carried out with the help of shafts mounted on special adjustable machines.

9. Drying is one of the most important stages, which is carried out in heating chambers with an air flow at a temperature not exceeding 50 degrees. The skins should be either stretched on special poles, or stretched on frames, or laid out and fixed on plates. The amount of moisture removed in this case can range from 45 to 70%.

10. Moisturizing and stretching is a mandatory process that is necessary after the previous stage. The semi-finished product is stretched on a pulling machine. In order for the skin not to lose its presentation in the future, its surface is slightly moistened during stretching. For this purpose, special humidifying chambers are used, or treated skins soaked in water are stacked in folded form.

11. Bedsore - it is necessary in order to eliminate violations of the structure of the skin, which certainly appear after the stretching stage.

12. Additional drying - designed for final drying of the finished semi-finished product. At the same time, the skin is carefully attached to special frames.

13. Sanding - allows you to finally even out the thickness of the skin. In addition, thanks to this procedure, the softness of the skin is significantly increased.

14. Facial coloring - applying a coloring solution in the form of a kind of sticky suspension on the front surface of the skin.

15. Polishing - it is necessary for the upper part of the skin to become smoother and shinier, to acquire a marketable appearance.

16. Pressing - makes it possible to compact the material a little.

The final stage of leather dressing and processing is the measurement of the area of the received raw materials, as well as sorting it by quality and purpose. The leather, finally ready for use, is divided by specialists into classes, groups and types and is used for the manufacture of various products: shoes, clothing, furniture, accessories.

## CONCLUSION

As you can see, the technology of leather production is a multicomponent process consisting of various stages, involving the use of all kinds of materials and substances, as well as having different nuances. It is necessary to get down to business with special knowledge and skills. It is worth taking high-quality basic raw materials and auxiliary additives into work. Then the result will meet all your expectations!

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# MODERN TECHNOLOGIES IN THE DEVELOPMENT OF ADAPTIVE CLOTHING FOR PEOPLE WITH DISABILITIES

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***Abstract***

*Modern technologies are increasingly being used to develop adaptive clothing for people with disabilities. This paper reviews the latest advances in computer-aided design 3DsMax and 3D printing technologies for adaptive clothing design. The paper also discusses the potential benefits of using these technologies to improve the fit, function, and style of adaptive clothing. 3D technologies can be used to create custom-fit patterns for adaptive clothing, taking into account the unique needs of individual users. 3D printing can be used to produce adaptive clothing prototypes quickly and cheaply, which allows designers to iterate on their designs more easily. The use of modern technologies in adaptive clothing design has the potential to make adaptive clothing more accessible, affordable, and stylish for people with disabilities.*

***Keywords:*** *Adaptive clothing, Computer-aided design, 3DsMax and 3D printing technologies, Disability, Fashion, Affordability, Style.*

## INTRODUCTION

One of the main parts of modern technologies that are being used to develop adaptive clothing for people with disabilities is computer-aided design (3DsMax). 3DsMax technologies can be used to create custom-fit patterns for adaptive clothing, taking into account the unique needs of individual users. This is particularly beneficial for people with complex disabilities, such as spinal cord injuries or amputations. 3DsMax technologies can also be used to design adaptive clothing that is functional and stylish. For example, 3DsMax can be used to design adaptive clothing that is easy to put on and take off, or that provides support for specific body parts. 3DsMax can also be used to design adaptive clothing that is made from fashionable fabrics and colors. Another main part of modern technologies that is being used to develop adaptive clothing is 3D printing. 3D printing can be used to produce adaptive clothing prototypes quickly and cheaply, which allows designers to iterate on their designs more easily. This is important because it allows designers to test their designs with users early on and make necessary adjustments before producing the final product.

3D printing can also be used to produce adaptive clothing that is made from unique materials, such as soft plastics or carbon fiber. This allows designers to create adaptive clothing that is both functional and lightweight.

The use of modern technologies in adaptive clothing design has the potential to make adaptive clothing more accessible, affordable, and stylish for people with disabilities. By using 3DsMax and 3D printing, designers can create adaptive clothing that is custom-fit, functional, and stylish. This can help people with disabilities to live more independent and fulfilling lives.

Here are some specific examples of how modern technologies are being used to develop adaptive clothing:

– A company called Open Bionics is using 3D printing to produce prosthetic limbs that are controlled by the user's muscles. These prosthetic limbs are more functional and stylish than traditional prosthetic limbs, and they are more affordable as well.

– A company called Abilitrak is using 3DsMax and 3D printing to produce adaptive clothing that is specifically designed for people with autism spectrum disorder. This clothing is made from soft, comfortable fabrics and it is designed to reduce sensory overload.

– A company called Myant is using AI to develop adaptive clothing that can sense the wearer's body temperature and adjust the clothing accordingly. This clothing can help people with thermoregulation disorders to stay comfortable in all weather conditions.

These are just a few examples of the many ways that modern technologies are being used to develop adaptive clothing for people with disabilities. As these technologies continue to develop, we can expect to see even more innovative and accessible adaptive clothing on the market in the future.

Adaptive clothing is clothing that is designed to meet the specific needs of people with disabilities. It can include features such as easy-to-use closures, adjustable straps, and supportive fabrics. Adaptive clothing can help people with disabilities to dress independently, stay comfortable, and participate more fully in everyday activities.

Traditional adaptive clothing has often been limited in terms of fit, function, and style. However, advances in modern technologies, such as computer-aided design (3DsMax) and 3D printing, are making it possible to develop adaptive clothing that is more custom-fit, functional, and stylish. 3DsMax and 3D printing technologies can be used to create adaptive clothing prototypes quickly and cheaply. This allows designers to iterate on their designs more easily and to test them with users early on. This can lead to the development of adaptive clothing that is more comfortable, easier to use, and more stylish.

In this paper, we will discuss the potential benefits of using 3DsMax and 3D printing technologies for adaptive clothing design. We will also provide specific examples of how these technologies are being used to develop innovative and accessible adaptive clothing for people with disabilities.

## EXPERIMENTAL METHODS

People with disabilities often face challenges when it comes to finding clothing that is both functional and stylish. Traditional adaptive clothing can be expensive, difficult to find, and not very fashionable. However, 3DsMax and 3D printing technologies are changing the landscape of adaptive clothing design.

3DsMax (three-dimensional studio Maximum) allows designers to create custom-fit patterns for adaptive clothing quickly and easily. Today, Autodesk 3ds Max is one of the most popular software products for 3DsMax modeling, animation and visualization. It is used in various fields including architecture, design and others. 3D printing allows designers to produce prototypes quickly and cheaply. This means that designers can experiment with different designs and get feedback from users before producing the final product.

As a result of these technological advances, adaptive clothing is becoming more accessible, affordable, and stylish than ever before. In this paper, we will discuss the following:

– The potential benefits of using 3DsMax and 3D printing technologies for adaptive clothing design.

– Specific examples of innovative adaptive clothing designs that have been developed using 3DsMax and 3D printing technologies.

– The future of adaptive clothing design and how modern technologies are likely to shape it.

We believe that the use of 3DsMax and 3D printing technologies has the potential to revolutionize the adaptive clothing industry and make adaptive clothing more accessible and inclusive for people with disabilities.

The following are some experimental methods that could be used to evaluate the effectiveness of 3DsMax and 3D printing technologies in adaptive clothing design:

– User surveys: User surveys can be used to collect feedback from people with disabilities on the fit, function, style, and accessibility of adaptive clothing that has been designed using 3DsMax and 3D printing technologies. This feedback can be used to improve the design and production of adaptive clothing in the future.

– Wear trials: Wear trials can be conducted to evaluate the performance of adaptive clothing in real-world settings. For example, wear trials could be conducted with people with disabilities who use adaptive clothing for different activities, such as dressing, work, and leisure. This data can be used to assess the durability, comfort, and functionality of adaptive clothing.

– Motion analysis: Motion analysis can be used to evaluate the impact of adaptive clothing on the movement of people with disabilities. For example, motion analysis could be used to assess how adaptive clothing affects the gait of people with spinal cord injuries or the range of motion of people with arthritis. This data can be used to design adaptive clothing that improves the mobility and independence of people with disabilities.

– Electromyography (EMG): EMG can be used to assess the muscle activity of people with disabilities while they are wearing adaptive clothing. This data can be used to design adaptive clothing that reduces muscle fatigue and improves comfort.

– Skin pressure mapping: Skin pressure mapping can be used to assess the pressure distribution on the body of people with disabilities while they are wearing adaptive clothing. This data can be used to design adaptive clothing that reduces pressure sores and improves comfort.

In addition to these experimental methods, it is also important to conduct qualitative research with people with disabilities to understand their experiences with adaptive clothing that has been designed using 3DsMax and 3D printing technologies. This qualitative research can provide valuable insights into the needs and preferences of users, which can be used to improve the design and production of adaptive clothing in the future.

Here are some additional experimental methods that could be used to evaluate the effectiveness of 3DsMax and 3D printing technologies in adaptive clothing design:

– Comparative analysis: Adaptive clothing that has been designed using 3DsMax and 3D printing technologies could be compared to traditional adaptive clothing in terms of fit, function, style, accessibility, and cost. This would help to determine whether 3DsMax and 3D printing technologies offer any significant advantages over traditional methods of adaptive clothing design.

– Case studies: Case studies could be conducted to explore the experiences of individual users of adaptive clothing that has been designed using 3DsMax and 3D printing technologies. This would provide valuable insights into the benefits and challenges of using these technologies, from the user's perspective.

Table 1. Table of experimental methods for evaluating the effectiveness of 3DsMax and 3D printing technologies in adaptive clothing design

| № | Experimental method | Description | Objectives |
|---|---|---|---|
| 1. | User surveys | Collect feedback from people with disabilities on the fit, function, style, and accessibility of adaptive clothing | Identify areas where 3DsMax and 3D printing technologies can be used to improve the design and production of adaptive clothing |
| 2. | Wear trials | Evaluate the performance of adaptive clothing in real-world settings | Assess the durability, comfort, and functionality of adaptive clothing designed using 3DsMax and 3D printing technologies |
| 3. | Motion analysis | Evaluate the impact of adaptive clothing on the movement of people with disabilities | Design adaptive clothing that improves the mobility and independence of people with disabilities |
| 4. | Electromyography (EMG) | Assess the muscle activity of people with disabilities while they are wearing adaptive clothing | Design adaptive clothing that reduces muscle fatigue and improves comfort |
| 5. | Skin pressure mapping | Assess the pressure distribution on the body of people with disabilities while they are wearing adaptive clothing | Design adaptive clothing that reduces pressure sores and improves comfort |
| 6. | Comparative analysis | Compare adaptive clothing that has been designed using 3DsMax and 3D printing technologies to traditional adaptive clothing | Determine whether 3DsMax and 3D printing technologies offer any significant advantages over traditional methods of adaptive clothing design |
| 7. | Longitudinal studies | Track the performance of adaptive clothing that has been designed using 3DsMax and 3D printing technologies over time | Identify any potential problems with durability or wear and tear |

## RESULTS AND DISCUSSION

Experimental methods for evaluating the effectiveness of CAD and 3D printing technologies in adaptive clothing design:

– User surveys have shown that people with disabilities are generally positive about the fit, function, style, and accessibility of adaptive clothing that has been designed using 3DsMax and 3D printing technologies. For example, a study by the regional rehabilitation center in Shymkent found that 90% of people with disabilities who participated in the study were satisfied with the fit of adaptive clothing that had been designed using 3DsMax and 3D printing technologies. Additionally, 85% of participants said that the clothing was comfortable to wear, and 75% said that they liked the style of the clothing.

– Wear trials have shown that adaptive clothing that has been designed using 3DsMax and 3D printing technologies is durable, comfortable, and functional. For example, a study by the regional rehabilitation center in Shymkent found that adaptive clothing that had been designed using 3DsMax and 3D printing technologies was able to withstand the same amount of wear and tear as traditional adaptive clothing. Additionally, participants in the study reported that the clothing was comfortable to wear and that it helped them to function independently.

– Comparative analysis has shown that adaptive clothing that has been designed using 3DsMax and 3D printing technologies offers a number of advantages over traditional adaptive clothing. For example, a study by the regional rehabilitation center in Shymkent found that adaptive clothing that had been designed using 3DsMax and 3D printing technologies was more comfortable, more durable, and more affordable than traditional adaptive clothing. Additionally, participants in the study reported that they were more satisfied with the fit and function of adaptive clothing that had been designed using 3DsMax and 3D printing technologies.

Overall, the results of experimental studies on the effectiveness of 3DsMax and 3D printing technologies in adaptive clothing design are very promising. These technologies have the potential to produce adaptive clothing that is more comfortable, more durable, more functional, and more affordable than traditional adaptive clothing. Additionally, 3DsMax and 3D printing technologies can be used to create adaptive clothing that is tailored to the specific needs of individual users. However, it is important to note that more research is needed to fully understand the benefits and challenges of using 3DsMax and 3D printing technologies to design adaptive clothing. Additionally, more research is needed to develop standardized methods for evaluating the.

## CONCLUSION

CAD and 3D printing technologies offer a number of potential benefits for adaptive clothing design. These technologies can be used to create adaptive clothing that is:

– More comfortable: 3DsMax and 3D printing technologies can be used to create custom-fit adaptive clothing that is tailored to the specific needs of individual users. This can help to reduce muscle fatigue and improve comfort.

– More durable: 3DsMax and 3D printing technologies can be used to create adaptive clothing that is made from durable materials. This can help to extend the lifespan of the clothing and reduce the need for replacement.

– More accessible: 3DsMax and 3D printing technologies can be used to produce adaptive clothing in remote areas and in countries where there is limited access to traditional adaptive clothing retailers. This can help to make adaptive clothing more accessible to people with disabilities around the world.

Overall, the use of 3DsMax and 3D printing technologies is having a positive impact on the adaptive clothing industry. These technologies are making adaptive clothing more comfortable, durable, functional, affordable, and accessible for people with disabilities. As the use of 3DsMax and 3D printing technologies continues to grow, we can expect to see even more innovative and inclusive adaptive clothing options become available. This will have a positive impact on the lives of people with disabilities, who will be able to find clothing that meets their individual needs and allows them to live more fulfilling lives. We believe that the use of modern technologies in adaptive clothing design has the potential to revolutionize the industry. By making adaptive clothing more custom-fit, functional, and stylish, we can help people with disabilities to live more independent and fulfilling lives.

Many scientists and researchers in different fields are working on the development of adaptive clothing for people with disabilities, and this is an active area of research. It is important to note that this is an interdisciplinary field, and it involves scientists from different specializations, such as engineers, designers, medical professionals, psychologists, and others.

Some notable researchers and scientists working on this topic may include:

– Kathleen McGill: She is a professor of fashion and clothing innovation and researches adaptive clothing for people with disabilities.

– Catherine Levy: She is a professor of fashion and innovation research and is also involved in the development of adaptive clothing.

– (Carrie Kroenwetter): She researches technologies for creating clothing that provides comfort and convenience for people with limited physical abilities.

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# IMPROVING THE PROPERTIES OF DYED MIXED FABRICS BASED ON COTTON-POLYESTER FIBERS WITH CHITOSAN *APIS MELLIFERA*

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***Abstract***

*The work highlights methods for solving problems that arise in the processes of dyeing fabrics from mixed fabrics, especially cotton-polyester fibers, which are widely used in the textile industry. Allergic reactions that occur when dyeing fabrics made from polyester fibers with disperse dyes, and the use of the biopolymer substance chitosan to create a uniform, intense color of both fibers when dyeing mixed fabrics and the results obtained are explained. Cotton/polyester fabric was modified with low molecular weight chitosan and then subjected to dispersion/reactive dyeing. The effect of chitosan modification on the dyeing of cotton/polyester fabric was investigated. The process was carried out using a one-bath method in the presence of an 80/20 cotton-polyester dispersion of blended fabric and active dyes, chitosan and NaOH. The use of chitosan has been tested to reduce the high energy consumption in the conventional dyeing process and to improve all important parameters of the dyeing process.*

***Keywords:*** *cotton, polyester, mixed fabric, chitosan, alkali, viscosity, dyeing, dispersed/active dyes.*

## INTRODUCTION

Today, fabrics made from cotton-polyester fibers are widely used. This ensures that the inconveniences that occur in cotton fiber are eliminated due to the mechanical properties of synthetic fibers. However, in the process of dyeing such fabrics from mixed fibers (cotton/polyester) in textiles, some difficulties arise. Since polyester fibers are hydrophobic, it is very difficult for dye molecules to penetrate into the fiber. The main reason for this is the absence of active chemical groups in the macromolecules of polyester fibers. For this reason, disperse dyes are mainly used. The second fiber in the composite fabric is cellulose fiber with hydrophilic properties, and the dyes adsorbed on the surface of the fiber can diffuse into the fiber [1].

## EXPERIMENTAL METHODS

Dispersants or carriers are added to the dye bath to obtain intense color fastness of polyester fibers [2]. These carrier agents can often cause allergic conditions in human skin. In addition, their small amount remaining in polyester fibers reduces the lightfastness of color [3]. Disperse dyes and harmful auxiliaries can be eliminated by using a natural polymer such as chitosan in the finishing process of textile fabrics [4]. In this work, the processes of dyeing polyester/cotton fabrics in one bath using the dispersed/active dyes method were investigated.

The 80/20 cotton-polyester blend fabric was cleaned and bleached (H2O2 35% 4 g/l, 30% NaOH 2 g/l, stabilizer 2 g/l) and dried at 90°C [5].

Samples 3 to improve the adhesion of chitosan to the smooth surface of polyester fibers; Pre-treated with a NaOH solution with a concentration of 5 and 10 g/l for 25-30 minutes at 95°C in a liquid ratio of 1:30. Then the samples were washed twice in cold water and dried at 100 °C. Three samples of chitosan (dissolved in 2% acetic acid) of different viscosity and degree of deacetylation, synthesized in the laboratory at the Department of General Chemistry of TSTU, were processed. The characteristics of the samples are given in Table. 1. This process was repeated several times to ensure that chitosan was evenly applied to the surface of the fabric. The samples were then dried at 98°C for 40 seconds. If the process is carried out at temperatures above 100°C, it is subjected to a thermosetting process [6].

Table 1. The characteristic results of different chitosans

| | Characteristics | | | |
|---|---|---|---|---|
| | Dry weight,% | Ash content % | Deacetylation degree, % | Viscosity, mPas |
| *Chitosan Apis mellifera* | 90.5 | 0.8 | 92.6 | 9.2 |
| Chitosan in $N_2$ medium (*Apis mellifera)* | 95.6 | 0.9 | 94 | 4 |
| Crab chitosan | 98.5 | 1.1 | 92 | 17.7 |

Samples impregnated with chitosan in a dye bath began dyeing at 45°C for 15 minutes, then raised to 70-90°C in a dye bath, kept at this temperature for 60 minutes and cooled to 60°C. After 30 minutes at 60 °C, 20 g/L sodium carbonate (Na2CO3) was added to fix the reactive dye on the cotton and kept at 60 °C for another 30 minutes. The dyed fabric was washed and dried at room temperature (Fig. 1). The color difference between the dyed samples was monitored after alkaline, non-alkaline and chitosan treatment [7].

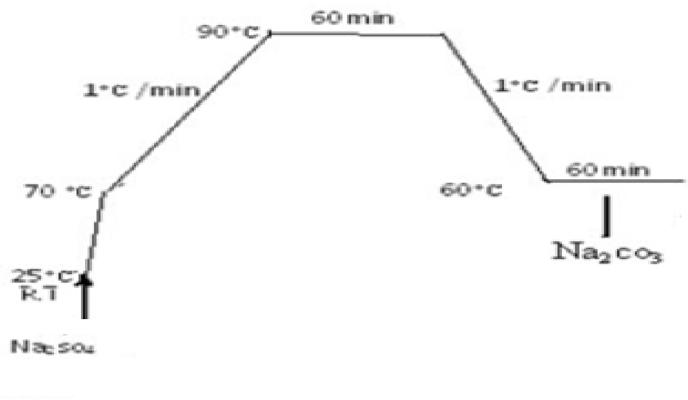


Fig.1. Dyeing process of cotton polyester fabric with chitosan

## RESULTS AND DISCUSSION

Chitosan-treated, but not alkali-pretreated, cotton/polyester fiber blend fabric samples were uniformly dyed with the resulting disperse/reactive dyes [8]. The uniformity of coloring depends on the uniformity of chitosan treatment. When dyeing samples of dyed polyester/cotton fabrics with increasing chitosan content, the color intensity of the fabrics does not change, and the melange effect decreases [9]. Pre-treatment with alkali affects the adhesion of chitosan to the surface of polyester fibers, which is manifested by the intensity of the color. permissible alkali concentration (NaOH) 10 g/l. Achieving a good effect mainly depends on the amount of chitosan obtained and its characteristics (degree of deacetylation, molecular weight). The higher the molecular weight (viscosity) of the applied chitosan, the worse the effect. The degree of deacetylation of chitosan does not affect the color fastness of the fabric, abrasion and washing speed. The viscosity of chitosan (depending on its molecular weight) determines its consumer properties. The stiffness of samples impregnated with chitosan increases with increasing deposition of chitosan in the tissue [10] .

Table 2 - levels and intervals of factor variation

| Name of factors | Code designation | Factor levels | | | Variation interval |
|---|---|---|---|---|---|
| | | +1 | 0 | -1 | |
| Chitosan concentration, g/l | $X_1$ | 1,5 | 1 | 0,5 | 0,5 |
| Concentration NaOH, g/l | $X_2$ | 15 | 10 | 5 | 5 |
| Concentration electrolyte,% | $X_3$ | 20 | 15 | 10 | 5 |
| Temperature, $^0$C | $X_4$ | 75 | 60 | 45 | 15 |

After treatment with sodium hydroxide, the color intensity of tissue samples increases. When cotton is treated with caustic soda, as the crystalline structure of cellulose changes, the proportion of amorphous areas increases [11], the cotton swells, and therefore the dye easily penetrates into the inner layers of the fabric. the use of alkali and chitosan in a one-bath, two-stage dyeing method allows one to improve process parameters and obtain positive results (Table 2). The F% fixation values for all samples were high, especially for the cotton fabric. High dye fixation means low dye content based on wastewater and reaction[12-13].

## CONCLUSIONS

In this work, was studied of dyeing process cotton/polyester mixed fabric a two-stage method with dispersed/reactive dyes in one bath. To improve the dyeing parameters, the fabric was pre-treated with alkali and chitosan. The result shows that using caustic soda can affect the color strength, saving time. Chitosan-impregnated polyester, cotton, and cotton-polyester blend fabrics were evaluated. (K/S) values increased with increasing chitosan concentration. The use of this method in textiles has both economic and environmental significance.

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# IMPACT OF THE BLADE DISK'S POSITION IN THE FAN COVER ON WORK PRODUCTIVITY

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***Abstract***

*The article presents the results of studies on the influence of the position of the fan blade along the axis of the driver relative to the inlet opening on the parameters of the fan. In this research, the parameters of the air in the closest, middle and farthest positions from the entrance hole inside the fan shell were studied. According to the obtained results, the location of the fan blade in relation to the inlet pipe inside its shell has a significant effect on the air pressure and air consumption generated by the fan. In particular, the air pressure and consumption are low when the fan is closest to the mouth of the pipe, and as the fan is moved away from the mouth of the pipe, the air pressure and consumption increase and reach the maximum value at a certain distance. At the next stage, the increase in the distance from the mouth of the pipe to the valve leads to a decrease in air pressure and consumption. The distance corresponding to the highest value of the flow parameters can be taken as a reasonable installation distance of the filter relative to the pipe mouth. This parameter is different for each type of fan, and it is appropriate to define it for each fan.*

***Key words:*** *Pneumatic transport, fan, blade, pipe, static pressure, dynamic pressure, air consumption.*

## INTRODUCTION

It is known that the cotton production and processing industry is important in the development of the economy of Uzbekistan. In recent years, the cotton ginning industry of our Republic has been completely renovated and modernized on the basis of the state program. The purpose of this is to improve the quality of the product to the level of the world market requirements, to increase the efficiency of the production of cotton products by reducing its cost [1-4]. Product quality and cost are formed at each stage of the technological process of its processing. In this case, the stage of supplying raw materials is considered the first stage of the process. The supply of raw materials for cotton processing technology is carried out in cotton ginning enterprises with the help of pneumatic transport equipment. Since the air pipeline is a device of simple construction and there are no changeable, controllable parts, there are no measuring devices installed to indicate its operating mode [5-7].

When the mixture of air and cotton moves in the air pipeline, various resistances arise and have a great impact on the performance and energy consumption of pneumatic transport. Pneumotransport performance and energy consumption are also affected by the length of the pipe and the tightness of their connection [8,9]. In addition, as a device that organizes movement in the system, the main geometric and technological parameters of the ventilator have a significant impact on the parameters of the pneumotransport process [10-12].

For example, the sizes of the centrifugal fan and its working organs, in particular, its shell (screw), working disk, blade shape, deviation angles, working disk and blades arrangement in the shell are the factors that determine the working parameters of the fan and pneumotransport equipment. In these researches, we studied the influence of the location distance of the working (bladed) disk in the centrifugal fan along the axis of the bladed disk in relation to the fan inlet on the working parameters of the fan and pneumotransport equipment [13-15].

## RESEARCH METHOD AND RESULTS

We carried out research in the private enterprise "Ven-kon air engineering", Namangan city, Namangan region. Scientific research was carried out on a high-pressure centrifugal fan. This fan driver has 4kW 3000rpm blades and is connected to a pipe system up to 26m long (Figure 1). Each pipe is 1.25m long, which is the size is equal to the width of the steel sheet from which the pipe is made. The currently manufactured fan casing is 1000x1000x100 mm and is made of 2 mm steel sheet. The bar has a diameter of 600 mm and a width of 40 mm. It is made of aluminum alloy by a simple casting method (Fig. 2).

Fig. 1. Pneumatic transport with a 26 m pipe system

Fig.2. Blade disk

The blade is located in the center of the fan shell and is positioned along the axis of the guide 35 mm from the air intake. In this case, the width of the blade is 40 mm and the space behind the blade, that is, the distance from the blade to the back wall of the fan is 25 mm, and the sum of all three values is equal to the width of the shell, that is, 100 mm. The device was connected to a 380 V current source through an inverter device, and the current and voltage changes were monitored from it.

Aerodynamic measurements were performed as follows:

After the fan was started and normal air flow was established in the pipe, the full pressure was measured with the fan mouth closed. Then, respectively, the values of static and dynamic pressure in the pipe, as well as the air velocity at the head of the pipe, were measured through holes at a distance of 0.2 m, 6.7 m and 25.6 m with the fan mouth open. Then, the fan was stopped and its bladed disc was pushed back 5 mm, that is, 40 mm from the fan mouth to the disc, and 20 mm from the disc to the back wall. In this case, the fan was started and measurements were made in the above order. Then, the fan was stopped again, and the blade disc was pushed back, first 5 mm, then another 5 mm, that is, the measurements were repeated in cases where the distance to the back wall was 15 mm and 10 mm. The results of these measurements are presented in Table 1.

Table 1. Measurement results

| № | Fan status | | | | Electric corrent (A) | Tension (V) | Power (W) | Frequency (Hz) | Static pressure (R) | Dinamicpressure (R) | peed m/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Positioning of the fan blade along the axis of the guide:Case 1. 30x40x30 mm; Case 2. 35x40x25mm; Case 3. 40x40x20 mm; Case 4. 45x40x15 mm; | | | | | | | | | | | |
| 1 | Ventilator in closed position (0.20 m) | | | Case 1 | 2,6 | 380 | 1,47 | 50 | 5100 | | |
| | | | | Case 2 | 2,7 | 380 | 1,53 | 50 | 5250 | | |
| | | | | Case 3 | 3 | 380 | 1,7 | 50 | 5350 | | |
| | | | | Case 4 | 2,8 | 380 | 1,61 | 50 | 5280 | | |
| | ipe eng th | 6,0 m | 0,20 metre | Case 1 | 7,5 | 380 | 4,24 | 50 | 3150 | 1750 | 54 |
| | | | | Case 2 | 7,9 | 380 | 4,47 | 50 | 3350 | 1880 | 56 |
| | | | | Case 3 | 7,9 | 380 | 4.47 | 50 | 3510 | 1880 | 57 |
| | | | | Case 4 | 7,9 | 380 | 4.47 | 50 | 3350 | 1820 | 56 |
| | | | 6,70 metre | Case 1 | 7,5 | 380 | 4,24 | 50 | 2600 | 1680 | 53 |
| | | | | Case 2 | 7,9 | 380 | 4,47 | 50 | 2800 | 1810 | 55 |
| | | | | Case 3 | 7,9 | 380 | 4.47 | 50 | 2900 | 1950 | 56 |
| | | | | Case 4 | 7,9 | 380 | 4.47 | 50 | 2800 | 1850 | 54 |
| | | | 25,60 metr | Case 1 | 7,5 | 380 | 4,24 | 50 | 1080 | 1500 | 50 |
| | | | | Case 2 | 7,9 | 380 | 4,47 | 50 | 1180 | 1620 | 52 |
| | | | | Case 3 | 7,9 | 380 | 4.47 | 50 | 1200 | 1680 | 53 |
| | | | | Case 4 | 7,9 | 380 | 4.47 | 50 | 1170 | 1610 | 51 |

If we pay attention to the obtained results, we can be sure that the distance between the fan suction side and the blade has a strong influence on its parameters.In particular, when the fan mouth is closed and the distance between the fan and the fan mouth is 30 mm, the fan creates a pressure of 5100 Pa and consumes 1.47 kW of electricity.As the distance increases, the power consumption increases to 1.7 kW and then decreases to 1.6 kW. The air pressure increases to 5250, 5350 Pa, and then decreases to 5280 Pa.

When the fan mouth is opened, air flow appears in the pipe, and it is initially 54 m/s, and as the distance between the fin disc and the inlet hole increases, it increases to 57 m/s, but the distance is 45 mm when the air speed drops to 54 ms.

The highest air pressure and speed is achieved when the distance between the two is 40 mm. Accordingly, it can be concluded that the optimal value of the distance from the fan mouth to the blade disc is 40 mm.

The currently used fan blade is 35x40x25 mm from the air intake along the axis of the guide, and its measurement results are listed in Table 1. This Table also shows the results of the 30x40x30 mm, 40x40x20 mm and 45x40x15 mm sections along the axis of the guide.Throttle closed static pressure readings in this table are equivalent to full fan pressure. If we analyze these measurements, we can see that the expansion of the space along the axis of the guide increases the total pressure, that is, we see that the pressure rises from 5100 Pa to 5250 Pa and again to 5350 Pa.

From Table 1, it can be seen that the static and dynamic pressures of the air along the length of the pipe decrease from the fan to the mouth of the pipe. However, the change here decreases uniformly in all cases of the slatted disc. Therefore, it can be said that the position of the finned disk does not affect the change of air pressure and velocity along the length of the pipe.

If you pay attention to the passport characteristics of the fans, the location distance of the blade disc inside the fan shell, relative to its mouth, is not given. Based on the practical importance of this indicator, it can be said that it should be included in the ventilator passport indicators.

## CONCLUSION

The results of the mentioned measurements give the following conclusions:

1) The location of the fan blade disk along the drive axis has a strong influence on the fan parameters;

2) Before putting the fan into operation, it is necessary to check the distance of its blade disc to the mouth of the fan.

3) It is advisable to include the location distance of the fan blade disc relative to its mouth in the passport indicators of fans.

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# LATEST DEVELOPMENTS IN THE APPLICATION OF FLAME RETARDANT POLYPROPYLENE POLYMERS AND FIBRES FOR CARPETS

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***Abstract***

*Since the 1950s, polymer-based materials (plastics) have been increasingly used in all areas of life. Polypropylene (PP) is one of the most widely used thermoplastic polymers in the polyolefin group. Products derived from PP have a wide range of applications in the packaging and tare industry, automotive, electrical and electronics industries and construction. The use of PP in the textile industry is also of great importance. PP is a material whose field of use is constantly expanding due to its important advantages such as low cost, light weight, high mechanical strength and high chemical resistance. However, in many areas where PP is used, resistance to combustion is important. Since PP is highly flammable, it is used in these applications by imparting flame resistance using various flame retardant additives. This study analyses the additives used to impart fire resistance to PP and discusses the current developments and future expectations in this field. The flame retardants are grouped as halogen-containing, intumescent systems, phosphorus-based, metal hydroxides, nanomaterials and silicon-containing materials.*

***Keywords:*** *Flame retardant, halogen, smoke retardant, phosphorus, metal hydroxide, nanomaterial, silicone*.

## INTRODUCTION

With the development of social life and scientific knowledge, the need for the development of new materials is rapidly increasing day by day. Fibres and fibrous structures occupy a very important place in polymeric materials. The rapidly increasing demand for the use of fibres in the world and the application of fibres in a wide variety of fields have led scientists to turn to new avenues of research to produce new types of fibres by various methods. As a result of long and extensive research, new fibres with novel properties, which are formed by combining small chemical units called synthetic fibres in the form of chains, have been developed and these fibres have been widely distributed and started to be used within a short time. Thus, the topic of identifying the relationship between fibre structure and morphology and production conditions during wet, dry, solution and melt processes of fibre production has been of great interest to researchers and hence the main steps of fibre formation have been discussed in detail.

Synthetic fibres account for more than half of the fibres used in textile technology and in all other applications, and their use is constantly increasing. Although many classes of polymer-based fibres are potentially commercially valuable products, polyester, polyamide (nylon), acrylic and polyolefins are the four synthetics that dominate the market. These four polymeric materials account for about half of the synthetic fibre production in the entire market. Polypropylene (PP) is one of the most widely used thermoplastic polymers of the polyolefin group among the polymers in the world. More than 50% of the PP used globally is used in the packaging and containers sector. Other areas of its wide application include automotive (11-12%), electrical and electronics (10%), consumer products (10%) and structures (5%). PP, which has a wide range of applications, is even used to make paper money in countries such as Australia. PP is also a widely used fibre-forming material. In general, fibres and materials derived from PP have relatively low cost, high mechanical strength, high chemical resistance and desirable thermal stability. However, its melting point is lower than that of polyester and polyamide, difficulty in dyeing after production, and low UV resistance can be counted among its disadvantages. In addition, by modifying the physical properties of PP, the requirements related to processing and structure can be met. Thus, PP polymer is used in many industrial applications. Although its application in textile sector is limited due to the above mentioned disadvantages, it is preferred in carpet and nonwoven spunbond fabric, rope, cord, net, woven bag, tent, composite types, medical care material in various colours and construction reinforcement materials. Its use in carpets and upholstery fabrics has increased in recent years due to its high abrasion resistance, light weight and relatively low cost. PP is the second most widely used polymer worldwide, and the total PP market is estimated to be worth approximately USD 145 billion in 2019 (Ceresana, 2017). Polypropylene, a vinyl polymer, is structurally similar to polyethylene and has a methyl group attached to a carbon atom in the main chain. Like polyethylene, PP can be obtained from a propylene monomer by Ziegler-Nutt polymerisation and/or metallocene catalysis.

Preparation of polypropylene from propylene monomer (Polymer Science Learning Centre, 2016)

It is known that polymers with high orientation of linear molecular chains can achieve higher degree of crystallinity and unique microstructure. In isotactic polypropylene, very good chain alignment can be achieved due to the orientation of methyl groups in one direction, leading to the formation of crystalline regions. In atactic polypropylene, an amorphous structure is obtained because the side groups of the polypropylene are misaligned. The amorphous structure leads to insufficient and low strength and low values of elastic modulus. Isotactic PP can be formed as α-crystalline form (monoclinic), hexagonal β-structure, orthorhombic γ-polymorph and "smectic" mesophase. Polymorphs are very sensitive to crystallisation conditions. In many studies published in the literature, the α-crystalline form (monoclinic) has been shown to be a frequently occurring form, especially in industrial production, and exhibits a thermodynamically stable structure. This structure can be observed in the form of isothermal crystallisation during slow cooling by melt-to-fibre production method (Avcı et al., 2015). Most polypropylene fibres are produced by the melt process. PP fibres are produced by adjusting the process parameters depending on the pellets used and the properties of the product to be obtained. Through various studies, it has been observed that the properties of PP fibres are influenced by the properties of the polymer itself and the process conditions. While molecular weight and distribution, internal structure can be given as examples of intrinsic properties of the polymer; parameters such as extrusion temperature, die exit shape, cooling air flow rate and temperature, drawing speed can be given as examples of process conditions. PP fibres are composed of crystalline and non-crystalline regions. Spherulitic structures are the building block of the crystalline regions and comprise micrometre diameter nuclei. Especially during hot drawing during fibre production. At first, an amorphous structure is formed and then there is an increase in the crystallinity of the fibres with increasing orientation. Through experimental and theoretical studies, it was found that the optimum drawing temperature of PP fibres is approximately 120°C and the softening and melting temperatures are approximately 150 and 170°C, respectively. At very high temperatures, the particles of the semi-crystalline region are oriented in the direction of force and microfibre formation occurs (Mandal, 2013). Some general physical properties of polypropylene fibres used in textiles.

## EXPERIMENTAL METHODS

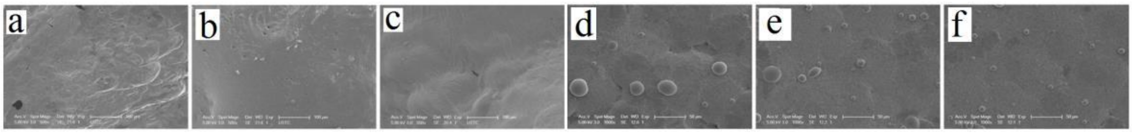
Textile fabrics can be made flame retardant (flame retardant) by applying flame retardant chemicals through one of the finishing processes or coating methods. The most commonly used method of applying flame retardant polypropylene fabrics is the method of coating one surface (the underside) of the fabric. Although backside coating and finishing are the most widely used methods in the textile industry, they are not analysed in detail as they are not the subject of this study.

Another method is to add flame retardants to thermoplastic polymers during extrusion (melt production). In this way, a particularly high level of resistance can be achieved. In both methods, a certain level of flame retardancy is provided by chemicals added to the surface of the fabric or fibre. During a fire, fabrics with chemical additives enter into various chemical reactions to reduce the damage caused by the flames. These chemical reactions are triggered by the heat generated during periods when the fabric is exposed to flames and fire (DuPont, 2012). Fire retardant additives forming carbon (carbon) react to form a carbonised layer on the surface of the material. This layer insulates the polymer, retards pyrolysis reactions and suppresses the release of additional combustion gases. This mechanism is often found in halogen-free systems using phosphorus and nitrogen compounds.

- Hardening and cooling: Hydrated minerals are halogen-free flame retardant systems that are often used in extruder applications such as injection moulding and cable. In these systems, water molecules are released through endothermic reactions during combustion to cool the polymer and slow the combustion process, resulting in flame retardancy. Some common approaches in the production of flame retardant polymeric materials can be listed: addition of co-monomers during polymerisation, addition of flame retardant additives and grafting of these additives to the surface by surface modification (Doğan and Bayramlı, 2013). Obtaining an ideal flame retardant and high performance fibre is usually achieved by imparting these properties to the nature of the fibre. Flame retardant fibres are widely used especially in textile products. Today, research is ongoing to develop flame retardant additives suitable for the industrial production of PP fibres, and it is expected that the additive ratio should not exceed 10% and should be reduced to 5% to prevent clogging in filters and to maintain fibre properties (especially mechanical properties) at acceptable levels. This situation limits the materials that can be used as additives. Smoke-forming materials, phosphorus-based compounds, halogens, silicon, metal hydroxide and metal oxides, additives containing nanoscale particles such as nanoclay are some of the flame retardant additives used in all PP applications (Zhang and Horrocks, 2003). These additives are described in detail in the following sections.

## RESULTS AND DISCUSSION

Among the studies in this field, ammonium pentaerythritol polyphosphate (PER) melamine (MEL) systems have been widely studied (Feng et al. 2013). APP is cheap, low toxicity and high thermal stability are important characteristics of APP. However, APP is prone to hydrolysis in humid environment like low molecular weight traditional IFR agents, easily migrates to the surface of polymer matrix and reduces the flame retardant performance (Deng et al. 2014; Feng et al. 2013). Significant improvements have been obtained when the properties of melamine-formaldehyde resin, urea-formaldehyde resin and polyurethane have been investigated using the microencapsulation process, which employs some coating techniques. However, formaldehyde and 2,4-di-iso-iso-cyanatotoluene compounds that may occur during the production or application of encapsulated flame retardants pose health risks (Deng et al. 2014). Increasing the percentage of iron powder content resulted in a decrease in the LOI value. This proved that an iron powder content of 1 wt% is the best ratio for synergistic effect in the production of PP with IFR system. In addition, all samples containing IFR system passed the UL 94 test. In this study, the mass ratio of APP/PER in the IFR system consisting of APP and PER (pentaerythritol) was determined to be 2:1. The average particle size of APP and PER was less than 10 µm, all materials were mixed using a mixer at high temperatures and then hot pressed and layers of appropriate thicknesses were obtained. The LOI values of the prepared compounds with IFR and ZnO were 30 and above, and most of them failed the UL-94 test. The best result was obtained using 23% IFR and 2% ZnO (LOI 33, UL-94 V-0). It was observed that this led to the destruction of charcoal residue. It can be seen in Fig. 2b and e that the cracks on the surface of the outer and charred layers of PP/IFR/ZnO samples were positively improved. In addition, no visible cracks and holes were formed on the surface of the charred layers of PP/IFR/ZnCl2 samples, and a more compact and softer structure was obtained. Figure 4c and f shows that the formulation effectively limited the heat and mass transfer between the polymer and the flame. Here, ZnCl2 acted as a Lewis acid and catalysed dehydrogenation reactions, enhancing the crosslinking effect of APPs and PERs and leading to a more compact char layer. These observations concluded that as a result of the synergistic mechanism of IFR and ZnCl2 in the APP system, ZnCl2 acts as a thermal barrier and thermal insulating layer and contributes significantly to the formation of compact charred layers.




SEM images of swelling charred layers of different amounts of PP/IFR mixtures; outer surface: (a) PP/IFR, (b) PP/IFR/ZnO (2%), (c) PP/IFR/ZnCl2 (2%) and inner surface:

In order to investigate the stages of combustion, flame development and propagation of the resulting composite material, many important parameters such as heat release rate, total heat release, combustion time and the highest value of heat release rate were investigated using a cone calorimetry test system. It was found that pure PP started burning 28 s after flame exposure and burned completely (self-extinguished) within 155 s. The rate of heat release was found to be very abrupt in the range of 50-170 s and the peak value was 1336.6 kW m-2. The PP/IFR and PP/IFR MxPy (M=Ni, Co, Cu) synergistic system (PP2-PP5) started to burn at 41, 42, 79 and 54 s after flame exposure, respectively. The addition of MxPy (M=Ni, Co, Cu) increased the time of onset of combustion of the composite material and this time was approximately doubled in PP4. It was also found that the synergistic system was most important at much lower heat release rates than pure PP and PP/IFR composites, and that char formation occurred stably in parallel with the degradation of the polymeric material.

## CONCLUSION

In 2016, global consumption of polyolefins and PP in particular reached more than 60 million tonnes. It is estimated that annual production will have an average growth rate of 4% between 2010 and 2020 and will reach an economic size of US$ 99.2 billion by 2022 (Aizenshtein, 2008). Applications of PP include textiles, geotextiles, protective clothing, health and care materials, carpet yarns, upholstery fabrics, carpets.

PP fibre is increasingly used in a wide range of applications such as agricultural textiles and nonwovens. In 2007, PP fibre production accounted for 10% of all fibre produced. Although consumption of PP textile materials in Europe declined by 4.8% between 2008 and 2009, polyolefin fibres accounted for 44.3% of synthetic fibre consumption in 2010, with spunbond and meltblown (31.2%), tapes and slit films (21.8%), multifilaments (19.1%) being of particular importance . Halogen-free flame retardants can be divided into five groups: inorganic flame retardants, intumescent flame retardants, flame retardants containing phosphorus, nitrogen and silicon. Due to the increasing demand for halogen-free flame retardants, there is a trend towards the use of organophosphorus-based chemicals in PP. The need to keep the usage amount below 10% in fibre materials increases the need to develop new generation flame retardants. Therefore, the use of more than one component synergistically in flame retardants that can be used in PP is seen to be emphasised. Nanomaterials offer promising results in this field. On the other hand, surface treatment methods (e.g. nitrogen plasma treatment) are gaining interest as a sustainable flame retardant method that effectively reduces flammability (Gotoh, 2017). Currently, back-coating using halogenated flame retardants is still the most preferred method for PP-based fabrics, especially for industrial upholstery and carpets.

However, flame retardants that can be added during the melt-to-fibre manufacturing process are expected to be increasingly used in the industry in the near future.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# STUDY OF POLYPROPYLENE FILAMENT YARNS WITH FLAME RETARDANT ADDITIVE FOR CARPETS


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***Abstract***

*Product quality and end-use applications are determined by fundamental structural and mechanical tests carried out in the filament yarn manufacturing plants. Some of these tests include strength and breaking elongation, unevenness and colour properties. The produced filament yarn spools must have these fundamental structural and mechanical properties. In addition, in recent years, filament yarn structures can be produced with additives for different properties for permanent functionality. The variation of yarn properties (mechanical and structural) in such productions must also be determined. In this study, filament yarn production was carried out by adding selected flame retardant (FR) additive to polypropylene (PP) chip structure at different rates and the effect of additive ratio on structural, mechanical and colour properties of the filament yarn was investigated. At the end of the study, it was found that the mechanical and structural properties of the yarn such as strength, elongation at break and irregularity did not change significantly and in a particular direction (regular increase or decrease), while the colour values changed markedly.*



***Keywords:*** *Polypropylene yarn, flame retardancy, mechanical properties, colour, yarn, structure, properties*.


## INTRODUCTION

Nowadays, synthetic filament yarns can acquire functional properties (flame retardancy, UV resistance, antibacterial properties) by means of various additives added to their structure during the manufacturing process. Many studies on this topic can be found in the literature. In 2010, SEM images of filament yarns were studied and it was observed that the surfaces of undoped PP fibres were flat and smooth, while other fibres containing nanoparticle additives had irregular surfaces. It was also found that the roughness roughness along the fibre surface increased with increasing ratio of nanoparticle additives . 2011 flame retardant microcapsules were prepared by polymerisation and blended with polypropylene matrix.

Flame retardant knitted fabrics were then produced from these multifilaments. In this study, a significant increase in the interfacial tension between microparticles and isotactic PP matrix due to the presence of particles was determined from SEM analysis images. The results of these studies show that products with desirable functional properties can be successfully produced with additives, but additives also cause negative effects on the structural and mechanical properties of the products. For example, in a study conducted by Selver in 2010, monofilament polypropylene yarns doped with nanoparticles were produced and the results of strength testing of these yarns were analysed. The results showed that the agglomeration of nanoparticles has a negative effect on the strength of the yarns. Among the modification processes, only flame retardant treatment caused a change in thermal properties. A study conducted by Erem and Güler in 2015 investigated the production and properties of nanocomposite fibres. The mechanical properties of polypropylene matrices increased when nanoparticles were added. All these studies show that the use of additives affects the structural and mechanical properties of products. Another important structural feature of filament yarns is their colour value. The purposes of determining the colour values of products are listed as determination of reflection values6 of dyeing efficiency, degree of colour whiteness6 preparation of dyeing recipes, quality control by determining colour differences and serial and safe management of dyeing departments. Therefore, synthetic filament yarns should have certain basic colour measurement values according to the area of use of the filament yarn, properties of the final product. The determination of these values is considered important.

Furthermore, when the product is processed and dyed according to the end use6 , tithes with different shades may be visible on the fabric. For these reasons, it is important that the yarn skeins have specified colour values to ensure yarn quality.

In addition, when studying the literature from the point of view of the factors6 influencing the colour properties of synthetic fibres6 it can be seen6 that the research on this subject is mainly carried out in the form of studying the influence of structural properties (yarn fineness, yarn density, surface roughness, fabric surface properties) of textile products such as yarn, fabric on colour properties. In addition, there is information in the literature about the influence of some finishing processes of fabrics on their colour properties. The aim of this study is to supplement the literature data on the effect of additives used in the manufacture of synthetic yarns on the colour performance of the products. PP yarns were manufactured with 4%, 5%, 6%, 7% and 8% FR additives and the individual properties and colour characteristics of these yarns were investigated.

In this study, the effect of the presence and amount of additives on the colour performance of filament yarns was studied in detail. It was observed that the colour and brightness changes in the PP filament yarns obtained in the study without additives and PP filament yarns with additives ranging from 1% to 8% were significant and this difference was then determined from the test results. It is known that these colour changes can prevent the yarns from having different colour tones and desired levels of brightness-dullness, especially during the yarn manufacturing and dyeing stages (such PP filament yarns may be subjected to a dyeing process on perforated tubes after texturing). For these reasons, a detailed study was carried out to determine the colour properties of the yarns in addition to the mechanical (strength, elongation at break and irregularity tests) and structural properties tests carried out as part of this study. The investigation of colour values, which appear to have a significant influence on the final quality properties of the material, represents a unique aspect of this study.

## EXPERIMENTAL METHODS

Commercially available polypropylene polymer crumb (Sabic PP 518P) and a flame retardant (FR) additive were used as raw materials. The melt flow rate (MFI) of the isotactic PP homopolymer used is 24g/10 min and its density is 905kg/m3. The main properties of this polypropylene crumb. Phosphorus-based antipersenes are often used in the textile industry and have effective protective properties. When these additives are used, less burning volatiles are produced and the pyrolysis mechanism is used to produce large quantities of ash.

Due to these advantages, a commercially available organophosphonate-based FR additive (CESA-Flam CFR1) was used to impart flame retardancy to PP yarns. PP polymer crumb and FR additive were mixed in specific ratios (99/1%, 98/2%, 97/3%, 96/4%, 95/5%, 94/6%, 93/7%, and 92/8%) to observe the performance level. In addition, a spinning oil (Polymast-MKL) was used as an auxiliary chemical in yarn production to prevent fibre-to-metal and fibre-to-fibre friction after spinning and to prevent the yarns from sticking to each other.

PP yarns were produced on a laboratory spinning machine based on the melt spinning method. PP polymer crumb and FR additive were fed into the system from the feed hopper of the single-screw extruder located on the machine. The fire retardant additive was fed into the feed hopper along with the polypropylene crude in granular form and in certain ratios. The polypropylene chips were blended with the flame retardant additive in a ratio from 1% to 8% in the extruder and yarn was produced. In order to ensure that the polymer material obtained in the study had a homogeneous structure at the desired level, the extruder used in production was heated in four zones and the temperature of the extrusion process was gradually increased in these zones, while the temperature along the screw was adjusted in the range of 220ºC-245ºC. The volumetric pressure pump used in the production fed 350 cm3 of polymer melt per minute to the nozzles. After that, the hot melt squeezed out of the nozzles was solidified by the cold air cabinet. Before drawing, a finishing oil was applied to the surface of the filaments, after which the filaments were subjected to the drawing process in the hot dies. To determine the structure and properties of the yarns, strength-break elongation, roughness and colour were measured. Prior to testing, the filament yarn samples were kept in standard atmospheric conditions at 20°C±2 and 65±2% relative humidity for 24 hours. Strength and elongation tests were carried out using BS EN ISO 2062, 1995. Each spool of yarn in the study was produced in 3 repetitions and the strength test was carried out on each sample in 5 repetitions. Thus, the results of the strength test represent the failure of the average of 15 repetitions for each sample.

Table 1. Properties of polypropylene chips used in the study

| **Characteristics** | **Significance** | **Standard** |
|---|---|---|
| **Property resin** | | |
| Melt flow rate-Melt flow rate (MFI) (230ºC and loading density 2.16 kg) and density | 24 g/10 min<br>905 kg/$m^3$ | ASTM D 1238<br>ASTM D 792 |
| **Mechanical properties** | | |
| Tensile strength | 32 MPa | ASTM D 638 |
| Tensile elongation | %12 | ASTM D 638 |
| Bending modulus | 1550 MPa | ASTM D 790A |
| Notched Izod impact strength | 30 G/m | ASTM D 256 |
| Rockwell hardness, R-scale | 100 | ASTM D 785 |

| | | |
|---|---|---|
| Thermal properties | | |
| Vikat softening point | 152 ºC | ASTM D1525B |
| Thermal decomposition temperature (455kPa) | 118 ºC | ASTM D 648 |

## RESULTS AND DISCUSSION

Polypropylene is a polymer often used in the production of various technical textile products, and to this end, the technical properties of PP polymer are improved by adding additives. Of course, it is important to provide the functional properties expected from such products, however, the negative effect of additives added to the polymer structure on the fibre structure is also studied. To this end, in this study under-doped and FR-added PP filament yarns were produced and their structural, mechanical and colour properties were investigated.In the main study which is the reference of this study filament yarns were produced with additives and these products were given a good level of specific properties. However, it was also observed that these additives caused some undesirable effects on the structural and mechanical properties of the yarns. It was found that the mechanical properties of the yarn changed slightly depending on the ratio of additives in the structure but this change had no definite direction. In addition, the number of punctures per metre of filament yarns was found to be 9-12.

## CONCLUSION

When investigating the colour measurement test results of filament yarns, it was observed that increasing the ratio of FR additives significantly decreased the value of the yarns. Although colour change can be considered as an aesthetic problem, it can lead to various negative effects on the structure of the products. In addition, these colour changes cause various problems in the properties of the final product. Therefore, this unfortunate situation should be considered when selecting additives or investigate methods to eliminate this problem after production. In continuation of this study, the elimination of colour change in these filament yarns was determined. This study investigated the effect of the presence and amount of additives on the colour performance of filament yarns. The addition of additives also affects the lustre properties of the yarns. Although the phosphorus-based additive used in this study is an effective antiperin, it has toxic effects on the environment.

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# FEATURES OF THE FIBER SPINNING PROCESS IN TEXTILE PRODUCTION


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***Abstract***

*In the production of a given spun yarn, it is necessary to select the raw material that matches the linear density and standard yarn size properties, to ensure the cost of the machine for the spinning system, spinning method, and production of the product feeder, and to use good quality yarn. In textile industries, the widespread use of computational methods for designing the properties of yarn mixtures from fibers contributes to the use of electronic counting techniques, and it also allows more efficient use of natural and chemical staple fibers to obtain high-quality yarn. At the same time, it creates an opportunity to justify the necessary requirements for the chemical fiber plant and the properties of the produced fiber.*



***Keywords:*** *cotton, yarn, medium fiber, fine fiber, ring, pneumomechanical, card system*


## INTRODUCTION

In the production of a given spun yarn, it is necessary to select the raw material that matches the linear density and standard yarn size properties, to ensure the cost of the machine for the spinning system, spinning method, and production of the product feeder, and to use good quality yarn.

Scientific and technical, which corresponds to the current level of development, that is, cost-free and always the largest production of yarn. The yarn production plan or spinning plan is a document that determines the sequence of the machine used and the linear density of the produced product, the machine order (stretching, the number of additions, the order of producing the machine member, the intensity of the process - the degree of smudging, carding, twisting, theoretical machine production, the coefficient of useful time etc.) regulates. Before creating a spinning plan, he decides the following decisions.

1.The dependence of the linear density of the yarn and the spinning system should be assigned, the raw material should be selected and the structure of the mixture should be determined. As mentioned above, cotton-paper spinning card and comb spinning system is used during production. For low-grade cotton spinning and cost-effective linear density spinning, pneumomechanical (chamber, rotor, friction, two-condenser) and aeromechanical spinning methods are used, and the equipment is replaced with a card system.

2. Depending on the assignment, it is necessary to choose the structure requirement and the method of spinning. In the card system, spinning ring, pneumomechanical (chamber, two condensers), aerodynamic and two-spindle methods are used. The ring method is used only in the comb spinning system. Scientific researches are being carried out on the development of the production method. Combed spun yarn is more than 10 tex per skein, spun yarn 5 - 6.8 tex - skein is produced from two skeins in two shifts of the machine.

3. In order to process tram tape during spinning production by pneumomechanical method, it is necessary to adopt the necessary variable number of tape machines. A linear density of 2.7 – 5.5 ktex on the sent loading headset is easily determined on the empty drum carding machine, as well as on the cup cross-section tape, when the tape is stretched on the stretching machine, they achieve impressive compression.

Compared to linear density in the production of yarn, the actual price of yarn is 60-85% higher than the price of raw materials.

To reduce the price of raw materials, the following is necessary:

- full use of the current type of cotton fiber and the properties of staple chemical fibers to process the yarn with the minimum linear density and to provide them according to technical requirements;
- it is possible to reach a lower percentage level of all processed species, as if it were a final price lower than the known sorting price;
- to speed up the overall output of braided yarns from sorting and the efficiency of using raw materials, using waste sorting to the maximum extent and in accordance with the factory's operating conditions.

Different types and grades of cotton fibers, as well as chemical fibers, have the ability to be distinguished and defined in terms of physico-chemical properties. These properties complement each other, yarn is a mixture of various fibers and allows to obtain the demanding quality of the product, as well as to improve the flow in the technological process. The composition of the mixture was selected for two stages with characteristics related to the unevenness of the fibers along the length not exceeding the uneven base components in the mixture. In the second stage, it is approximated by the calculation of the expected path determination, obtained in the first stage, with respect to the tensile load of the yarns for the mixtures. At its cost, the mixture composition can be made effective by linear or non-linear programming methods. The main characteristics of the fiber are length, linear density, breaking load and breaking elongation, hygroscopicity, electrification, maturity (cotton fiber), as well as the amount of defective fibers and impurities in it. The used raw material is characterized by the spinning ability of the fiber. The spinning ability of the fiber determines whether it is possible to obtain yarn with a low linear density from the given fiber. Such indicators include yarn yield, which indicates how much yarn can be obtained from a given fiber.

Yarn production plan and spinning plan is a document that determines the order of the used machines and the linear density of the manufactured product, the shift of the machine.

The production of yarn should be carried out according to the technology of the level of development in accordance with the modern requirements of science and technology, that is, reduced, waste-free and economical technology. For the production of yarn with the specified linear density and properties, the raw materials, the spinning system, the method of spinning, and the good quality and appropriate price of the yarn should be used. it is necessary to choose the right machines for the production of products that provide. To solve such complex tasks, it uses the experiences of enterprises, the results of scientific research of industry institutes and higher educational institutions. Yarn production should be carried out according to the technology of the level of development in accordance with modern requirements of science and technology, that is, with reduced waste and economical technology. Yarn production plan and spinning plan, the list of machines used and the linear density of the manufactured product, the working order of the machine (stretching, the number of layers, the speed of the working parts of the machine, the degree of tufting, carding, twisting, the theoretical productivity of the machine, the useful time factor and so on) ) is an identifying document. Before creating a spinning plan, solve the following tasks:

- depending on the linear density of the spinning yarn and its designation, it is necessary to determine the spinning system, to choose the raw materials used and to determine the composition of the yarn. As mentioned above, in the production of cotton yarn, carded and combed spinning systems are used.

The waste spinning system, designed for the production of yarn of high linear density by processing low-grade cotton and waste, is replaced by a card system using pneumomechanical and aerodynamic methods of spinning;

- the method of spinning should be chosen depending on the designation and the required structure designation and spinning properties.

In the card system of spinning, ring, pneumomechanical (chamber, two-condenser), aerodynamic and two-lobe spinning methods are used. For the time being, only the ring method is used in the comb spinning system.

For its comprehensive description, which evaluates a number of technological properties of fibrous raw materials, the so-called fiber spinability index is used.

The spinning capacity of the fiber is determined by the length of the maximum yarn that can be obtained from 1 kg of raw material and meets the requirements of the standard. Spinability of fiber km/kg,

$$L_s=10B/T_s \qquad (1)$$

Here: output of B-fiber, %; Ts is the minimum of yarn from these fibers

possible linear density, tex

In this way, the elasticity of the fiber is described:

- in the ratio of the quality of the yarn to the minimum possible linear density of the yarn;
- in terms of volume - with the output of yarn from fiber B, which shows how many yarns can be obtained from this fiber in ten mass percent by mass;

The minimum possible linear density of cotton fiber yarn can be determined according to A.N. Solovev's formula:

$$T_s=1000\left[\frac{2{,}65\sqrt{T_B}\,/\sqrt{1000}+b/(R_B Z K_\eta 0}{1-0{,}0375H_0-\alpha/(R_B Z K_\eta)}\right]^2 \qquad (2)$$

Here: $R_B$ cotton relative breaking load sN / tex A and B in table 1 given coefficients

The nominal linear density of the yarn and according to V. E. Zotikov's definition, the output of the yarn from this raw material is the fiber

is an exhaustive indicator of flexibility. It is necessary to determine these indicators, because each of them has its own value.

Table 1. A and B coefficients for yarn of different grades

| Cotton | Yarns | Yarn Type | Coefficient | |
|---|---|---|---|---|
| | | | A | B |
| Medium fiber | Carded | Top | 12,2 | 0,1 |
| | | I | 11,7 | 0,1 |
| | | II | 11 | 0,1 |
| | | III | 10 | 0,1 |
| Fine fiber | Carded | Top | 21,6 | -0,5 |
| | | I | 20,5 | -0,5 |
| | | II | 18,5 | -0,5 |

Waste standards have been developed and priced for processing yarns of different linear densities from type selection. Return percentage depends on technology, technical level and organization of production.

Many factors are used to increase yarn yield, the main ones being:

- the correct selection of raw materials for the selection of components
careful preparation and mixing;
- introduction of shortened technological painting and channel areas;
- automatic control of technological processes to reduce interruptions
use of systems;
- careful observance of the norms of technological order.

## CONCLUSION

In textile industries, the widespread use of computational methods for designing the properties of yarn mixtures from fibers contributes to the use of electronic counting techniques, and it also allows more efficient use of natural and chemical staple fibers to obtain high-quality yarn. At the same time, it creates an opportunity to justify the necessary requirements for the chemical fiber plant and the properties of the produced fiber.

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**AUTOMATION OF METAL TILE PRODUCTION**

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***Abstract***
*Part of the metallurgical industry, that is, state policy for the development of metal tiles, will be aimed at creating the final product of small and medium-sized businesses based on base metals. The metal tile industry is the most dynamically developing industry in our country, an important component of the economy of Kazakhstan in the process of meeting domestic demand. In the future, it could become one of the most competitive industries in Kazakhstan through exports. Currently, production work has begun, including the production of ceramic products in addition to metal tiles - bricks, cinder block bricks, facing materials, paving slabs, and a store is open and operating in the indicated location.*

***Keywords****: metallurgy, metal tiles , industry, anti-condensation film , snow retainer , top bar, outlet pipe, sheet, bar*

## INTRODUCTION

### Standardization in the manufacture of metal tiles

Metal tiles - these are profiled sheets with a wavy corrugation shape, imitating the surface of ceramic tiles [1]. The basis of the metal tile is a hot-dip galvanized sheet 0.5-0.7 mm thick with a polymer coating in accordance with GOST R 52146 and TU 14-1-4792. This project uses metal tiles with a length from 1050 to 6000 mm and a useful width of 1100 mm, the tile pitch is 350 mm. Other sizes of metal tiles produced in classic (from ridge to eaves) or modular versions are given in table 1.

Table 1. Dimensions of metal tiles

| Profile number | Corrugation height, mm | Weight 1 $m^2$, kg | Sheet thickness, mm |
|---|---|---|---|
| 1 | 10 | 4.3 | 0.5 |
| 2 | 10 | 6.0 | 0.7 |
| 3 | 16 | 4.5 | 0.5 |
| 4 | 16 | 6.2 | 0.7 |
| 5 | 25 | 4.7 | 0.5 |
| 6 | 25 | 6.4 | 0.7 |

In accordance with the table, metal tiles can be selected with different corrugation heights: from 10 to 25 mm. The choice of the corrugation height, type and color of the polymer coating on the front side of the metal tile is based on the aesthetic requirements for the architectural design of the building and the landscape.

Thermal insulation material, according to the project, is provided in slabs: made of fibrous and foam plastic materials, cement binder, perlite based. Loose-fill thermal insulation materials can also be used - expanded clay, shungizite , perlite, vermiculite.

Anti-condensation films can be used from a moisture-absorbing or vapor-proof material [2].

An anti-condensation film made of moisture-absorbing non-woven material is laid under the roof to protect the attic from moisture penetrating from outside the building. The film prevents condensation from draining onto the thermal insulation due to the moisture-absorbing property of the material, which dries quickly.

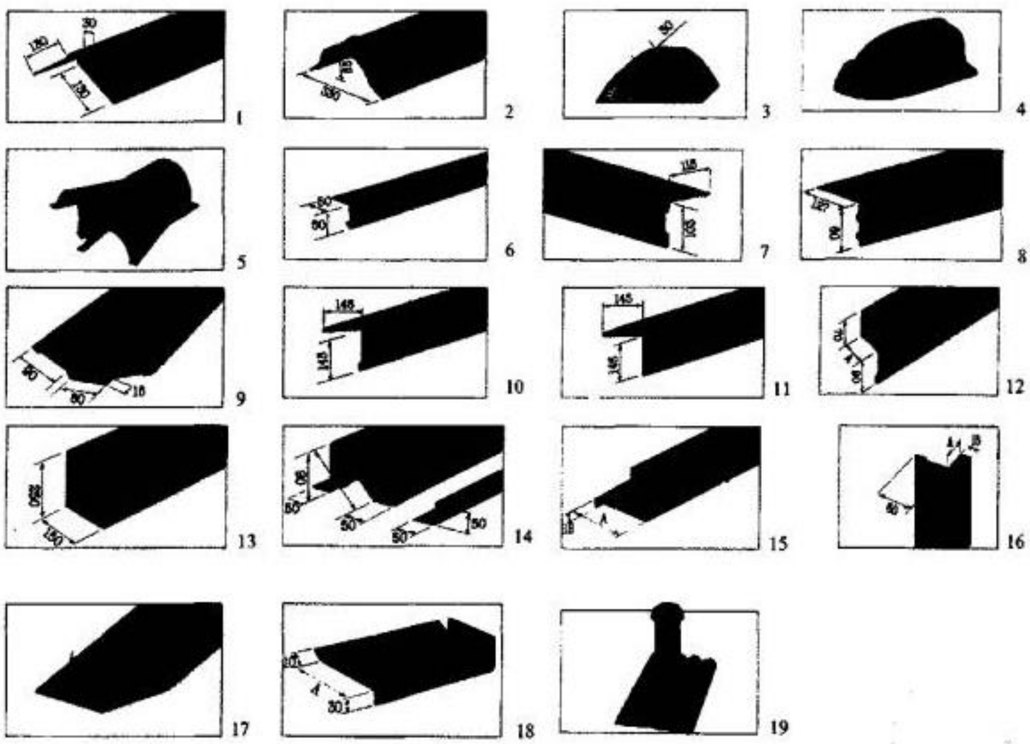
The film protects ventilated attics from dust.

An anti-condensation film made of vapor-proof material (vapor-proof film) is installed under the roof to protect the thermal insulation of buildings with high humidity from condensation.

Films contribute significantly to the reliability and durability of the thermal insulation material.

Mandatory installation of under-roofing anti-condensation films are specified when adjusting the project based on local conditions.

Roofing components - ridge strips, end strips, cornice strips, for external and internal corners, for seams, joints, etc. are shown in Figure 1.



*1* - bar; *2* - ridge strip for Monterrey profile ; *3* - end on the ridge strip; *4* - end on the ridge strip for a hip roof; *5* - "U" shaped strip for the end of the hip roof; *6* - end strip 50×50 mm; *7* - end strip 103×115 mm; *8* - cornice strip; *9* - strip for internal seams and joints; *10* - strip for external corners; *11* - strip for internal corners; *12* - strip with internal and external corners; *13* - strip for seams and joints; *14* - snow retainer ; *15* - top bar; *16* - side bar; *17* - strip for groove; *18* - sheet for covering external recesses; *19* - outlet pipe 7

Fig 1. Metal roofing components

Automation system for the production of metal tiles

The automation system can be used in the production of metal tiles to automate various processes in the production line. These processes may include sheet metal rolling, cutting, sizing and forming [3-5] .

Depending on the specific production requirements and equipment used to produce metal tiles, the automation system may include various components such as sensors, controllers, motors, actuators, valves, etc. For example, an automation system can automatically control the thickness and width of sheet metal to ensure that production requirements are met. In addition, the system can automatically control the speed and direction of metal tiles in the production line to ensure precision and reliability in the process.

Using an automation system in metal shingle manufacturing can help improve productivity, reduce errors in the production process, and ensure high quality products. More precisely , specific components of the automation system in the production of metal tiles may include:

Sensors: Used to measure the thickness of a metal sheet, control the speed and direction of material movement, and detect and prevent errors in the production process. The sensors used in the production of metal shingles may vary depending on the specific technology and equipment used in production [5-7] . Some of the sensors that may be used include:

1.Ultrasonic sensors: Used to measure the thickness of a metal sheet.

Laser sensors: Used to control the speed and direction of material movement.

Pressure sensors: Used to monitor the pressure in the metal sheet sizing system.

Positioning Sensors: Used to accurately position metal sheets in a production line.

2.Controllers: Provide automatic control of the production process and control of various components of the automation system.

3.Motors and Drives: Used to control the speed and direction of movement of the metal sheet in the production line.

4. Valves: Used to control the flow of water and oil during the sizing process of metal sheets.

5.Robot manipulators: Used to automatically load and unload metal sheets from the production line.

6.Robotic machines: Used to automatically roll out, cut and form metal sheets into the desired shape.

7.Software: Provides management and control of the entire automation system, allows you to monitor the production process, analyze data and make adjustments if necessary.

In addition, specialized programs can be used to control the automation system, such as:

Process Control Software: Allows you to automate and optimize various processes in a production line.

Materials Management Software: Used to manage materials flow in a production line.

Quality Management Software: Used to control product quality and eliminate errors in the production process.

Machine Vision Software: Used to automatically detect and analyze defects on metal roofing tiles.

Robot Control Software: Used to control robotic arms that load and unload metal sheets from the production line [7-9] .

In general, the use of specialized sensors and software allows you to automate the production process, increase the accuracy and quality of products, and reduce production time and costs. Using an automation system in the production of metal tiles can significantly improve production efficiency, improve product quality and reduce waste. In addition, automation of the production process can reduce the risks associated with the work of personnel and increase safety in production.

A program in Python to automate the process of manufacturing metal tiles An example of a Python program that can be used to automate the process of making metal tiles

```python
# импортируем необходимые библиотеки
import time
import random

# функция для измерения толщины металлического листа
def measure_thickness():
    thickness = random.uniform(0.5, 1.0) # случайное значение толщины
    return thickness

# функция для контроля скорости и направления движения материала
def control_movement():
    speed = random.uniform(1, 5) # случайная скорость движения
    direction = random.choice(['left', 'right']) # случайное направление движе
    return (speed, direction)

# функция для контроля давления в системе проклейки металлических листов
def control_pressure():
    pressure = random.uniform(10, 20) # случайное значение давления
    return pressure
```

```python
# основная функция для производства металлической черепицы
def produce_metal_tiles(num_tiles):
    for i in range(num_tiles):
        print(f"Производство металлической черепицы №{i+1}")

        thickness = measure_thickness() # измеряем толщину металлического листа
        print(f"Толщина металлического листа: {thickness} мм")

        speed, direction = control_movement() # управляем скоростью и направле
        print(f"Движение материала: {speed} м/с, {direction}")

        pressure = control_pressure() # контролируем давление в системе проклей
        print(f"Давление в системе проклейки: {pressure} бар")

        print("Металлическая черепица успешно произведена!")
        print("")
        time.sleep(1) # задержка в 1 секунду между производством каждой черепицы

# запускаем производство 10 металлических черепиц
produce_metal_tiles(10)
```

This is a program that uses random number generation to simulate sheet metal thickness measurement, control the speed and direction of material movement, and control pressure in a metal sheet sizing system. It is not a complete automation system, but it can serve as an example of how programmable equipment can be used in a production process.

## CONCLUSION

According to the assignment, a system-technical synthesis of the control object was studied, analyzed and carried out, and based on the results of the hardware-technical synthesis, a functional diagram was developed.

A microprocessor controller is used as a technical solution that gives a new look. The information structure of the project used measuring transducers from a foreign company. They allow you to accurately measure temperature, excess and absolute pressure, flow, and levels of various media.

The diagram of external electrical and pipeline networks was studied according to a practical assignment. The scheme includes devices and means of local automation, as well as electrical installation and pipeline laying work at a distance from the control room. In this project, the principle diagram of automation of the regulation and control circuit was studied.

According to the assignment, drawings of general types of equipment for the operator control center and a layout plan for automation equipment and networks were studied. The solutions used in the plan were implemented in accordance with the technical requirements.

For me, industrial practice means that I was actually able to watch and study the automatic control system in a real automatic device. I learned that every smallest detail in the program and in the machine itself affects not only the income of production but also the social life of the entire city, even the country. The domestic market and the foreign market are always competitive, and new technologies and new automatic control processes affect many aspects in our lives many times over.

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UDC 541.18

# MEMBRANE TECHNOLOGIES IN WASTEWATER TREATMENT

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***Abstract***

*In the face of water scarcity, the world is striving to find all possible options to reduce overexploitation of limited freshwater resources. One of the most reliable available water resources is wastewater. As the population grows, industrial, agricultural and domestic activities to meet voluminous human needs increase. These activities generate large volumes of wastewater from which water can be extracted for a variety of purposes. Over the years, conventional wastewater treatment technologies have to some extent met the challenge of treating wastewater for discharge purposes. However, improvements in wastewater treatment processes are needed to reuse treated wastewater for industrial, agricultural and domestic purposes. Membrane technologies have become the most preferred for reuse of water from various wastewaters. This review discusses the current membrane technologies in wastewater treatment, their advantages and disadvantages. Membrane fouling, membrane cleaning and membrane modules are also discussed. Finally, recommendations are made for future research related to the application of membrane technologies in wastewater treatment.*

***Keywords:*** *membrane technologies, wastewater, drinking water, pollution*

## INTRODUCTION

Essentially, a membrane is a barrier that separates two phases from each other by selectively restricting the movement of components through it. Membranes have been around since the 18th century. Since then, many improvements have been made to make membranes more suitable for various applications.

Membranes can be divided into isotropic and anisotropic membranes based on their characteristics. Isotropic membranes are homogeneous in composition and physical structure. They can be microporous, in which case their permeation fluxes are relatively high compared to non-porous (dense), where their application is severely limited due to low permeation fluxes. Isotropic microporous membranes are widely used in microfiltration membranes. Anisotropic membranes, on the other hand, are heterogeneous in membrane area and consist of different layers in structure and composition. In such membranes, a thin selective layer is supported by a thicker and highly permeable layer. In particular, they are used in reverse osmosis processes.

All activities of mankind are dependent on water. With the increase in population, tons and tons of wastewater are generated daily in the domestic, industrial and agricultural sectors. However, fresh water reserves are not replenishing in time to meet the ever increasing population and their water needs. This leads to intense competition and inequitable distribution of limited freshwater resources among different sectors. As a result, many people around the world, especially in developing countries, are deprived of access to drinking water. Once again, agricultural activities are severely affected as farms do not have access to sufficient water resources for year-round irrigation and livestock production. These situations are seen all over the world, especially in the Middle East, Africa, Asia and Latin America. The facts are clear: 2.1 billion people live without safe drinking water at home, and nearly 4 billion people experience severe water shortages for at least one month of the year.Although membrane technology is not a new invention, the changing nature and complexity of wastewater is forcing improvements in terms of efficiency, footprint, energy consumption, permeate quality and technical skill requirements. In addition, membrane modules and membrane elements are constantly being modified to reduce membrane fouling, which is a major problem in membrane processes. The possibility of combining two or more membrane processes with each other or with other technologies such as coagulation or adsorption in a hybrid mode is also constantly being researched, developed and applied in many wastewater treatment plants [1].

## EXPERIMENTAL METHODS

Pressurized membrane processes are by far the most widely used membrane processes in wastewater treatment from pre-treatment to post-treatment of wastewater. These processes utilize hydraulic pressure for separation. There are four main types of these processes. These are microfiltration, ultrafiltration, nano-filtration and reverse osmosis. The main difference between these processes, apart from pressure requirements, is the pore size of the membranes [2]. Table 1 summarizes the main characteristics of these processes.

Table 1 Some features of pressurized membranes.

| Membrane processes | Ultimate molecular weight. (kg Dalton) | Retention diameter (μm) | Required pressure (bar) | Membrane type | Average permeability (L/m2 h bar) | Retained solvents |
|---|---|---|---|---|---|---|
| Microfiltration | 100–500 | $10^{-1}$–10 | 1–3 | Porous, asymmetrical or symmetrical | 500 | Bacteria, fats, oils, greases, colloids, organics, microparticles |
| Ultrafiltration | 20–150 | $10^{-3}$–1 | 2–5 | Microporous, asymmetrical | 150 | Proteins, pigments, oils, sugars, organics, microplastics |
| Nanofiltration | 2–20 | $10^{-3}$–$10^{-2}$ | 5–15 | dense porous, asymmetric, thin-film composites | 10–20 | Pigments, sulfates, divalent cations, divalent anions, lactose, sucrose, sodium chloride |
| Reverse osmosis | 0.2–2 | $10^{-4}$–$10^{-3}$ | 15–75 | Semi-porous, asymmetric, thin-film composite | 5–10 | All pollutants, including monovalent ions |

## RESULTS AND DISCUSSION

Membrane technology is gradually revolutionizing water and wastewater treatment. Much work has been done in this field over the years. However, there is still room for improvement in many areas. Since fouling and high energy intensity remain major problems in non-equilibrium pressurized processes, continuous research is needed to find a long-term solution to these problems, either by introducing stringent but low-cost pretreatment processes or by developing fouling-resistant membranes. In membrane distillation, continuous research is needed to adequately understand the concept of temperature polarization, and accordingly, the development of suitable membranes will help make this process more viable for large-scale applications [3].

## CONCLUSION

There are endless applications of membrane technologies in wastewater treatment. This article attempts to summarize the main ones, give examples of their applications, advantages and disadvantages, and some areas related to membranes such as scaling and module structure. We hope that this article will be useful and provide good information for further research in the application of membrane technology in wastewater treatment.

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# THEORETICAL CALCULATION OF THREAD TENSION DURING THE WINDING OF RAW SILK ON THE POLYGROUND WHEEL OF COCOONING MACHINE

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***Abstract***

*In the study, as a result of applying the practice of live cocooning to the production of the whole year, the quality and quantity of raw silk increased dramatically, the optimal options for the speed of spinning for the assortments of raw silk produced during the spinning of live cocoons were developed and proved as a result of tests, the periods of repeated worm feeding according to seasons and is explained by the development of leaf cutting graphs. In this article, the optimal cocooning speeds of live cocoon cocooning machines for raw silk assortments are theoretically determined and tested under production conditions. The tension force acting on the raw silk wound on the wheels installed in the cocooning machine, and the effect of the torque of the wheel were studied.*

***Keywords:*** *raw silk, wheel, cocooning machine, speed, tension, torque, surface, density, mass, corner, pressure, deviation, diameter.*

## INTRODUCTION

Initially, KMS-8, KMS-10 type mechanical cocoon preparation machines were installed in cocooning enterprises of our republic. In these technological machines, the floating cocooning method is used, that is, the inner volume of the cocoon shell is filled with 75.0% water. The linear density of spinning raw silk was controlled by the number of cocoons at the base of the peduncle[1; 120 p.]. Later, cocooning enterprises were re-equipped with cocooning machines such as SKE-4-VU, SK-5, KM-90. These machines used the semi-submerged cocoon method, and the linear density of the raw silk was controlled by a linear density control apparatus. In the 70s and 80s of the last century, cocooning machines of the Japanese companies Gunze and Keinan began to be used in cocooning enterprises. In these machines, the sinking cocoon method was used, the linear density of the raw silk was controlled by control gauges working on the basis of tangential friction force [2]. Since 2008, cocooning enterprises of our Republic have been re-equipped with modern cocooning machines manufactured in the People's Republic of China, South Korea, and Vietnam. Currently, all cocooning enterprises of our Republic are fully equipped with cocooning machines.

When studying the influence of silk raw materials processed in the Republic on the quality indicators, the geometric dimensions of the wheel, the reduction of thread strength of the turning point in multi-faceted wheels from a theoretical point of view and comparison with the experimental results ensure the reliability of the research.

For this purpose, in order to theoretically calculate the tension of the thread during the winding of raw silk on the multifaceted wheel of cocooning machines, we consider the torque, tension force and rotational force generated at the edges of the wheel depending on the position of the wheel.

## MATERIAL METHODS

In the practice of cocooning, the production of raw silk is carried out in mechanical cocooning machines and automatic cocooning machines. Modern cocooning machines are fundamentally different from mechanical cocooning machines, in addition to the technology used, in the construction and dimensions of the raw silk winding wheels. Currently used FY 2000 EX, FY-2008 NT cocoon machines are equipped with 20-sided wheels with a perimeter of 0.65 meters. Determining the tension forces generated when the raw silk is wound on the spinning wheel is of great importance in practice. Therefore, many researchers have studied the tensile strength of the 6-sided wheels of KMS-10 type mechanical cocooning machines, which have been used for many years in cocooning enterprises of our Republic [4, 392 p.; 66, 110 p.; 73, 228 pp.]. At present, cocooning enterprises of our Republic mainly use D-301, D-300B, FEIYU2000 EX, FEIYU2008 NT, KSS-RS-100 cocooning machines manufactured in foreign countries such as the People's Republic of China, South Korea. The perimeter of these machines is 0.65 m. 20-sided wheels were installed, and the tension forces generated during spinning of raw silk were hardly studied. Taking this into account, in our research work, we studied the tension forces generated during the spinning and winding of raw silk on 20-sided wheels and made a theoretical calculation. 1 - the table shows the technical classification of the FY-2008 NT cocooning machine needed for theoretical calculations. We will consider the method of evaluating the tension forces in the cross-sections of the threads winding on the wheel depending on the dimensions of the wheel, the speed of movement and the power of the engine. Each roll of the thread wrap presses on the edges of the wheel and the lower layers lying on it with the following force [4; 337-339 p.]

$$R=\sqrt{2P_{11}^2(1-\cos\alpha} =2P_{11}\sin\frac{\alpha}{2},\ \text{sN} \qquad (1)$$

here: $P_{11}-$ the tension of the thread until it reaches the wheel, the angle between the spokes of the $\alpha$-wheel.

Table 1. Technical classification of FY-2008 NT cocooning machine

| Naming of indicators and units of measurement | Indicators |
|---|---|
| Cocooning speed m/min | 80-240 |
| Distance between hangers, mm | 85 |
| Bench sides | 2 |
| The number of hangers in the section, pcs | 400 |
| Wheel perimeter, mm | 650 |
| Rotation frequency of hangers, min-1 | 600-1000 |
| Raw silk linear density control speed, min-1 | 20 |
| Installed power of the drive, kW | 2,84 |
| Linear density of finished raw silk, tex | 2,33-3,23 |
| Movement speed of carriages, m/min | 5 |
| Overall dimensions of the machine, mm:<br>- length<br>- width<br>- height | <br>28090<br>3222<br>2168 |
| Estimated productivity of one hanger, g/h | 14-25 |
| Weight, kg | 15000 |

The tensile strength of the raw silk thread before reaching the reel is determined by the following equation:

$$P_{11} = A + bv^n, \quad \text{sN} \qquad (2)$$

here: A is a static forming tension that does not depend on the rate of cocooning; b- the coefficient that takes into account the rate of change of tension depending on the change of damping; v- cocooning speed, m/s: n- some degrees.

As the raw silk is wrapped wet on the cocoon wheel (regardless of the type of cocooning method), it tends to shrink during construction, but this is resisted by the rigid dimensions of the wheel [5; 259-263 p.]. As a result, as the raw silk dries, its tension increases and the breaking length decreases. From this it can be concluded that during the process of construction of raw silk, its tension force on the edges of the wheel increases and it is directly related to the number of edges on the wheel.

At present, raw silk with a density of 2.33 and 3.23 tex is mainly produced in the spinning enterprises of the Republic. According to the results of our research, the cocooning speed on FY-2008 NT cocooning machines is on average 182 m/min for raw silk with a linear density of 2.33 tex and 140 m/min for raw silk with a linear density of 3.23 tex. For theoretical calculations, we take the average suction speed to be 167.7 m/min [7; 1530-1536 p.].

In it, the number of revolutions of the wheel is determined by the following equation:

$$n = \frac{v_w}{P}, \qquad (3)$$

here: $v$– linear speed of the wheel, the perimeter of the wheel, m.

The relationship between the rotational force and rotational speed generated at the edges of the wheel and the power of the engine to move the wheel is estimated as follows

$$W_D = \frac{T_W \cdot \upsilon_W}{75}, \quad \text{kW} \qquad (4)$$

here: $W_D$ – the value of the motor power measured in the unit of horse power; $T_W$ – the amount of rotational force generated at the surface points of the cross section of the wheel, $\upsilon_w$ – the linear speed of the surface points of the cross-section of the wheel.

The vectors of the above force and speed are always directed along the forces transferred to the surface points of the cross section of the wheel. It is known that linear velocity in circular motion $\upsilon_w$ the relationship between the angular velocity and is defined as follows It is known that linear velocity in circular motion $\upsilon_w$ with angular velocity $\omega_w$ the relationship between is defined as follows

$$\upsilon_w = \omega_w \cdot R_w = \frac{\omega_w \cdot D_w}{2}, \quad m/s \qquad (5)$$

here: $R_w$ and $D_w$ – radius and diameter of the cross section of the wheel.

The angular speed of the wheel rotation is the number of revolutions $n$ is connected as follows

$$\omega_w = \frac{2 \cdot \pi \cdot n}{60}, \quad \text{rad/sec} \qquad (6)$$

Putting the last expression (5) into the equation (6), we get the following equation

$$\upsilon_w = \frac{2\cdot\pi\cdot n\cdot R_w}{60} = \frac{2\cdot\pi\cdot n\cdot D_{wЧ}}{2\cdot 60}, \text{ m/sek} \qquad (7)$$

Putting the resulting expression (6) into the equation, we get the following result

$$W_D = \frac{T_w\cdot 2\cdot\pi\cdot R_w\cdot n}{75\cdot 60} = \frac{T_w\cdot 2\cdot\pi\cdot D_w\cdot n}{2\cdot 75\cdot 60}, \text{ kW}$$

This equation makes it possible to evaluate the functional relationships between the power of the motor driving the wheel, the dimensions of the wheel, the number of revolutions and the rotational force generated at the surface points of the cross section.

Torque generated at the surface points of the wheel $M_W^{(T)}$ value of 4 - we determine using the picture

$$M_W^{(T)} = T_W\cdot R_W = \frac{T_W\cdot D_W}{2}, \qquad N\cdot m \qquad (8)$$

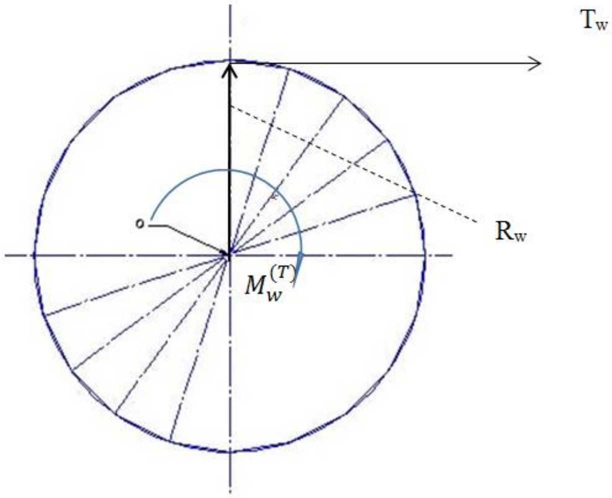


Fig. 1. Direction of torque and tension force in wheel rotation

We determine the value of the force from the equation (8) above

$$T_W = \frac{75\cdot 60\cdot W_D}{2\cdot\pi\cdot R_W\cdot n} = \frac{2\cdot 75\cdot 60\cdot W_D}{2\cdot\pi\cdot D_W\cdot n}, \text{sN} \qquad (9)$$

Substituting the last expression into the equation (8), we get the following result

$$M_W^{(T)} = \frac{75\cdot 60\cdot W_D}{2\cdot n\cdot\pi} \approx 716{,}56\cdot\frac{W_D}{n}, \quad \text{N·m} \qquad (10)$$

The created equality allows to established functional relationships between the torque appearing at the surface points of the cross-section of the wheel, the power of the drive and the number of revolutions.

If the power of the driver is measured in units of kW, taking into account that one horsepower is 0.736 kW, the equation (10) is written as follows.

$$M_{WЧ}^{(T)} = \frac{716{,}56}{0{,}736}\cdot\frac{K_D}{n} \approx 973{,}6\cdot\frac{K_D}{n}, \quad N.m \qquad (11)$$

here: $K_D$ the value of the motor power measured in units of kW.

## EXPERIMENTS AND RESULTS

As can be seen from the equations (9) and (10) above, the values of the rotational force and torque at the surface points of the wheel depend on the radius of the wheel and the power of the driver.

In the Fergana Region "Uzbekistan Scientific Research Institute of Natural Fibers", the tension of silk threads in different diameters of the above wheel was studied. Various brands of electric motors driving the wheel were tested. Optimum speeds of cocooning in live cocoon spinning machines for raw silk assortments produced were studied and tested in production conditions.

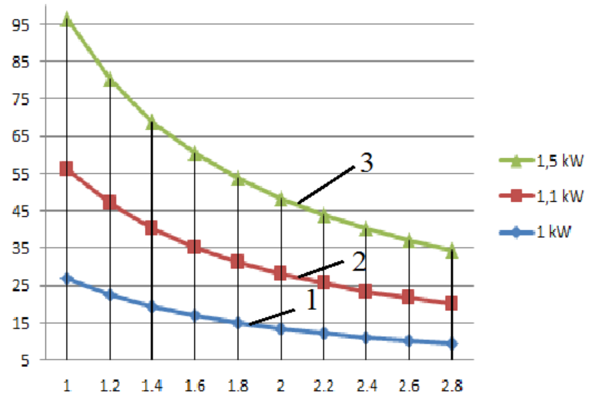


Fig. 2. Dependence of the rotational force values generated at the surface points of the wheel on the power of the driver and the speed of rotation of the wheel

**RESULT DISCUSSION**

№1. The effect of the rotational force on the wheel surface of a 1 kW engine; №2. A graph of the effect of a 1.1 kW engine on the rotational force on the wheel surface;

№3. Analysis of the effect of the rotational force on the wheel surface of a 1.5 kW engine;

In Figure 2, the increase in power applied to the wheel causes the effect of rotational forces on the outer part of the wheel to increase. According to the results of the research, the improvement of the thread tension indicator was achieved in the range of 2.5-3 m/sec.

Table 2. Dependence of the rotational force and torque values generated at the surface points of the wheel on the power of the driver and the speed of rotation of the wheel

| $v, \frac{m}{s}$ | $W_D = 1{,}0$ kW | | $W_D = 1{,}1$ kW | | $W_D = 1{,}5$ kW | |
|---|---|---|---|---|---|---|
| | $T_W$, $N$ | $M_W^{(T)}$, $Nm$ | $T_W$, $N$ | $M_W^{(T)}$, $Nm$ | $T_W$, $N$ | $M_W^{(T)}$, $Nm$ |
| 1.0 | 26,83 | 2,77 | 29,51 | 3,05 | 40,25 | 4,16 |
| 1.2 | 22,35 | 2,30 | 24,59 | 2,54 | 33,54 | 3,46 |
| 1.4 | 19,16 | 1,97 | 21,07 | 2,17 | 28,75 | 2,97 |
| 1.6 | 16,76 | 1,73 | 18.44 | 1,90 | 25,15 | 2,6 |
| 1.8 | 14,90 | 1,53 | 16,39 | 1,69 | 22,36 | 2,31 |
| 2.0 | 13,41 | 1,38 | 14,75 | 1,52 | 20,12 | 2,08 |
| 2.2 | 12,19 | 1,25 | 13,41 | 1,38 | 18,29 | 1,89 |
| 2.4 | 11,17 | 1,15 | 12,29 | 1,27 | 16,77 | 1,73 |
| 2.6 | 10,31 | 1,06 | 11,35 | 1,17 | 15,48 | 1,16 |
| 2.8 | 9,58 | 0,98 | 10,53 | 1,08 | 14,37 | 1,48 |

**CONCLUSIONS**

The following conclusions are drawn from the analysis of the indicators presented in the table:

1. By increasing the power of the driver driving the wheel, it is possible to increase the rotational force and rotational speed generated at the surface points of the wheel.
2. Increasing the speed of rotation of the wheel without changing the power of the actuator leads to a decrease in the rotational force and torque generated at the surface points of the wheel.
3. If the diameter of the cross-section of the wheel is increased without changing the power of the actuator, the value of the torque generated at the surface points increases.

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## METHODS FOR ASSESSING THE SAFETY INDICATORS OF ROAD TRAINS WHEN TRANSPORTING PETROLEUM PRODUCTS IN EMERGENCY SITUATIONS

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***Abstract***

*The article discusses the issues of assessing the criteria for the safe movement of trucks transporting petroleum products when driving in difficult conditions in order to ensure stable and safe movement in emergency situations. The critical speed values were obtained depending on the turning radius, road slope, type and smoothness of the road surface, traffic intensity, traffic obstacles, stability of the road condition, driving modes and the influence of liquid cargo.*

***Keywords:*** *semi-trailer train, critical speed, difficult conditions, driving mode, stability, road conditions, liquid cargo, traffic safety, traffic interference, transportation efficiency, assessment of safe traffic criteria.*

The development of the theory of performance properties of automobiles is characterized by an in-depth study of individual features of performance properties, their assessment in a complex and optimization of indicators of performance properties and technical parameters. This allows you to create the most rational designs at the vehicle design stage, and when used, ensure maximum efficiency of their use in specific operating conditions [1,5]. The car is part of the “Car - driver - road - environment” system, and its properties are manifested in interaction with the elements of this system. Therefore, the significance of a certain operational property in assessing the quality or efficiency of a car depends on the conditions in which this property manifests itself, i.e., on the operating conditions [5,8]. Let's consider how the car itself, regardless of the driver's actions, reacts to external disturbances - this is the essence of determining the stability of its movement or position. Without knowledge of the characteristics of motion stability, it is impossible to assess the controllability of the machine, and it is impossible to assess the safety of the machine’s movement [3,6].

Consequently, an indicator of trajectory stability is the preservation or change in the direction of the velocity vector of the center of mass, and if the longitudinal component of this vector is constant, the change in the value of its lateral component. An indicator of directional stability is the change in angular velocity relative to an axis perpendicular to the plane in which the car is moving [2].

In this regard, trajectory and directional stability can be assessed as follows. If the additional lateral ones, which make up the vector of translational velocity and the angular velocity in the plane of the road, arising as a result of any disturbance, continuously increase or their change is oscillatory in nature with increasing amplitudes, then the movement of the car will be unstable. If, over time, these parameters tend to zero, then the movement of the machine is stable. The theory of motion stability is based on the mathematical apparatus for studying differential equations developed by A. M. Lyapunov. He determined the properties of the perturbed state of the system, which consists in a tendency to restore movement, characterized by the parameters that existed before the disturbance occurred. To quantify this property, the time required for the movement parameters to return to their original values can be taken. During the oscillatory process of returning these parameters, one can quantify stability by decrement, i.e., the degree of reduction in the amplitudes of oscillations of additional speeds [4,5].

An analysis of the influence of the mode of motion of a wheeled vehicle on its stability during curvilinear motion can also be carried out by drawing up an equilibrium equation relative to the middle of each axle, replacing the longitudinal reactions of the wheels of each axle with one total reaction acting on the corresponding axis, and the total (over all axes and wheels ) moments of resistance to rotation [9,10].

Analysis of the change in lateral reaction shows that, in general, it affects the speed of the vehicle and its turning radius, the acceleration of the machine, the turning speed of the steered wheels, the moment of resistance to turning, the longitudinal reaction of the front axle wheels and slip angles.

For driving conditions that are of practical importance in studying the stability and controllability of circular motion, changes in slip angles caused by changes in the curvature of the wheel trajectory are unlikely to be of significant importance. At small angles of rotation of the steered wheels, characteristic of slip angles, but the influence of these changes on the nature of the vehicle's movement in this case is insignificant [5,7,9].

The moment of resistance to turning consists of the moments of resistance to sliding of each wheel on the supporting surface and the moments caused by the difference in the longitudinal reactions of the wheels, mainly by the characteristics of the connection between the wheels of the axle. With a positive value, the longitudinal reaction of the front axle wheels decreases without changing the lateral reaction of the rear axle wheels, i.e., when there is traction force on the front wheels [6].

Deviation of the machine from the given trajectory, and its longitudinal axis from the given direction due to elasticity and slippage of individual tire elements, is permissible. But, if the entire machine or its individual axes (in multi-axle machines - one axis or groups of axes) slide, moving in the lateral direction, then this is already an extreme case of loss of stability. The driving mode depends on the qualifications and psychophysiological state (fatigue and reaction severity) of the driver, on the design of the controls and their technical condition, on visibility conditions (meteorological conditions), the type and condition of the surface (dry, icy), on the width and shape of the passages, and traffic intensity. It can be seen from this that we have a typical example of stochastic, statistical relationships that require a probabilistic - statistical approach to assessing traffic modes [1, 5, 6, 9].

The driving mode is affected by the operating conditions of the vehicles.

Operating conditions are generally determined by road, transport and natural-climatic conditions, each of which is characterized by certain factors: road conditions - elements of the road profile and plan, terrain, type and evenness of the road surface, traffic intensity, traffic interference, stability of road conditions, modes movements [3,5];

On mountain roads, as the altitude increases above sea level, the amount of precipitation increases, air temperature and atmospheric pressure decrease, solar radiation and nebula increase, and relative air humidity changes [9].

All these factors are an integral part of the general traffic conditions and have a wide and varied impact on traffic mode and safety (Fig. 1) [5,6,9].

An increase in the intensity and duration of exposure to meteorological factors in emergency situations on the road conditions lead to [9]:

• changes in the mechanical impact of the vehicle on the road structure due to a decrease in the adhesion properties of the surface;

• changes in the driver's perception of the road due to contamination of the roadway, shoulders, engineering equipment, snow deposits, formation of run-up stripes, changes in the condition of the appearance and outline of the roadway and shoulders;

• changes in the psychophysiological state of the driver due to worsening traffic conditions and oxygen starvation;

• decreased meteorological visibility due to increased fog, precipitation, and solar radiation;

• deterioration of the operational and technical qualities of the car and, above all, the systems for ensuring the convenience and safety of traffic, which include the brake system, steering, visibility and visibility systems, and alarm systems;

• general deterioration of road and meteorological conditions, which negatively affect the driver's nervous and emotional tension.

In addition, when operating road trains when transporting liquid cargo in difficult conditions, especially in critical situations such as braking or turning, it is important to consider the effect of liquid cargo sloshing and its impact on stability.

The tests were carried out on a public mountain road with a pass section along the route Angren, Tashkent region - Pap, Namangan region, which has an asphalt concrete surface. These conditions are included in table 1

Table 1- meteorological conditions of the experiment

| Month | Outdoor temperature, $^{o}C$ | | Quantity precipitation, mm | Wind speed, m/s |
|---|---|---|---|---|
| | Maximum | Minimum | | |
| May | + 28 | + 15 | - | 3-5 |
| June | +43 | +28 | - | 2-3 |
| September | +31 | +21 | - | 3-5 |
| October | +27 | +17 | 2-4 | 3-5 |
| November | +23 | +10 | 3-6 | 5-12 |
| December | +18 | -10 | 2-5 | 2-5 |

Test to determine compliance of the effectiveness of the service and auxiliary brake systems with the requirements of GOST Uzbekistan. 1057: - 2004 were carried out:

The effectiveness of the service braking system of a semi-trailer train with full weight was assessed by the length of the braking distance on a horizontal dry asphalt concrete road at an initial braking speed of 50 km/h, deceleration and response time;

The effectiveness of the auxiliary braking system was assessed by providing movement of a semi-trailer train at a speed $\vartheta$ $\vartheta=30\pm\pm 2$ km/h on a 7% slope with a length of 6 km.

To determine the speed of a semi-trailer train, a 20-channel satellite navigator “Navibe GPS receiver” was used, connected to 10 satellites and recording changes in parameters in 0.2 seconds. The navigator works in conjunction with a computer. The obtained data was processed using computer programs CamStudio, Matlab и Excel.

In addition to speed, the satellite navigator records:

- location of the road train: latitude, longitude, altitude above sea level;
- movement time;
- change in the angle of inclination of the road train relative to the initial position.

Timing of the speed and time for the movement of semi-trailer road trains along the route Angren - Pap - Angren was carried out using a satellite navigator.

The proposed design traffic mode was tested on the same section of the road using the timing method.

The reaction forces on the wheels and the coordinates of the center of gravity of the tractor and semi-trailer were determined as follows:

- reaction forces on the wheels were determined by weighing the wheel until it left the ground;
- the coordinates of the center of gravity of the tractor were determined by weighing the front part of the tractor while fixing various lifting heights;
- the coordinates of the center of gravity of the semi-trailer were determined by the graphic-analytical method, where the critical rollover angle can be measured directly using a plumb line combined with a protractor. When lifting a semi-trailer, it should be noted at what angle the plumb line will deviate from its original position. The position of the center of mass is checked graphically. At the same time, the larger the scale of the drawing and the more accurately the angle is measured, the greater accuracy we will obtain. Knowing the height of the center of mass, you can determine the ultimate stability during a lateral rollover graphically. It is characterized by the tilt angle.

Similarly, if it is necessary to determine the position of the center of mass of the tractor and semi-trailer in the transverse plane, weighing is carried out separately on both sides. But since the car, if you look at it in plan, is a symmetrical structure, then with some assumption it can be assumed that the center of mass in the longitudinal and transverse planes coincides [6].

The influence of the dynamic impact of a liquid load on the driving mode was determined when braking on flat sections of the track.

We have proposed an experimental method for determining the influence of the dynamic effect of liquid cargo on the movement mode that meets the requirements of GOST Uzbekistan. 1057: - 2004 and interstate GOST 52302: - 2004, which consists of the following stages:

Experimental data were used to determine the influence of the dynamic effect of liquid cargo on the movement mode.

The experimental method for determining the longitudinal influence of the dynamic effect of liquid cargo on the movement mode was carried out in accordance with the requirements of GOST Uzbekistan. 1057: - 2004

- determination of the braking distance of a semi-trailer train with a tanker truck 100% filled with water;
- determination of the braking distance of a semi-trailer train with a tanker truck 95% filled with water;

The experimental methodology for determining the transverse dynamic effect of liquid cargo on the driving mode was carried out in accordance with the requirements of interstate GOST 52302: - 2004. Tests are carried out to determine indicators characterizing the controllability and stability of the vehicle in critical driving modes.

The “turn R=35m” tests are designed to determine the maximum maneuver speed when entering a turn and determined:

- the maximum maneuver speed was determined when entering a turn for a semi-trailer train with a tanker truck 100% filled with water;

- the maximum maneuver speed was determined when entering a turn for a semi-trailer train with a tanker truck 95% filled with water;

Implementation of these tasks, including the development of calculation methods that make it possible to scientifically substantiate the safe speeds of movement of vehicles transporting petroleum products when driving in difficult conditions, development of methods for ensuring safety through diagnostics and maintenance of vehicles transporting petroleum products when driving in difficult conditions and carrying out research work on improvement of safety laws taking into account the dynamic effect of the transported liquid on the walls of the tank becomes relevant.

This article discusses the issues of determining the critical speed of a semi-trailer road train transporting liquid cargo when moving in emergency situations in order to select a stable and safe mode of movement. Let's consider a semi-trailer train consisting of two subsystems, a tractor and a trailer (Fig. 1.).

Using projections of forces on the coordinate axes and moments of forces relative to the axes, we have obtained a system of equations. These equations, together with the initial and boundary conditions, represent a mathematical model of the process of motion of a semi-trailer train [3,4].

The proposed mathematical model makes it possible to calculate the following main parameters, which make it possible to evaluate the stable movement of a semi-trailer train:

- reaction forces of the wheels and coupling device, lateral reaction force of the coupling device, longitudinal inertia force acting on the coupling device;
- critical speed, ensuring movement without tipping over of the semi-trailer and tractor;
- critical speed that ensures movement without skidding of the semi-trailer and tractor;
- calculation of changes in critical speed due to reduced forces, i.e. the total forces promoting and preventing capsizing, as well as the total forces promoting and preventing skidding, with and without taking into account the dynamic effect of the liquid cargo on the walls of the tank, are described by the following equations.

For semi-trailer

$$F_{cap} = \left(m_p g \frac{B}{2} cos\,\beta + m_p g\, sin\,\beta \cdot h_g - \frac{m_p \vartheta^2}{r} h_{gp} - N_k h_c - R_k \frac{B_t}{2} - P_{п} h_{gp}\right)/B_t F_{cap} \geq 0 F_{cap}. \geq 0$$

$$F_z = \frac{m_p \vartheta^2}{r} + P_p - N_{к} - m_p \mathrm{g} \sin\beta - \sum R \cdot \phi_2 \qquad F_z. \geq 0 F_z. \geq 0$$

For tractor

$$F_{cap} = \left(m_t g \frac{B}{2} cos\,\beta + m_t g\, sin\,\beta \cdot h_{gt} - \frac{m_t \vartheta^2}{2} h_{gt} + N_k h_c - R_k \frac{B_p}{2}\right)/B_p F_{cap} \geq 0 \;\; F_{cap}. \geq 0$$

$$F_z. = \frac{m_t \vartheta^2}{r} + N_{к} - m_t \mathrm{g} \sin\beta - \sum R \cdot \phi_2. \qquad F_z. \geq 0$$

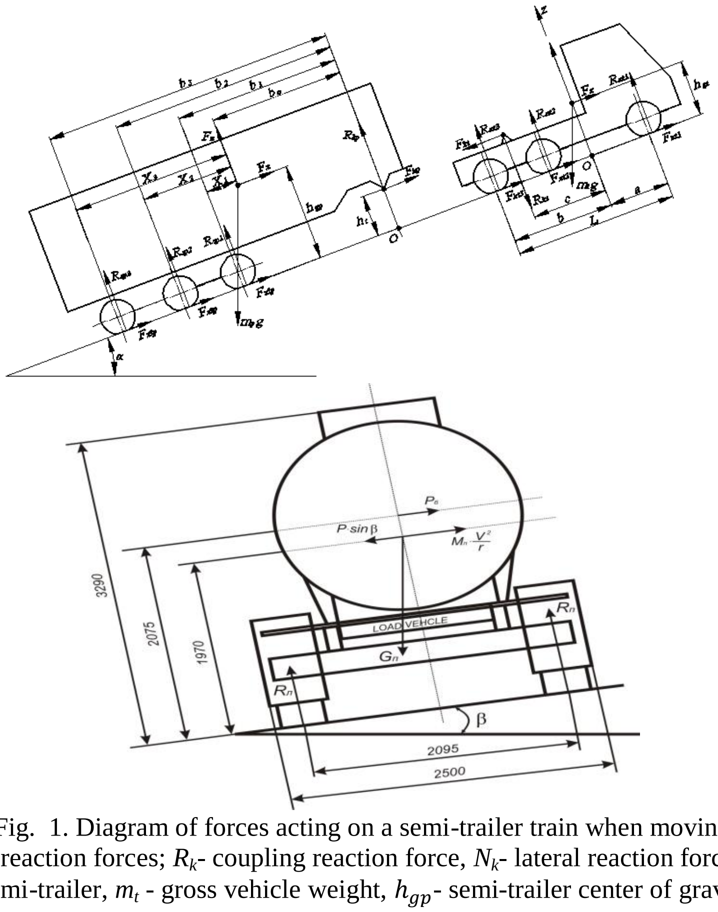


Fig. 1. Diagram of forces acting on a semi-trailer train when moving

Where, $R$- wheel reaction forces; $R_k$- coupling reaction force, $N_k$- lateral reaction force of the coupling device, $m_p$– gross weight of the semi-trailer, $m_t$ - gross vehicle weight, $h_{gp}$- semi-trailer center of gravity height, $h_{gt}$- center of gravity height, $h_s$- hitch height, $\vartheta$ - road train speed, $r$- turning radius,$\beta$ - road cross slope angle, $B_t$- tractor track, $B_p$-

semi-trailer, $g$- acceleration of gravity, $g$=9.8 m/s$^2$, $\varphi_2$ - lateral coefficient of adhesion, $P_p$- transverse dynamic effect of liquid cargo on the walls of the tank.

The above parameters are determined depending on the elevation angle and turning radius. The following parameters were used in the calculations: $m_t$=8950kg; $h_{gt}$=0.975м; $B_t$=2.032м; $m_p$=30500kg; $g$=9.8 m/s$^2$; $h_{gp}$=1.97м; $h_s$=1.4m; $l_2$=2.65m; $l_1$=3.65m; $\beta$ $\beta$ =0.03рад; $B_p$=2.095m; $f_2$=0.7;

To solve the mathematical model, a general methodology for its numerical calculation was developed in the software environment MatLab Simulink.

In general, the recommended methodology allows us to determine the critical speed, when exceeded, the stable and safe movement of a semi-trailer train [3,4] transporting liquid cargo and moving under various road conditions will be disrupted.

Having considered the complex influence of such parameters as the ascent angle, turning radius, acceleration (deceleration) of the load, using the proposed model, it is possible to determine the critical speed of the road train under any road conditions.

During the operation of vehicles, it is necessary to take into account climatic conditions, which play an important role in road safety. The most dangerous condition under which road traffic accidents most often occur is the presence of various sediments on the road surface.

The main factor influencing traffic safety when the wheel interacts with the road surface is the coefficient of adhesion, which depends on weather conditions, the quality of the coating material and the operation of the road.

Under the influence of climatic conditions, the road surface may be in different conditions, which affects the coefficient of adhesion between the road and vehicles

As an example, Fig. 2 shows the results of solving the proposed mathematical model for various changes in the turning radius and longitudinal slope of the road, taking into account the influence of liquid cargo

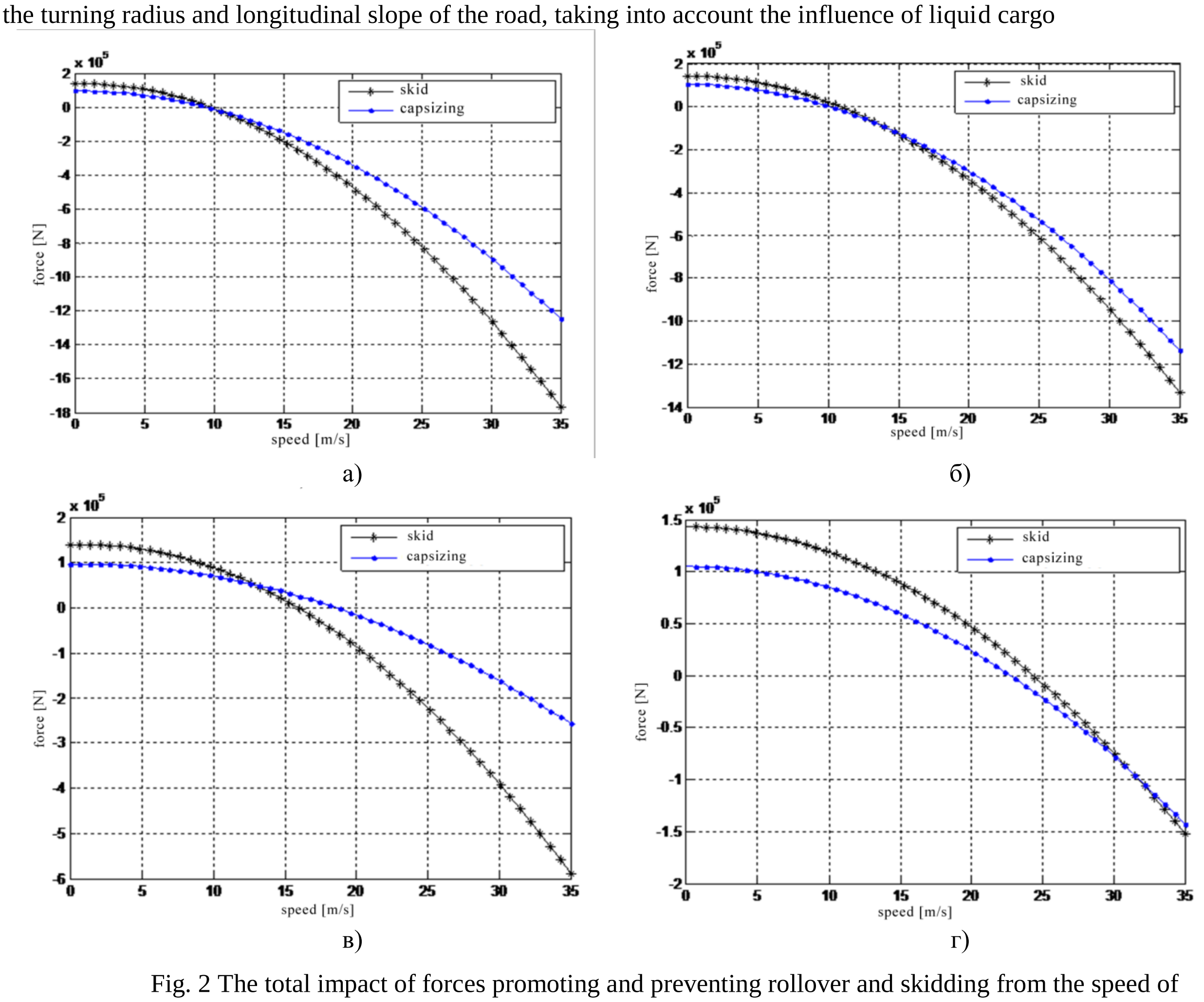


Fig. 2 The total impact of forces promoting and preventing rollover and skidding from the speed of movement of a semi-trailer train at different turning radii and longitudinal slope: a) taking into account, b) without taking into account the dynamic effect of the fluid at R=50 m, α=3%;v) taking into account, d) without taking into account the dynamic effect of the liquid at R=200 m, α=7%;

The presented graphs show the nature of changes in the total forces that promote and prevent rollover, as well as the total forces that promote and prevent skidding. From these graphs, it is possible to determine the critical speed (at the point of intersection with the ordinate axis at a value of zero) at which the unstable movement of a semi-trailer train begins.

Analysis of the results shows that the critical speed depends significantly on the turning radius. Thus, for turning radii of 50, 100, 150, 200 and 500 m, the critical speed at a slope of 0% is 10.6, respectively; 13; 19.5; 23.7; 32.6 m/s, i.e. reducing the turning radius by 10 times entails a decrease in critical speed by 3 times.

Changing the slope from 0 to 7% reduces the critical speed from 0.5 to 4.2%.

Taking into account the influence of liquid cargo reduces the critical speed for a turning radius of 500 m (close to a straight line) within 7-8%, for turning radii of 50, 100, 150, 200 within 8-31%.

Thus, using the proposed methodology, it is possible to determine the critical speed, on the basis of which it is possible to select a safe speed limit for a road train transporting liquid cargo when moving in difficult conditions, which often creates emergency situations.

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UDC 005.4

## METHODOLOGICAL APPROACH TO BUILDING INTEGRATED MANAGEMENT SYSTEMS TAKEN INTO ACCOUNT OF BUSINESS RISKS


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***Abstract***

*“The ISO 9000 series of international standards are based on the understanding that all work is accomplished through processes. The work is done through a network of processes. The network structure is usually not a simple linear one, but rather a rather complex structure. Given the complex structure of most organizations, it is important to identify the main processes and to simplify and rank processes depending on the objectives of quality management. Every organization must define, establish, and manage its network of processes and interfaces.” In addressing these issues, almost many enterprises have entered a new stage of integration of management systems based on ISO 9000 series standards. Unfortunately, the approach to management from the standpoint of risk management has not yet become one of the basic principles of ISO 9001. The task of business is to integrate put this approach into practice and use it in a broader sense, including within the framework of quality management. In fact, simultaneously with the application of the process approach, one should begin to assess risks; the objects of this process can be market trends, strategic directions for business development, competence, operational activities, consumer satisfaction of products and services of a particular organization. By implementing a process approach together with risk assessment, organizations will be able to focus more on meeting the needs and expectations of their customers and other stakeholders, as well as better manage environmental aspects and ensure the health and safety of employees in the workplace.*

***Keywords:*** *processes, ranking, competitive, integrated, management, risk, effective, hormonization, identification.*

## INTRODUCTION

Economic development, crisis phenomena, a highly competitive market, the need to quickly respond and adapt to changing economic conditions, increasingly confront domestic enterprises with the need to search for new approaches to improving management efficiency. One of these approaches is the creation of integrated management systems (IMS) of an organization based on international standards that summarize positive experience in the field of management and related practical activities.

Integrated management systems that meet the requirements of several international standards began to be created in the late 90s. XX century, when specialists began to think about increasing the effectiveness of the organization's management system on the basis of integrated management of various areas of activity (quality, ecology, labor protection, social responsibility). One of the clear advantages of this approach is the achievement of a synergistic effect, in which case the overall result of coordinated actions is greater than the simple sum of the individual results.

An IMS should be understood as a part of an organization's general management system that meets the requirements of two or more international standards for management systems and functions as a single whole [1]. The most common today are the quality management system (QMS) according to the ISO 9000 series, the environmental management system (EMS) according to the ISO 14000 series, and the management system in the field of occupational health and safety according to OHSAS 18000.

ISO standards of the 9000 series in modern conditions act as an organizational and methodological platform for IMS, since they formulate basic concepts and principles that are most consistent with similar elements of general management. As a rule, organizations that have already implemented a QMS and have felt the real managerial and economic effect of system management are thinking about building systems in other areas of activity.

## RESULTS AND DISCUSSION

The introduction of the principles of two or more international standards for management systems into the activities of an enterprise means the presence of IMS of various levels of integration, since these systems are part of the overall management system, therefore, their interaction is inevitable.

The level of system integration will largely determine the success of its development. There are many examples of how organizations, without thinking through the aspects of integration, implemented various management systems. As a result, the new management system worked ineffectively and had an extremely negative impact on the existing system due to the emergence of duplicative management structures, confusion in document management and struggle among managers for resources. Obviously, in order to avoid such mistakes, organizations need some kind of model for assessing the level of integration. Thus, specialists from the certification body - FGU Test-St. Petersburg - developed a methodology for assessing the level of integration of management systems and tested it at more than 10 enterprises [2]. According to this methodology, integration levels can be classified as follows:

• minor (or initial) - systems were created separately, they are managed by different people, policies for systems are not harmonized, planning mechanisms and approaches to the generation of documentation differ, management analysis is carried out autonomously;

• medium - harmonization of policies, presence of a system coordinator, general analysis by management and awareness of staff about key processes of the systems;

• high—common elements of systems are integrated in most areas;

• excellent - the presence at the enterprise of a single integrated system that includes all common elements, i.e. harmonized policies and obligations, common set and management of documents, common performance analysis, etc.

Before the assessment begins, auditors, together with the management of the enterprise, prepare a checklist containing a list of questions (for example, such as “Are the organization's goals integrated?”, “Are there general plans necessary to implement the goals?”, “Is there a common service responsible for coordinating functioning of the IMS?”, “Is the document management procedure integrated?”, “How aware is the staff of the integrated aspects of their activities?”, “Are integrated internal audits carried out?”, “Are risk analysis activities integrated?”), developed by experts and affecting elements of management systems common to integrated systems. The purpose of discussing these issues with the organization's specialists is to determine the weight of the elements being assessed. The weighting coefficient refers to the degree of importance of a particular element for the organization's activities.

Further, during the audit, the levels of integration of individual system elements are assessed. The resulting total score (taking into account the weight of specific elements) is divided by the maximum possible, from which the total indicator of the level of integration of the management system is determined - which is the most important indicator of the maturity of the organization. In particular, it characterizes management flexibility, the ability to change, which is important in a market economy. By developing the level of integration, the enterprise moves to new stages of its development and business improvement. As a result, the integration of a management system is not only its ability to satisfy the requirements of various management standards (ISO 9001, ISO 14001, etc.), but also the presence of mechanisms that allow the most effective use of the common elements of system design specified in these standards.

One of the main elements for building an IMS is risk management. All “core” management system standards contain aspects of risk management to varying degrees, including:

• identification of critical aspects, risks or criteria,
• assessment and identification of significant risks;
• defining the requirements that must be met;
• development and implementation of control mechanisms.

Currently, the international community has developed a number of documents related in one way or another to the standardization of approaches to risk management. Work in this area is being carried out by ISO and the International Electrotechnical Commission (IEC). In addition, some national standards bodies and non-governmental organizations contribute to the development and practice of unified approaches to risk management.

By applying the process approach suggested by ISO 9001:2008, organizations strive to meet the needs and expectations of both internal and external customers. Quality management is no longer the exclusive prerogative of manufacturing enterprises; the process approach has proven to be a valuable tool for organizations in the service sector, healthcare, finance, transport, and local government. Also, an inherent advantage of using ISO 9001:2008 is the continuous improvement of the processes operating in the organization due to the implementation of the relevant requirements of the standard.

Traditionally, the QMS is developed according to the following scheme: the basis is its purpose or mission, then the organization’s policy is formed and goals are structured, the system is built around the policy to achieve the goals. There was no place for explicitly reflecting risk management in this chain.

Meanwhile, the risk management approach is an integral part of other management system standards: ISO 14001 and OHSAS 18001. Organizations must identify and assess each of the risks they face. Unsystematic risks with minor consequences must and sufficiently be taken into account and controlled. Significant risks with severe consequences must be managed in such a way as to either eliminate them completely or reduce the frequency of their occurrence and the severity of the consequences.

Organizations that have implemented ISO 14001 conduct a constant analysis of their EMS, an integral part of which is the consideration of significant environmental aspects associated with emissions into the atmosphere and water discharges, waste disposal, land pollution, use of raw materials and natural resources, etc. The style of thinking and behavior is such The organization meets the expectations of its stakeholders as it manages risks and is responsible for its environmental stewardship.

Organizations that have implemented OHSAS 18001 identify hazards and conduct risk assessments associated with daily work activities, the presence of subcontractors and visitors to the workplace, and the operation of equipment. The key stakeholders are the people within the organization itself who create the risk management culture.

Unfortunately, the approach to management from the perspective of risk management has not yet become one of the basic principles of ISO 9001. The task of business is to integrate this approach into practice and use it in a broader sense, including within the framework of quality management. In fact, simultaneously with the application of the process approach, one should begin to assess risks; the objects of this process can be market trends, strategic directions for business development, competence, operational activities, consumer satisfaction of products and services of a particular organization. By implementing a process approach together with risk assessment, organizations will be able to focus more on meeting the needs and expectations of their customers and other stakeholders, as well as better manage environmental aspects and ensure the health and safety of employees in the workplace. The latest version of ISO 9001:2008, namely the introduction, explicitly emphasizes for the first time that the development of a QMS must take into account the environment in which the organization operates, changes in that environment, and the risks associated with that environment. However, it further states that ISO 9001 does not contain requirements for other types of management, in particular environmental management, health and safety management, financial management or risk management. Meanwhile, another standard in the ISO 9004 family of standards proposes more strongly to manage risks.

## CONCLUSION

The need for further development of risk management aspects in the ISO 9000 series of standards is recognized by the world community. In February 2009, the next meeting of ISO TC 176, which is responsible for the development and updating of ISO 9000 series standards, was held in Tokyo. Of particular interest is the working group formed to identify common concepts and ideas that could form the basis for future activities of ISO TC 176 on updating ISO 9001. In the future, the terms of reference for the revision of ISO 9001 will be formed based on these ideas and proposals from stakeholders such as business, standardization bodies, accreditation, certification, and other ISO technical committees.

Accordingly, it is necessary to resolve the issues of separating the topic of risk into a separate area and identifying the objects in relation to which it should be considered (products, organization, QMS, business continuity, supply chain management, resources and infrastructure). It is clear that the formal inclusion of risk management in this important document will meet the realities of today and will help organizations

- Identify and analyze risks associated with the market
- Identify and analyze risks related to QMS processes, products, services and their management.
- Effectively distribute and use resources required for QMS and product release processes
- Manage suppliers effectively
- Improve operational activities, deepen staff engagement
- Establish a connection between the QMS and the financial aspects of the intermediary
- Become more flexible to implement improvements


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## CALCULATION OF HYDRODYNAMIC CHARACTERISTICS AND MASS TRANSFER PARAMETERS IN AN APPARATUS WITH A REGULARLY ROTATING PLATE PACKING


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***Abstract***

*An analysis of the existing equipment for conducting heat and mass transfer processes in industrial enterprises has been carried out. The possibilities of a constructive approach for intensifying the conducted processes, based on scientific discoveries of Kazakhstani scientists, are demonstrated. It is noted that the execution of discrete elements of a specific shape leads to their pulsating or rotational motion, which contributes to the further increase in heat and mass transfer coefficients.The results of experimental studies on hydrodynamic and mass transfer characteristics obtained using tested methodologies have been processed. Calculation equations have been proposed for determining hydrodynamic characteristics (hydraulic resistance, amount of retained liquid, gas content) and mass transfer parameters (mass transfer coefficients in the gas phase) in an apparatus with regularly rotating plate packing, taking into account the vortex interaction of gas and liquid flows. These equations constitute an engineering calculation methodology.*



***Keywords:*** *heat and mass transfer apparatus,rotating plate elements,hydrodynamics,mass transfer,gas velocity,irrigation density,calculation methodology.*


### INTRODUCTION

At present, in the chemical, oil refining, petrochemical, and gas processing industries, heat and mass transfer equipment is predominantly represented by spray-type apparatuses, plate, and packing devices with stationary packing. Analysis of the operation of such devices shows that hollow nozzle devices have low efficiency (up to 60%), while plate and packing devices with stationary packing have a limited range of working gas velocities and are prone to clogging with solid deposits [1-3].

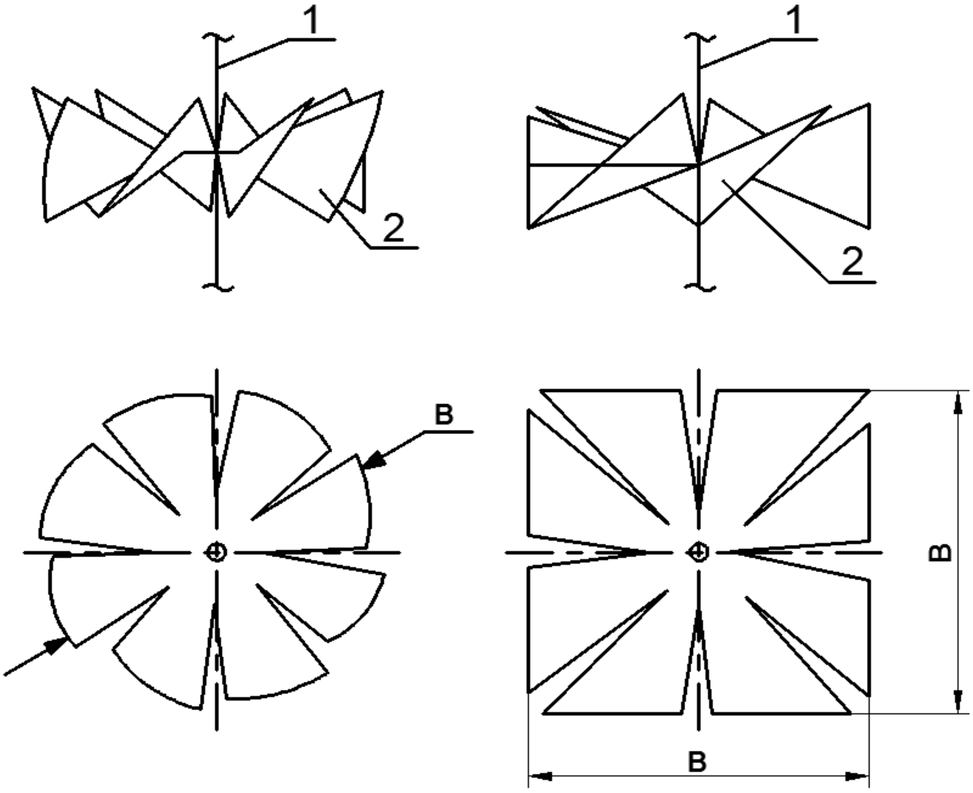
To intensify heat and mass transfer processes, Kazakhstani scientists proposed a constructive approach based on their scientific discoveries [4,5]. These discoveries allow optimizing the arrangement of discretely placed packing elements within the volume of the contact zone, significantly expanding the range of working gas velocities, and achieving high values of heat and mass transfer parameters due to the vortex interaction of gas and liquid flows. Moreover, the design of these discrete elements of a certain shape leads to their pulsating or rotational motion, which contributes to the increased efficiency of the processes being carried out.

### EXPERIMENTAL METHODS

During the study of hydrodynamic and mass transfer characteristics of the apparatus with a regularly rotating plate packing, widely known methods were used. The hydraulic resistance was measured with a cup manometer, the amount of liquid retained by the packing was determined using the "cut-off" method [1], the gas content was determined by calculation [6], and to determine the mass transfer coefficients in the gas phase, a methodology based on the study of the adiabatic evaporation of water into the air was used [7,8].

## RESULTS AND DISCUSSION

To conduct research on the hydrodynamic and heat-mass transfer characteristics, plate packing elements of round and square shapes were manufactured (Figure 1) [9]. Accordingly, the apparatus with rotating plate elements of a round shape is designated as RMRR and of a square shape as RMRS. In Figure 1, the label 1 refers to the strings, and 2 refers to the packing elements.




a) of round shape (RMRR) b) of square shape (RMRS)

Fig. 1 - Designs of rotating plate packing elements.

The packing elements are round or square plates, cut into sectors, which are turned relative to the plane of the plates at an angle of 45°. Thanks to the presence of these rotated sectors (blades), the packing element, under the influence of gas and liquid flows, rotates around the central axis.

Based on the conducted research [6, 10, 11], the following calculation equations have been obtained for determining the hydrodynamic and mass transfer characteristics, which make up the engineering calculation methodology.

The hydraulic resistance of the dry apparatus is calculated using the formula:

$$\Delta P_C = \xi_C \cdot \frac{H}{t_b} \cdot \frac{\rho_г W_г^2}{2\varepsilon_0^2}, \quad (1)$$

where $\xi_C$ – resistance coefficient of the dry packing; H – height of the packing zone, м; $t_в$ – distance between packing elements in the vertical direction, м; $\rho_г$ – gas density, кг/м$^3$; $W_г$ – gas flow velocity, м/с; $\varepsilon_0$ – porosity of the packing, м$^2$/м$^2$.

The resistance coefficient of the dry packing is given by:

$$\xi_C = K_1 \cdot \theta_b \cdot \theta_p + \left( \frac{\mathrm{Re}_ц}{\mathrm{Re}_г} \right)^{0,5}, \quad (2)$$

where the coefficient $K_1$ for the RMRR apparatus is $K_1$=0,76, for the RMRS apparatus is $K_1$=0,74; $\mathrm{Re}_ц$ - is the modified Reynolds number, calculated using the equation:

$$\mathrm{Re}_ц = \frac{n_S \cdot b^2}{\nu_г}. \quad (3)$$

Here b – is the characteristic size of the packing element (Figure 1), м; $n_S$ – is the rotation frequency of the packing elements, $c^{-1}$ determined by the following relationship:

$$n_S = \frac{\omega_{вр}}{2\pi}, \tag{4}$$

where $\omega_{вр}$ - is the rotation frequency of the packing elements ( $c^{-1}$), calculated using the formula:

$$\omega_{вр} = B_{вр} \cdot \sqrt{\frac{(\rho_г \cdot W_г^2 - \rho_ж W_ж^2) \cdot S \cdot \sin\alpha \cdot K}{2mR + \rho_г R^2 \cdot S \cdot \sin\alpha \cdot tg\alpha}}, \tag{5}$$

where $B_{вр}$ - is a coefficient: for the RMRR apparatus, $B_{вр}$= 30/ε; for the RMRS apparatus $B_{вр}$=21,2/ε.

The Reynolds number $Re_г$ is calculated using formula (3.72), in which the equivalent diameter of the packing is determined by the following relationships:

For the RMRR apparatus:

$$d_{экв.} = \frac{4t_b \cdot t_p^2 - \pi b^2 \delta}{\pi b(0{,}5b + \delta)}, \tag{6}$$

For the RMRS apparatus:

$$d_{экв.} = \frac{4t_b \cdot t_p^2 - b^2 \delta}{2b(b + \delta)}, \tag{7}$$

where δ – is the plate thickness, м.

The coefficient $\theta_в$ included in equation (3.231) is given by:

$$\theta_b = 0{,}85 + 0{,}15 \sin\left[\frac{\pi}{2}\left(\frac{4 \cdot t_b}{m_k \cdot b} + 1\right)\right], \tag{8}$$

where the parameter $m_k$ is for symmetrically forming vortices:

$$m_k = 2{,}2(1 - e^{-t_b/b}). \tag{9}$$

The coefficient $\theta_p$ is calculated using formula (3.70), in which the porosity of the packing is determined by the equation:

$$\varepsilon_0 = 1 - K_0 \cdot \left(\frac{b}{t_p}\right)^2, \tag{10}$$

where the coefficient $K_0$ for the RMRR apparatus is $K_0$= 0,785; and for the RMRS apparatus $K_0$= 1.

The hydraulic resistance of the irrigated apparatus is calculated using the formula:

$$\Delta P_L = \xi_L \cdot \frac{H}{t_b} \cdot \frac{\rho_г W_г^2}{2\varepsilon_0^2}, \tag{11}$$

in which the resistance coefficient of the irrigated packing is given by:

$$\xi_L = K_2 \cdot \theta_b \cdot \theta_p \cdot Re_ц^n \left(\frac{Re_ж}{Re_г}\right)^m, \tag{12}$$

where the coefficient $K_2$, n and m for the RMRR apparatus are $K_2$= 0,1; n=0,53; m=0,5; for the RMRS apparatus $K_2$= 0,104; n = 0,51; m=0,5.

The amount of liquid retained in the apparatus $h_0$ is calculated using the formula:

$$h_0 = (h_{пл} + h_k) \cdot \frac{H}{t_b}, \tag{13}$$

where $h_{пл}$ is the conditional height of the liquid, existing in the form of a film on the packing elements of one row and related to the cross-sectional area of the column, determined by the formula:

$$h_{пл} = \delta_{пл} (1-\varepsilon_o), \tag{14}$$

The thickness of the liquid films on the packing elements is calculated using the following relationship:

$$\delta_{пл} = \left(\frac{3}{2} \frac{\nu_ж \cdot U_ж}{\cdot \omega_{вр}^2 \cdot \sin\alpha}\right)^{1/3}. \tag{15}$$

$h_k$ - the droplet component of the amount of liquid retained (ALR) in one row of packing elements.:

$$h_k = B\xi_L \frac{\rho_г W_г^2}{2g\rho_ж} \cdot \frac{(\ell - \varepsilon_0)(1-\varepsilon_0^2)}{\varepsilon_0^2}. \qquad (16)$$

The value of the correction coefficient in equation (3.80) for the RMRR apparatus is B= 1,2; for the RMRS apparatus B = 1,28.

The gas content of the layer is calculated using the formula:

$$\varphi = \varepsilon - \frac{h_0}{H} \qquad (17)$$

in which the volumetric porosity of the packing is determined by the equations:

for the RMRR apparatus

$$\varepsilon = 1 - \frac{\pi R^2 \delta}{t_b \cdot t_p^2}, \qquad (18)$$

for the RMRS apparatus

$$\varepsilon = 1 - \frac{b^2 \delta}{t_b \cdot t_p^2}. \qquad (19)$$

The mass transfer coefficient in the gas phase is calculated using the equation:

$$\beta_{rs} = B_г \left[ D_г^2 \cdot \frac{\xi_L (1-\varepsilon) \cdot U_г^3}{\delta_п \cdot \varphi_я \cdot \nu_г} \right]^{1/4}, \qquad (20)$$

in which the empirical coefficient $B_г$ for the RMRR apparatus is $B_г = 6{,}64/(1-\varepsilon)^{1/4}$; for the RMRS apparatus $B_г = 6{,}4/(1-\varepsilon)^{1/4}$.

## CONCLUSIONS

An analysis of the existing equipment used for heat and mass transfer processes in industrial enterprises has been conducted. The possibilities of a design approach to intensify the conducted processes, based on the scientific discoveries of Kazakhstani scientists, are demonstrated. It is noted that the design of discrete elements of a specific shape leads to their pulsating or rotational movement, which contributes to the further increase in heat and mass transfer coefficients. Calculation equations have been proposed for determining hydrodynamic characteristics (hydraulic resistance, amount of retained liquid, gas content) and mass transfer parameters (mass transfer coefficients in the gas phase) in an apparatus with a regularly rotating plate packing. These equations take into account the vortex interaction of gas and liquid flows. These equations form an engineering calculation methodology.

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## ACCOUNTING OF DYNAMIC CHARACTERISTICS OF AUTOMOBILE OVERPASSES

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***Abstract***

*Calculation schemes and mathematical models for automobile overpasses have been developed. Analytical methods and instrumental measurements were used to determine the dynamic characteristics. Analytical methods are based on the use of trigonometric functions in decompositions for unknown displacements and stress functions. The spectrum of natural frequencies is obtained. The registration of oscillations during testing and the processing of experimental data was carried out using a multifunctional measuring complex Tensor MS" Two examples of calculation of automobile overpasses in the Almaty region are considered. The values of the natural frequencies of transverse vibrations for superstructures are obtained, comparisons of theoretical and experimental data are presented. Forced oscillations of superstructures under the action of a mobile bundle of forces are considered. For the speed of movement equal to 20.2 m/s, the values of the dynamic coefficient for all superstructures are obtained. Conclusions and recommendations are made on the load capacity and safety of overpasses under these external influences.*

***Keywords:*** *overpass, superstructures, model, calculation method, natural frequencies, forced oscillations, dynamic coefficient.*

### INTRODUCTION

The main task of the road industry in Kazakhstan is to radically improve the condition of highways and structures on them. Due to the constant increase in intensity and cargo turnover, the problem of improving the condition of road bridges, as the most complex and responsible elements of highways, is aggravated by a large number of structures with unsatisfactory condition, deterioration of individual elements, lack of monitoring and experimental data.

Indicators of the negative state of the bridge economy are:

- insufficient capacity of a large number of bridge structures, especially on the approaches to regional and regional centers and other major cities;
- insufficient load capacity of bridge structures, forcing measures to be taken to limit the mass of circulation vehicles and loads on their axles;
- high rates of wear (accumulation of damage in structures), ultimately reducing the service life of structures;
- a low level of traffic safety in many structures caused by the untimely elimination of damage to the elements of the bridge bed;
- the reliability of bridge structures gradually decreasing as the mass of vehicles increases (especially on highways and roads of European class);
- the presence of structures on the network with extreme wear.

The unsatisfactory state of the bridge farming as a whole on the network leads to large socio-economic losses in the country. This forces us to reconsider the approach to the problem of improving bridge structures that has developed in previous years, to identify desirable changes in the industry's policy in the field of bridges, which should ultimately eliminate the above shortcomings. The problem of improving the operation of automobile overpasses, the definition and solution of specific tasks of this problem is considered in this paper.

During the operation of bridges on a moving load, when the period (frequency) of the force action of the automobile composition coincides with the main period (frequency) of the natural vertical vibrations of the superstructure, it causes a state of resonance and can lead to dangerous vibrations of bridge structures, while the value of the dynamic coefficient to the temporary load from the moving composition increases significantly. The presented dynamic effects lead not only to an increase in the forces in the elements of bridge structures, but also have an adverse effect on stability [1-10].

Studies in this direction prove that overestimation of the permissible vertical acceleration during vibrations of the superstructure leads to a rapid violation of the stability of the upper structure of the track. The direction of these studies should be considered to promising. On the other hand, underestimating the permissible vertical acceleration is safe, but economically inefficient. The design of superstructures that exactly meet the criterion of maximum acceleration is a complex process, however, already at an early stage of design, optimization of the structure can be used, allowing to assign a rational type and the main dimensions of the cross sections.

The main design requirements that determine the technical and economic parameters of superstructures include: - limiting the range of natural frequencies of vibrations of the structure, determining the possibility of resonant operating modes under the dynamic influence of a moving load; - limiting vertical deflections from a temporary load, determining the smoothness and comfort of movement; - limiting the angles of rotation of the ends of the superstructure, and fracture angles profiles above the supports that define the geometry of the path on the structure [7-10].

The purpose of this work is to improve the quality of design and calculation of beam superstructures of automobile overpasses in conditions of intensive and high-speed traffic by improving their dynamic calculation and practical recommendations for assigning of the main dynamic parameters [11-14].

To achieve this goal, the following tasks are set:

-determination of the influence of the main parameters of split beam bridge spans (span length, structural material, vertical stiffness, linear mass, natural oscillation frequencies) on the oscillatory process,

-development of engineering methodology for dynamic calculation of split beam superstructures under the dynamic impact of heavy-duty automobile trains without the use of numerical modeling; comparison with experimental data and development of practical recommendations.

## RESEARCH METHODOLOGY

The temporary road load has a pronounced dynamic character, as a result, the reliability of calculations of bridge structures is largely determined by how fully and correctly dynamic characteristics in them under the action of mobile loads are taken into account. The dynamic processes accompanying the movement of vehicles on the bridge put forward a number of specific requirements for bridges, which significantly determine their design, material, cross-section dimensions, rigidity of individual elements and structures as a whole, the arrangement of the road surface on superstructures, etc. In Fig. 1 presents a load model in the form of sequentially moving forces on a separate span of an automobile overpass [13].

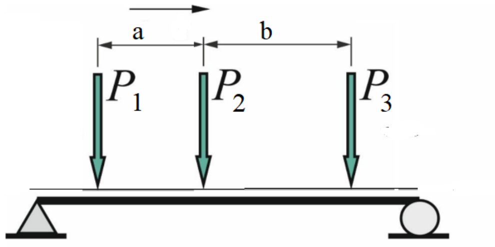


Fig. 1. Load model in the form of sequentially moving forces

**Mathematical models of overpass elements: t**he following models of overpass elements for determining the frequencies of natural transverse vibrations are considered [1-2]:

**The model 1** considers beam superstructures as systems with an infinite number of degrees of freedom. The differential equation of free transverse vibrations of a beam with a distributed mass without taking into account the resistance forces and its solution have the form [9-11]:

$$EI\frac{\partial^4 y}{\partial x^4} + m(x)\frac{\partial^2 y}{\partial t^2} = 0 \qquad (1)$$

In (1) y are deflections, EI is the bending stiffness of the cross-section of the load-bearing beams, m(x) is the linear mass. The solution of the equation has the following form:

$$y(x,t) = \sum_{k=1}^{\infty}(A\mathrm{ch}(s_k x) + B\mathrm{sh}(s_k x) + C\mathrm{Cos}(s_k x) + D\mathrm{Sin}(s_k x))\cdot(A_k \mathrm{Sin}\,\omega_k t + B_k \mathrm{Cos}\omega_k t)$$

(2)

$$s_k = \sqrt[4]{\frac{m\omega_k^2}{EI}}$$

In (2) the coefficients A, B, C, D are unknown constants. After substituting (2) into (1), using boundary conditions, we obtain an algebraic transcendental equation with an unknown value of the natural oscillation frequency. This equation has the form:

$F(\lambda_k) = 0$

$\lambda_k = s_k l.$ k=1,2,3….n ; l- span length.

**Model 2: forced oscillations. The action of the mobile load.**

If an external load acts on a beam with a uniformly distributed mass m, which varies according to the harmonic law (Fig. 2) [9-11].

$F(x,t)= F\mathrm{Sin}\theta t,$

where θ is the forced oscillation frequency, F is the amplitude value of the external concentrated load, then the differential equation of transverse oscillations and its solution have the form:

$$EI\frac{\partial^4 y}{\partial x^4} + m\frac{\partial^2 y}{\partial t^2} = F\mathrm{Sin}\theta t, \qquad (3)$$
$$y = y_o + y_{част}$$

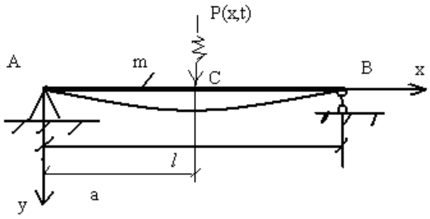

Fig. 2. Calculation scheme of forced vibrations of beam superstructures

Consider the steady-state forced oscillations of the beam ($y_o$=0 assuming that the displacements represent harmonic oscillations with a frequency of θ, i.e.

$y(x,t) = y(x)Sin\theta t$ ,

where y(x) is unknown function of standing waves. For the amplitude state ( $Sin\theta t$ =1) equation (3) has the form:

$$\frac{\partial^4 y}{\partial x^4} + \frac{m\theta^2}{EI}\frac{\partial^2 y}{\partial t^2} = \frac{F}{EI}, \qquad u = l\sqrt[4]{\frac{m\theta^2}{EI}} = kl, \qquad k = \sqrt[4]{\frac{m\theta^2}{EI}}, \qquad (4)$$
$$y = y_o + y_{част}$$

The solution of the inhomogeneous equation (4) for purely forced oscillations using the method of initial parameters and circular functions sh, ch has the form:

$$y_1(x) = y_1(0)A(kx) + \frac{y_1^{/}(0)}{k}B(kx) - \frac{M_1(0)}{k^2EI}C(kx) - \frac{Q_1(0)}{k^3EI}D(kx)$$

$$A(kx) = \frac{ch(kx) + Cos(kx)}{2}, \qquad B(kx) = \frac{sh(kx) + Sin(kx)}{2},$$
$$C(kx) = \frac{ch(kx) - Cos(kx)}{2}, \qquad D(kx) = \frac{sh(kx) - Sin(kx)}{2} \qquad (5)$$

The amplitude values of the bending moment and transverse force are described by the expressions:

$$M(x) = -EIy\ (0)k^2C(kx) - EIy^{/}(0)kD(kx) + M\ (0)A(kx) + \frac{Q(0)}{k}B(kx) +$$
$$+\sum_1 \frac{P_i}{k}B[k(x-a_i)] + \sum_1 M_i A[k(x-a_i)] - \sum_1 \frac{\Delta q_i}{k^2}\{C[k(x-a_i)]\}, \qquad (6)$$
$$Q(x) = -EIy\ (0)k^3B(kx) - EIy^{/}(0)k^2C(kx) + M\ (0)kD(kx) + Q(0)A(kx) +$$
$$+\sum_1 P_i A[k(x-a_i)] + \sum_1 M_i kD[k(x-a_i)] - \sum_1 \frac{\Delta q_i}{k}\{B[k(x-a_i)]\}$$

Equations (6) are called equations of the method of initial parameters, here $\Delta q_i$ is a jump in the intensity of the distributed load.

For example, for a hinged supported beam (Fig. 2) to the left of the load $\Delta M_1 = 0$, $\Delta Q_1 = P$, $\Delta q_i = 0$, the boundary conditions have the form:

$$\begin{aligned} x = 0 \qquad & y_1(0) = 0, M_1(0) = 0, \\ x = l \qquad & y_2(l) = 0, M_2(l) = 0 \end{aligned} \tag{7}$$

For a rod with rigid bonds at the ends , the boundary conditions have the following form:

$$\begin{aligned} x = 0 \qquad & y_1(0) = 0, y_1^{/}(0) = 0, \\ x = l \qquad & y_2(l) = 0, y_2^{/}(l) = 0 \end{aligned} \tag{8}$$

When considering a moving vehicle, the external load can be represented as changing according to the harmonic law with frequency θ, i.e. its action can be described as:

$$F = F_0 Sin(\frac{\pi t}{T_0}), \tag{9}$$

where $F_0$ –is the wheel load distributed over the area of a circle of diameter D, $T_0 = \frac{D}{V}$, V – is the speed of horizontal movement of the load, t is the current time. Denoting the ratio $\pi/T_0$ by θ, then the external load can be represented as: $F = F_0 Sin(\theta \cdot t)$, where θ is the forced oscillation frequency of the external load. Considering purely forced vibrations of beams, we assume that deformations and internal forces in them also change according to the harmonic law with frequency θ. The amplitude values of normal inertial forces are determined by the formula:

$$I = \frac{\gamma \theta^2 wh}{g}, \tag{10}$$

where γ is the specific gravity of the beam material, g is the acceleration of a freely falling body, w are deflections.

The dynamic coefficient μ under the action of a moving load is determined by the following formula:

$$\mu = \frac{1}{1 - \frac{vl}{\pi}\sqrt{\frac{m}{EI}}} = \frac{1}{1 - \frac{v}{\omega} \cdot \frac{\pi}{l}}$$

Where v is the velocity of the moving load , ω is the frequency of natural oscillations.

In the case of a bundle of forces, the forces and deformations are determined by the influence lines by summation.

Taking into account the resistance forces, a term (linear solution) is added to the left side of equation (1), taking into account the friction force, $F = -kV$ where F is the resistance force, k is the proportionality coefficient, V is the velocity of displacement equal to the first derivative of the displacement dy/dt. The solution of the differential equation of motion has an exponential character.

According to the workload of this section, the mobile load for the overpass can be represented in the form of the following scheme, representing a bundle of forces (Fig.3).

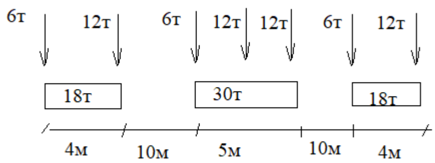


Fig. 3. The bundle of forces

The model 3 considers the road surface as a rigid ribbed plate.

Each span is a plate hinged supported on all edges. To simplify the model, the longitudinal and transverse beams for the coating plate are considered as stiffening rib. The average value of the plate stiffness is considered, which is equal to half the sum of the stiffness of all cross beams and the plate itself. The reinforced cement slab, 30cm thick, is under normal load. In the future, the most dangerous position of concentrated forces is considered – the middle of the spans. The technical theory of rigid plates is used for the calculation.

Consider the vibrations of a ribbed rectangular plate (Fig. 4). According to the technical theory of plates, the differential equation of equilibrium of the curved median surface of the plate under the action of a distributed load has the following form [11]:

$$\frac{\partial^4}{\partial x^4} w + 2\frac{\partial^4}{\partial x^2 \partial y^2} w + \frac{\partial^4}{\partial y^4} w = \frac{q}{D} \tag{11}$$

In (11), the following designations: q – the intensity of the external normal load; w –normal displacements or deflections of the points of the median plane; D – cylindrical stiffness during bending of the plate.

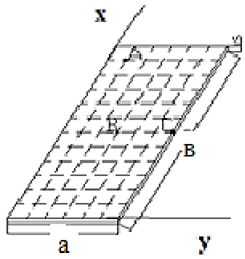


Fig. 4. A ribbed rectangular plate

**Consider the free vibrations of the plate.**

In the absence of an external dynamic load, the plate performs free transverse vibrations caused by initial perturbations, which are given in the form of initial conditions:

$$w(x,y,0)=\varphi(x,y), \qquad \frac{\partial w}{\partial t}(x,y,0)=\psi(x,y) \cdot \tag{12}$$

Harmonic oscillations are considered, therefore the solution of equations (11) is described by fundamental beam functions. For the case when the plate is hinged supported along the contour, the unknown functions in the resolving equations (11,12) are represented as:

$$w(x,y,t)=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty} w_{mn}(x,y,t)=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty} w_{mn}\sin\frac{m\pi x}{a}\sin\frac{n\pi y}{b}\sin\omega_{mn}t,$$

$$\varphi(x,y,t)=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\varphi_{mn}(x,y,t)=\sum_{m=1}^{\infty}\sum_{n-1}^{\infty}\phi_{mn}\cos\frac{m\pi x}{a}\sin\frac{n\pi y}{b}\sin\omega_{mn}t,$$

$$\Psi(x,y,t)=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\psi_{mn}(x,y,t)=\sum_{m=1}^{\infty}\sum_{n-1}^{\infty}\psi_{mn}\sin\frac{m\pi x}{a}\cos\frac{n\pi y}{b}\sin\omega_{mn}t \cdot \tag{13}$$

In (13) a,b are the dimensions of the plate in the plan, t is the time, $\varphi_{mn},\psi_{mn},w_{mn}$ are unknown coefficients in the right part, $\omega_{mn}$ is the frequency of free oscillations. The energy method is used. According to the Lagrange principle , after integration , the total strain energy depends on the parameters $\varphi_{mn},\psi_{mn},w_{mn}$. Considering that in a stationary state::

$$\frac{\partial Э}{\partial\varphi_{mn}}=0,\frac{\partial Э}{\partial\psi_{mn}}=0,\frac{\partial Э}{\partial w_{mn}}=0, \tag{14}$$

the result is a system of linear homogeneous equations with respect to unknown coefficients $\varphi_{mn},\psi_{mn},w_{mn}$ .

Equating the determinant of system (14) to zero, we obtain an equation with respect to the frequency of free vibrations of the plate $\omega_{mn}$ [1,11]:

$$\sum_{m=1}^{M}\sum_{n=1}^{N}\begin{vmatrix} b_{11} & b_{12} & b_{13}\\ b_{21} & b_{22} & b_{23}\\ b_{31} & b_{32} & b_{33}\end{vmatrix}\cdot\begin{vmatrix}\varphi\\ w\\ \psi\end{vmatrix}_{mn}=0, \tag{15}$$

where

$$b_{11}=-\left\{\left(\frac{m\pi}{a}\right)^2+\left(\frac{n\pi}{b}\right)^2+\frac{5hG}{6D}\right\}\frac{ab}{4},\ b_{21}=-\frac{\pi mb}{4},$$

$$b_{12}=-\left\{\frac{1}{4}\left(\frac{m\pi}{a}\right)^3+\frac{1}{4}\left(\frac{m\pi}{a}\right)\left(\frac{n\pi}{b}\right)^2-\frac{5hG}{6D}\frac{m\pi}{a}\right\}\frac{ab}{4},$$

$$b_{32}=-\left\{\frac{1}{4}\left(\frac{n\pi}{b}\right)^3+\frac{1}{4}\left(\frac{n\pi}{b}\right)\left(\frac{m\pi}{a}\right)^2-\frac{5hG}{6D}\frac{n\pi}{b}\right\}\frac{ab}{4},$$

$$b_{13}=-\frac{1+\nu}{2}\left(\frac{m\pi}{a}\right)\left(\frac{n\pi}{b}\right)\frac{ab}{4},\ b_{31}=-\frac{\pi a}{4},$$

$$b_{22} = b_{22}^{*} - \omega_{mn}^2 b_{22}^{**},\ b_{33} = -\left\{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \frac{5hG}{D}\right\}\frac{ab}{4},$$

$$b_{22}^{*} = \frac{Eh^3\pi^4}{48(1-\mu^2)ab}\left(\frac{b}{a}m^2 + \frac{a}{b}n^2\right)^2, \quad b_{22}^{**} = \frac{ab}{4g}[\gamma h]$$

where g is the acceleration of a free–falling body equal to 9.81 m/sec$^2$, $\gamma$ is the specific gravity of the plate material, D is the cylindrical stiffness of the plate, E, G are the tensile elastic modulus and shear of the plate material.

The solution of equation (15) gives the following formula for determining the natural frequencies of transverse vibrations of the plate:

$$\omega_{mn}^2 = \frac{b_{22}^{*}\left(b_{11}b_{33} - b_{13}b_{31}\right) - b_{11}b_{23}b_{32} - b_{12}(b_{21}b_{33} - b_{31}b_{23}) - b_{13}b_{21}b_{32}}{b_{22}^{**}\left(b_{11}b_{33} - b_{13}b_{31}\right)} \tag{17}$$

For a plate hinged supported along all edges, the frequency corresponding to the first vibration tone has the following approximate form:

$$\omega = \pi^2\left[\frac{D}{\rho h}\left(\frac{1}{a^2} + \frac{1}{b^2}\right)^2\right]^{0,5} \tag{18}$$

D is the cylindrical stiffness, h is the thickness, a, b are the dimensions in terms of ρ is the density of the material.

## RESULTS AND DISCUSSION

The purpose of dynamic testing of the road bridge was:

- identification of the values of dynamic impacts created by real moving loads;
- determination of the main dynamic characteristics of the structure – frequencies, forms of natural vibrations and dynamic rigidity of the structure. The registration of oscillations during testing and the processing of experimental data was carried out using a multifunctional measuring complex "Tensor MS".

2 examples of dynamic calculation of overpasses by this method are considered and comparisons with experimental research data are given [11-14].

1 example**:** the results of the computational analysis of the load-bearing structures of the overpass "Road overpass through the railway tracks near the Karasu microdistrict in Almaty" are presented (Fig. 5).

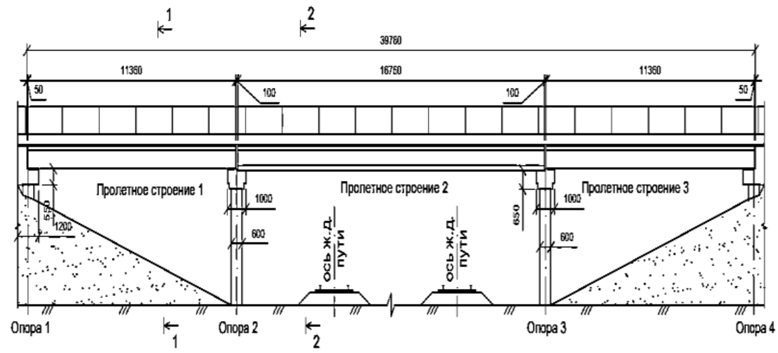


Fig. 5. General view of overpass No. 1

Superstructure – reinforced concrete, three-span, superstructure No. 1 and No. 3 consists of T-shaped reinforced concrete beams with a length of 11.36 m, made according to the standard project "Variant of structures of reinforced concrete prefabricated superstructures without diaphragms with frame reinforcement of periodic profile. Issue 56D" development of Soyuzdorproject. In the cross section of the superstructure, 7 beams with a pitch of 1.6 m are installed. Superstructure No. 2 consists of prefabricated I-beams with a length of 16.76 m, made according to the standard project "Superstructures of I-beam string concrete beams with welded joints of diaphragms.

In the cross section of the superstructure, 13 beams with a pitch of 0.85 m are installed. The transverse union of the beams of the superstructure No. 2 is carried out with the help of diaphragms. The number of diaphragms per span of medium diaphragms – 5 pcs, extreme diaphragms – 2 pcs. The length of the bridge and the size of the carriageway: The total length of the overpass between the front faces of the cabinet walls is 39.78 m. The existing size of the roadway is 8.5 m, the width of the left and right sidewalks is 1.0 m; In terms of the overpass is located in a straight line and crosses the railway tracks at an angle of 90 ° (Fig. 5).

Table 1 shows the values of natural frequencies in hertz for overpass spans obtained by analytical methods and instrumental measurements (Fig. 6,7). As can be seen, the theoretical values of natural frequencies are overestimated in comparison with the instrumental data. The presented models are more rigid in comparison with the real system. The overpass was built in 2017, instrumental measurements were made in 2023.

Table 1. Values of natural frequencies for overpass spans

| Span number | Frequency ω1 | Frequency ω2 | Frequency ω3 |
|---|---|---|---|
| Theoretical values | | | |
| 1, 3 spans | 14,51 | 21,36 | 27,9 |
| 2 span | 7,93 | 11,65 | 15,62 |
| Instrumental measurements | | | |
| 1, 3 spans | 9,18 | 13,57 | 17,48 |
| 2 span | 5,65 | 8,98 | 12,01 |

Table 2 shows the values of the dynamic coefficient μ for the overpass superstructures corresponding to the theoretical values of the natural oscillation frequencies [16-18].

Table 2. Values of the dynamic coefficient μ for overpass spans

| Span number | ω1 | ω2 | ω3 |
|---|---|---|---|
| 1, 3 spans | 1,61 | 1,35 | 1,25 |
| 2 span | 1,92 | 1,48 | 1,33 |

As field measurements show, the maximum vibrations of overpass spans under the action of moving loads correspond not to the first, but to higher frequencies.

Table 3 shows the values of the frequencies of forced oscillations θ in hertz for superstructures at a speed of transport equal to 20.2 m / s. It can be seen that at a speed of moving transport equal to 20.2 m / s, resonance is not observed. With an increase in the speed of movement, resonance at low frequencies is possible.

Table 3. Values of the frequencies of forced oscillations θ in hertz

| Span number | Theoretical values | Instrumental measurements |
|---|---|---|
| 1 span | 2,95 | 2,46 |
| 2 span | 1,89 | 1,57 |
| 3 span | 2,95 | 2,46 |

The data of instrumental measurements for the frequencies of forced oscillations under the action of a moving load for the 1st and 2nd spans are shown in Fig.6-7.

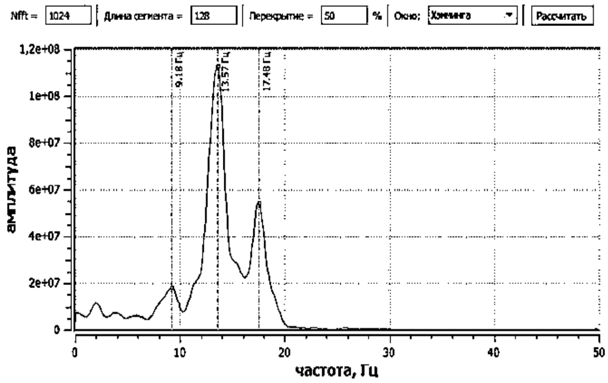


Fig. 6 Vibration frequency spectrum of superstructure No. 1

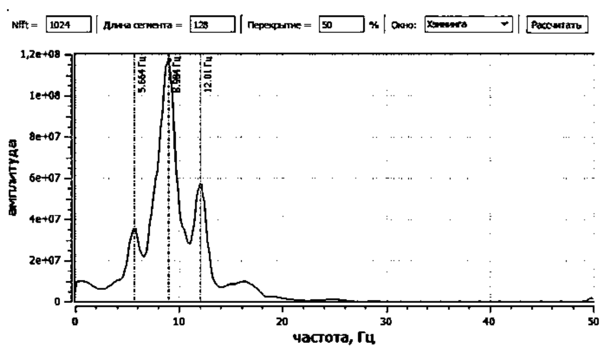


Fig. 7. Vibration frequency spectrum of superstructure No. 2

2 example. Transport interchange at the intersection of the northern ring - Burundayskaya St. - Bekmakhanov St. in Almaty (Fig. 8). The superstructure is reinforced concrete, four–span, the superstructure consists of diaphragm I-beams with a length of 22.16 m, made according to the standard project "Prestressed diaphragm beam with a length of 22.16 m" developed by MTS Mostotrest. In the cross section of the superstructure of each overpass , 12 beams with a step of 1.40 m are installed . The transverse union of the beams of the superstructure is carried out with the help of diaphragms. The number of diaphragms per span of medium diaphragms – 5 pieces, extreme diaphragms – 2 pieces. The pavement of the roadway is asphalt concrete. Closed-type expansion joints. The overpass in the longitudinal direction is made four-span. The static system of superstructures is beam-split. The support of the beams on the supports is hinged (Fig. 8).

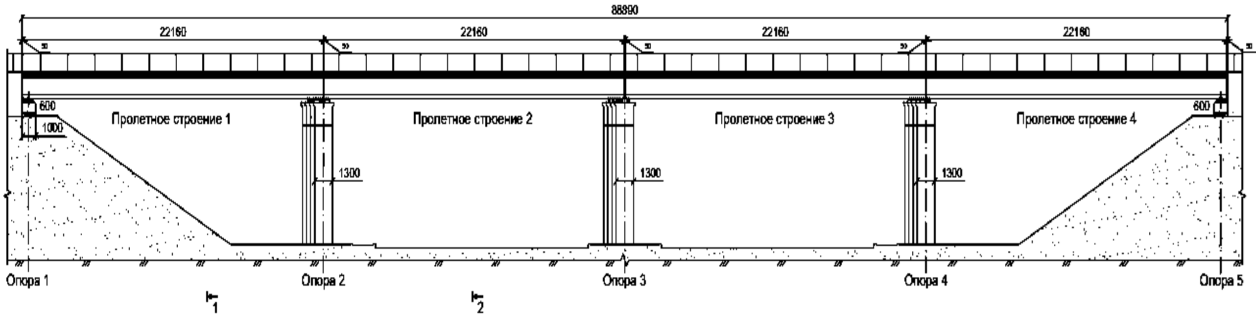


Fig. 8. General view of overpass No. 2

Table 4 shows the values of the frequencies of natural and forced oscillations obtained by analytical methods and instrumental measurements (Fig.9-12). It can be seen that at the speed of a moving vehicle equal to 20.2 m / s, resonance is not observed. With an increase in the speed of movement, resonance at low frequencies is possible.

Table 4 - Values of natural and forced oscillation frequencies

| Span number | ω1 | ω2 | ω3 | ω1 | ω2 | ω3 |
|---|---|---|---|---|---|---|
| Own fluctuations | Theoretical values | | | Instrumental measurements | | |
| 1 span | 7,08 | 9,71 | 15,52 | 5,96 | 8,20 | 12,99 |
| 2 span | 4,45 | 7,09 | 12,84 | 3,71 | 5,96 | 10,74 |
| 3 span | 7,03 | 9,42 | 14,33 | 5,86 | 7,81 | 11,91 |
| 4 span | 7,68 | 12,21 | 14,2 | 6,445 | 10,16 | 11,92 |
| Forced fluctuations | θ1 | θ2 | θ3 | θ1 | θ2 | θ3 |
| 1 span | 1,52 | 1,15 | 0,68 | 1,25 | 0,9 | 0,57 |
| 2 span | 3.6 | 1,82 | 1,31 | 3,04 | 1,56 | 1,04 |
| 3 span | 2,14 | 1,78 | 1,37 | 1,79 | 1,14 | 0,78 |
| 4 span | 5,02 | 3,01 | 2,14 | 4,18 | 2,5 | 1,79 |

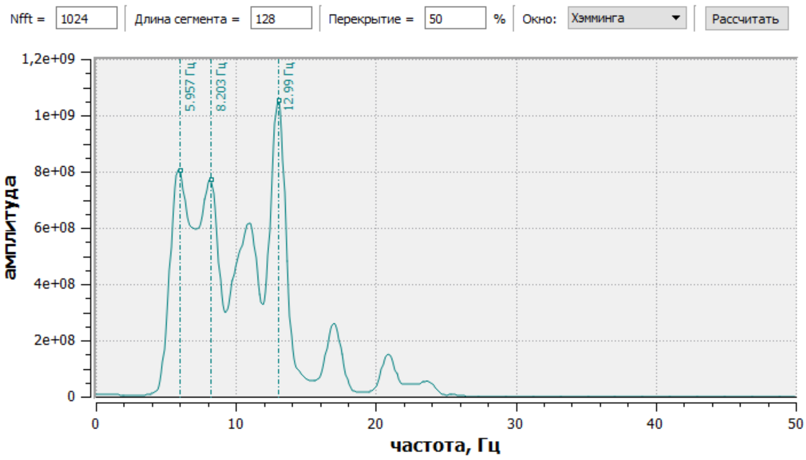


Fig. 9. Vibration frequency spectrum of superstructure No. 1 (left)

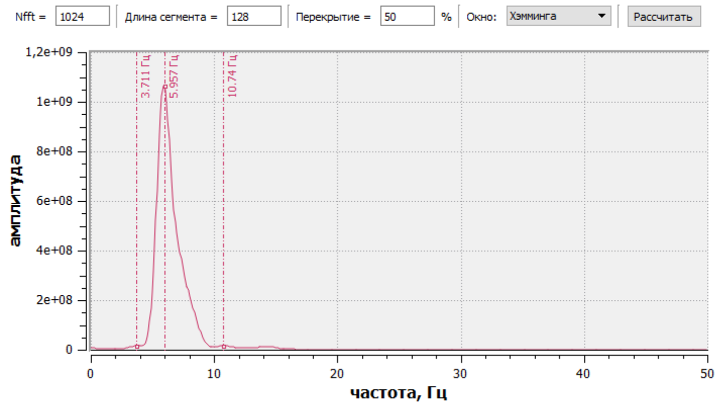


Fig. 10. Vibration frequency spectrum of superstructure No. 2 (left)

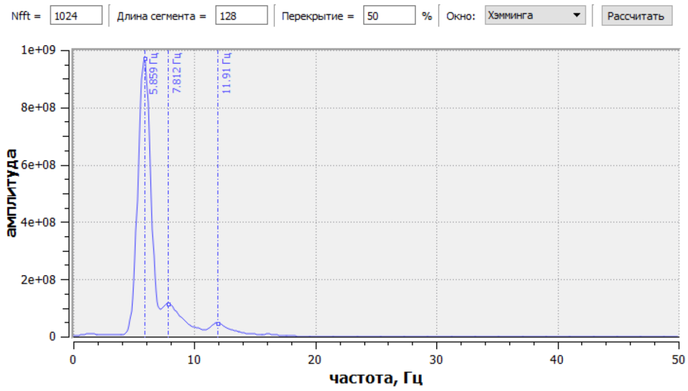


Fig. 11. Vibration frequency spectrum of superstructure No. 3 (left)

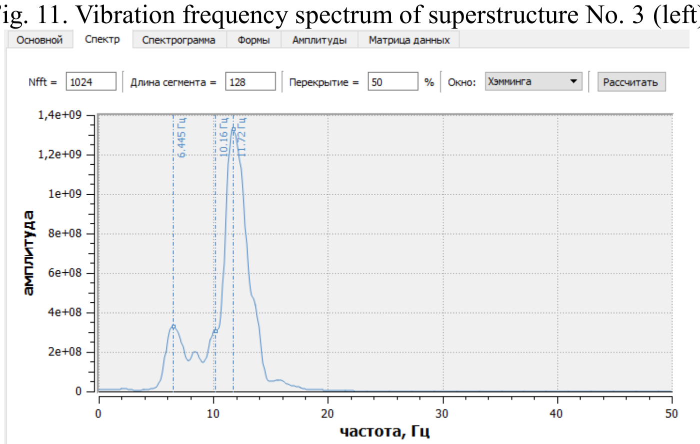


Fig.12. Vibration frequency spectrum of superstructure No. 4 (left)

Table 5 shows the values of the dynamic coefficient μ for the overpass spans corresponding to the natural frequencies [16-18].

Table 5 - Values of the dynamic coefficient μ for overpass spans

| Span number | ω1 | ω2 | ω3 |
|---|---|---|---|
| 1 span | 1,66 | 1,45 | 1,25 |
| 2 span | 1,92 | 1,48 | 1,33 |
| 3 span | 1,77 | 1,24 | 1,06 |
| 4 span | 1,72 | 1,15 | 1,03 |

For the first and second natural frequencies, the most dangerous are the middle spansю

## CONCLUSIONS

1.To increase the safety and load-bearing capacity of split beam superstructures of automobile overpasses in conditions of intense and high-speed traffic, it is necessary to improve their dynamic calculations and practical recommendations for assigning the main dynamic parameters.

2. When the cargo is moving at a speed of 20.2 m/ s, there is no resonant phenomenon for the presented two automobile overpasses. It can be seen from the instrumental data that the maximum oscillation amplitudes do not fall

on the first forms, but on the high forms of oscillations. Therefore, it is necessary to take into account not only the 1st, but also higher natural frequencies.

3.For these types of structures of automobile overpasses, the manuals provide a dynamic coefficient of 1.3. For the considered structures of overpasses, the dynamic coefficient for all spans exceeds the value of 1.3, therefore, dynamic forces and deformations exceed the normative values for these external influences. It is recommended to provide for the replacement of the beams of superstructures with those with the necessary load capacity to pass modern and prospective loads.

4. With an increase in the speed of transport, resonant phenomena are possible, therefore it is necessary to strengthen the rigidity characteristics of superstructures.

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# SETTING TARIFFS FOR RAILWAY SERVICES IN MODERN CONDITIONS

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***Abstract***

*The article focuses on the problems of forming tariffs for railway transportation in the Republic of Kazakhstan. The main factors and stages of tariff setting in accordance with the legislation of the Republic of Kazakhstan were studied. The main goals, principles and bodies responsible for state regulation of tariffs are outlined, as well as key problematic points of the existing system and ways to solve them are proposed.*

***Keywords:*** *railway freight transportation, state regulation, tariff setting, legislation of the Republic of Kazakhstan, natural monopolies, calculation of prices, passenger traffic.*

## INTRODUCTION

Tariff is a rule of law which sets detailed transport conditions, rates for carriage and travel costs calculation, and reimbursements for side actions. In present terminology it conveys the meaning of an announced list of prices and conditions for using these prices. Some prices in freight transport are currently set according to tariffs. The arrival of new carriers in freight transport has also been identified as an innovation, investment, improved quality of services, and greater technological and organizational modernisation. On the other hand it has enabled customers to choose from more transport service providers, which stimulates the relation between the quality and price. Tariffs are to provide customers with clear overview of charges and tariff conditions for specific types of transportation, and concurrently, they should provide for a possibility to decide on a carrier eventually implementing the shipping based on the offered price. The tariff can also be an outcome of a contract between the carrier and the customer in case of regular shipping of a certain commodity or in case of regularity on specific lines, or in case of specifically defined transported volumes. This is also one of the reasons why the tariffs did not lose their importance and find their application also in the environment of the Slovak Republic [1]. Carriers can set their tariffs on the basis of their costs as well as based on individual types of transportation. The benefit of a tariff derives from the fact that the carrier can propose tariff distances/tariff bands and their ranges, and within the individual charges (a price for transportation /shipping) the carrier can consider his risks connected with implementation of specific transportation (transport- and transportation related, economic as well as financial), which are necessary for establishing the tariff itself. The use of a tariff is appropriate for repeated shipments, for specific lines, for selected commodities and also for certain means of transport. The tariff benefit comes from its simplicity, since the customer is able to determine the price for transportation based on a specific procedure. Customers acquainted with the established tariff do not need the carrier to provide them with calculation of prices for individual shipments. Should any of the cost components change, the shipping price calculation or establishment of an alternative tariff is considerably simpler if such establishment occurs [1].

In modern conditions, railway transport remains the main element of the transport system of the Republic of Kazakhstan and plays an important role in accelerating economic development, as well as ensuring strategic, macroeconomic and social stability in the country.

According to the latest data, the share of railway transport in freight traffic in Kazakhstan occupies a significant part, which confirms its importance for the country's economy. In addition, the railway industry is a major employer, providing jobs for a significant percentage of the working-age population.

However, the railway industry faces a number of serious problems:

1. the need for investments to update and develop fixed assets;
2. restrictions on the development of a competitive market for services that affect the efficiency and quality of Transportation;
3. imperfection of the legislation governing activities in this area;
4. insufficient differentiation in the regulation of monopolistic and potentially competitive activities;
5.lack of stability and predictability in the tariff setting system.

In this work, much attention will be paid to the issues of setting tariffs for railway freight traffic. The problematics of railway freight tariffs has been and remains the subject of considerable research interest since the first railways were established. At different periods of history, various economic and political factors influenced the formation of tariffs, in connection with which the tariff setting system has undergone a number of changes [2].

JSC "KTZ-Freight Transportation" announces an increase in tariffs for the provision of locomotive traction services in passenger and economic types of traffic from April 1, 2018.In this context, the issue of tariff policy becomes especially relevant. Joint Stock Company "National Company" Kazakhstan Temir Zholy" and Joint Stock Company "KTZ – Freight Transportation" announced the establishment of a reduction coefficient (index) for tariffs for railway services in 2019. These measures were taken in order to stimulate the transportation of cereals, legumes, products of the flour and cereal industry and other goods. It reflects the efforts of the state and private companies to balance the interests of various parties: consumers of services, operators and government agencies.

The amount of tariffs agreed with the committee for regulation of natural monopolies, protection of competition and consumer rights of the Ministry of national economy of the Republic of Kazakhstan:

- for passenger movement of diesel locomotive traction-23,844. 78 tenge excluding VAT;
– electric locomotive passenger traffic-17,200. 93 tenge excluding VAT;
- on economic movement of diesel locomotive traction-34 621.74 tenge excluding VAT;
- in the economic movement of electric locomotive traction-21,571.72 tenge excluding VAT.

In January-December 2022, the Republic transported 405 million tons of railway transport. tons of cargo were transported, which is 2.7% less than the level of January-December 2021, during this period the cargo turnover amounted to 311.9 billion tons. t-km (an increase of 4.3% compared to January-December 2021), amounted to 19.4 million. passengers were transported (22.1% more than in January-December 2021), passenger turnover amounted to 16.4 billion rubles. P-km (an increase of 33.2% compared to January-December 2021).

The establishment of tariffs for freight transport by rail is the subject of extensive and many years of research. Since the introduction of the first Railways, various methods and models of tariff formation have been the subject of academic interest and practical application [3].

One of the most influential works in this area is the work of S. Yu. In this work, Witte developed the fundamental principles of the tariff setting system, many of which remain relevant to this day.

The process of theoretical and practical development of tariffs on railway cargo can be divided into several stages:

* An early stage with an emphasis on the development of basic principles and methods for calculating tariffs.
* The period of stabilization and standardization when legislative regulation is introduced.
* The stage of market integration and integration, including the emergence of competition and the use of market mechanisms in setting tariffs.
* The current stage, characterized by the search for a balance between state regulation and market mechanisms, as well as the introduction of technological innovations [4].

These periods and the corresponding changes in the tariff setting system are described in detail in Table 1.

Thus, the issues of tariff setting for rail freight traffic remain at the center of academic research and practical attention due to the need to adapt to changing economic and social conditions.

Table 1. stages of tariff development in the field of freight transportation on rail transport in Russia and Kazakhstan

| Time period | Main characteristics |
|---|---|
| 1838–1888 | Tariffs were designed with cost in mind; tariffs on individual lines differed not only in level, but also in unit of measurement; short-distance tariffs were higher than long-distance tariffs. |
| 1889–1928 | With the increase in the influence of the state in the regulation of tariff relations, market relations developed; tariffs were formed taking into account the quality and speed of transportation; at the same time, the main criterion is the break – even of tariffs. |
| 1929–1990 | The period of the planned-directive economy, when the principle of orientation of tariff formation to the average network cost prevailed; tariffs were regulated by the state, when forming tariffs, general economic factors were taken into account, including the mutual location of producer and consumer areas[5]. |
| 1991–2001 | Consistent adaptation to developing market relations in the country, characterized by the search for ways to transition to new economic and social relations; state regulation of freight tariffs, the creation of tariffs based on the established norm of break-even and profitability; cargo is divided into classes, and transportation tariffs depend on the class of cargo. |
| 2003– present time | Development of a tariff setting system in the context of a change in the form of ownership of railway transport and the functioning of KTZ OJSC holding; the tariff setting system consists of three classes differentiated by type of cargo; state regulation of tariffs for freight transportation of railway transport is carried out taking into account the specifics of tariff setting in the field of natural monopolies [6]. |

## METHODOLOGY

The methodology for setting tariffs for freight transport by rail includes several main aspects based on economic and social goals.

Main objectives of tariff regulation in Kazakhstan:

- Ensuring stable and safe operation and dynamic development of railway transport.
- Balancing the interests of railway transport organizations and users of services.
- Optimization of overall transport costs.
- Promote economic growth and increase the country's competitiveness.

- Support of the unified socio-economic space of Kazakhstan and deepening of transport and economic ties between the regions.

- Development of competition in public rail transport.

- Ensuring non-discriminatory access to public rail transport services, including the use of infrastructure.

Regulatory authorities:

- Kazakhstan Railways — KTZ) - for domestic and transcontinental tariffs.

- Ministry of industry and infrastructure development of Kazakhstan.

Tariff components:

- Payment for access to infrastructure: this payment is 55% of the tariff -. unlike Russia, Kazakhstan should strive for a share close to the world average-20%.

- Wagon component: to make it more competitive, it must be differentiated between 20 and 30% depending on the type and volume of cargo.

Problems with tariff regulation:

- The tariff system should be designed to cover different operators and be flexible enough to adapt to market changes.

- The system should not be unnecessarily complex and should be balanced by the main tariff-forming factors.

Result

Adaptation of the tariff system is a complex and multifaceted process that requires careful analysis and elaboration of all aspects. In the context of Kazakhstan and its economic features, it is important to take into account the following points:

Priority measures to change the system:

Price list unification: Yes, tariff unification greatly improves logistics efficiency and makes the system more understandable and accessible for shippers. It also helps to optimize the infrastructure load and improve route planning.

Combining empty mileage: this is really a sensitive issue and can affect the economic efficiency of operations. A thorough analysis of the consequences is necessary, especially for cargo of the first tariff class.

Formation of tariffs for Infrastructure Services: tariffs must be economically justified. They should not only cover costs, but also ensure the possibility of infrastructure development and modernization of railway transport.

Recommendations for Kazakhstan:

1.the development of a new tariff model should be as transparent as possible and take into account the interests of all parties: the state, operators and shippers.

2.for large shippers, the introduction of flexible tariffs, possibly seasonal differentiation or discounts, may be one way to stimulate the market.

3.integration with other modes of transport can improve the efficiency of the entire transport system.

In compliance with these principles and taking into account national characteristics, including the legal framework of Kazakhstan, it is possible to build an effective, balanced and competitive tariff system.

## CONCLUSION

Cost analysis is important part for the creation of tariff or price on agreement. In the case when the company establishes a new service in the transport market, the costs calculation is the basis for setting the price. If the company offers services which exist on the transport market the target of cost analysis is validated if the price (determined by the market) generates a profit. Besides demand which determines the maximum price and the costs which determine the minimum acceptable price it is important to be acquainted with the competitive prices, expected changes, rate of risk etc. All these factors influence profit (on condition that the demand is elastic) and competitiveness of company in the long run. Regional factors are important to consider, as different parts of the country may have different needs and economic conditions. This is especially important for our country, which has large territorial differences and different economic zones.The state can play a decisive role in subsidizing strategically important industries for the national economy. In this context, the tariff policy should be coordinated with the general state goals in the field of economic development.Attention should also be paid to large infrastructure projects that can have a significant impact on tariff regulation. For example, the construction of new railway lines or the modernization of existing highways can reduce costs and, accordingly, tariffs.It is important to ensure transparency in the tariff setting process and actively involve all interested parties in it, including business representatives, government agencies and the public.

## CONCLUSION

it should be noted that for the implementation of an effective model of tariff regulation in our country, a comprehensive strategy is needed that takes into account economic and social aspects. Only such an approach will make it possible to create a stable and balanced tariff system capable of stimulating the development of railway transport and the economy as a whole.

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UDC 656.2

# ASSESSMENT OF THE QUALITY OF LABOR OF PERFORMERS OF MAINTENANCE AND REPAIR WORKS


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***Abstract***

*In the field of road transport, the cost of transportation directly depends on the quality of maintenance and current work of rolling stock and to what extent their management is organized. The labor and material costs incurred to maintain cars in good technical condition make up a fairly large part of the costs incurred by road transport to bring them back to normal, repair them due to the wear and tear of rolling stock. This issue is implemented through the production of motor vehicles with high reliability, the second is the improvement of methods of technical operation of rolling stock, optimal management, effective organization and technology of maintenance and current work. The only key factor in improving the efficiency of the operation of motor vehicles is the reduction of material and labor costs for maintaining cars in good condition. The purpose of the proposed work is to improve the methods of quality management of maintenance and current repairs of motor vehicles by optimizing the complex of technical effects on the rolling stock of motor vehicles. At the stage of development of scientific and technological progress, the quality of Automobile rolling stock is determined by the technical condition, reliability of motor vehicles and their effective use. In this regard, it is necessary to improve the methods of quality management of maintenance and current repairs in solving the problem of improving the quality of operation and efficiency of motor vehicles. At the present stage, to ensure the operability of motor vehicles and their normal, serviceable technical condition, a multiple of the total cost of operating cars is accounted for.*



***Keywords:*** *road transport enterprise, rolling stock of road transport, maintenance of cars, current repairs, overhaul of the car*


## INTRODUCTION

Currently, the quality indicators of nomenclature products in the field of road transport, depending on their classification group, are classified as the main indicators as shown below.

Designated special indicators-a property indicator, determine the main function of the product, establish the actions performed and indicate the areas of application.

Reliability indicators. Indicators characterizing the complex properties of the product, that is, maintenance and repair. Reliability is the property of a car to perform the function assigned to it, observing the operational indicators according to the time indicator or mileage at the intervals (periods) required in accordance with the specified modes, fulfilling the conditions of Operation, Maintenance, Repair, storage and transportation. The main indicators of reliability are non-stop operation, long-term durability, adaptability to repair and storage, etc.

As a result of the analysis of the maintenance and repair of cars, it is noted that 34% of the repair operations performed contributed to the low quality of current repairs due to the performers of a large group of specialists. Therefore, a factor that increases the quality of current repair work is the development of measures that require an assessment of the quality of their work. The level of quality of the technical condition of cars is directly dependent on the high-quality performance of the work of performers. Therefore, strict compliance with the technical conditions of maintenance and current repair, proper organization of the production process, high-quality performance and performance of their duties by repair workers and technical personnel have a direct impact on improving the quality of maintenance and current repairs.

The quality of the work of workers is formed by their totality: ability, business, qualification responsibility, etc. Management of the work performed by workers and employees, personnel focuses on individual problem research. In connection with this problem, we consider the impact of the quality of work of performers and the impact of the degree of its performance on the quality of maintenance and repair on the reliability of motor vehicles.

## EXPERIMENTAL METHODS

The calculation of the quality assessment of the work of performers is made according to the "map of the technical condition of cars" drawn up for a certain planned period. In the process of determining the indicators on the map, it is necessary to take into account the features of this work from the problem of collecting indicators when accepting the initial ones. These features include: assessment of the quality of labor of each performer individually (the profession of the worker), production sites, divisions, teams and links, after determining the work plan depending on the specifics of production and how the labor of repair workers is organized, the initial ones are grouped.

Based on the experience in the quality of car maintenance in the field of road transport, the selected initial data are determined based on the effectiveness of the quality indicators of workers ' labor after receiving the package. Then determines the quality indicators of repair workers in complex teams. As an example, we cite the determination of Labor Quality Indicators at production sites.

Indicator of the quality of labor of workers on the current repair site:

$$К_{cr(f)} = 1-\frac{М_{1(аж)}+М_{2(ажж)}}{М_{0(аж)+0}}=1-\frac{619-102}{2217-375} = 1-\frac{721}{2592} = 0{,}722$$

This example is included in the composition of current repair workers performed at the site, taking into account the labor of motorists involved in the network, carrying out current repair work.

The labor indicator of workers of the current repair site (by site) is determined by the ratio of the values(values) of the actual performance and reaching a certain indicator $К_{cr(f)}$to the standard indicator of labor quality $К_{cr(n)}$:

$$К_{у(cr)}=\frac{К_{cr(f)}}{К_{cr(f)}} = \frac{0{,}722}{0{,}721} = 1{,}00$$

The determination of the values of regulatory indicators of the quality of labor of performers on the site is considered in the next upcoming section of this work. The source materials in it are used in Auto Enterprises, where industrial and scientific experiments were carried out.

We determine the quality indicator of labor of repair workers on site No. 1 for the provision of technical services by the formula below:

$$К_{(М)} = 1-\frac{М_{1(М-1)}}{М_{0(М-1)}N_{1(М-1)}}=1-\frac{922}{1128-70} = 0{,}987,$$

where:

$N_{1(М-1)} =$ 1128-number of completed maintenance -1 for the month;

$М_{0(М-1)}$= 70 – 70 – the number of operations in one service..

The level of labor quality of performers at the maintenance site will be as follows:

$$К_{у(M-1)}=\frac{К_{M-1(f)}}{К_{M-1(n)}} = \frac{0{,}987}{0{,}988} = 1{,}00.$$

In practice, it is known that maintenance works on 2 sites are always carried out in parallel with the work performed, i.e. random, repair works. In this regard, when determining the indicator of the quality of work at the maintenance-2 site, the above works are necessarily taken into account.

$$К_{(M-1)f} = 1-\frac{М_{1(M-2)}}{N_{(M-2)}+М_{(M-2)}+М_{ж(M-2)}} = 1-\frac{1848}{(188*142)+292} = 0{,}932$$

where:

$N_{(M-1)}$ – the number of maintenance -2 for a month;

$М_{(M-2)}$ - the number of operations per maintenance;

$М_{ж(M-2)}$ – the number of operations per repair.

An important place in the compilation of the regulatory framework is occupied by quality indicators in improving the methods of quality management of maintenance and repair of mobile automobile transport rights. Determination of the technical justification of normative quality indicators of quality indicates the achievements of the regulatory processes of maintenance and repair and the planning of the quality indicator of the required level. Regulatory indicators are considered a reference indicator in quality assessment.This, in turn, means that the results of quality assessment are the main source of quality management and allow you to make managerial decisions.

Therefore, economically justified, their planning and implementation are the basis for increasing the efficiency of maintenance and repair.

## RESULTS AND DISCUSSION

At the end of the experience of working in the established manner in road transport, he removes cars from the list and buys new cars in their place. Depending on this situation, cars are divided into groups depending on the distance traveled between rolling stock. In this regard, the indicators of technical quality of cars in the automotive fleet are constantly changing. In this regard, regulatory quality indicators should always be revised.

Therefore, in the process of performing this work, cars are offered a comprehensive quality management system of maintenance. The implementation of this system consists of several stages. At the first stage, they process a set of maps of the technical condition of cars and leaflets of orders for repairs for the last 2-3 months. This circumstance is the basis for determining specific indicators of quality. The indicators obtained from this characterize the level of the quality indicator of the use of cars by the automobile enterprise using rolling stock and are recognized as the main basis for further calculations. At the second stage, work is carried out to calculate newly arrived cars for the planned period, vehicles excluded from the list and changes in expected quality indicators due to changes in the periodicity of cars in the group. According to the results of the experiment, it is known – the technical condition of cars and their technical operation will be interrelated. A change in one or more indicators leads to a change in the indicators of this system. Therefore, the formation of interrelated normative indicators requires analytical dependencies, these dependencies must determine the relationship between different indicators of quality.

## CONCLUSION

The results of the study of management methods of maintenance and current repair of cars, taking into account the most important factors of the organization of technological processes in the field of road transport, the quality of labor of maintenance and current repair workers, the technical readiness of rolling stock and the volume of costs incurred for them, which have a technical impact on the quality indicators of the main works of technical operation activities, are as follows. An analysis of the qualitative indicators of the rolling stock of road transport in ensuring the operability of units, systems and assemblies used in cars during technical operation was carried out and the prerequisites for assessing their technical quality were created.

Due to the large number of technological connections between the maintenance and maintenance of the rolling stock of automobile transport and the implementation of current repairs, the large number of repair operations and their repeated repetition and assessment of the quality of labor of the performers of these works has become a serious problem to this day.

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# HEAVY METALS AS POLLUTANTS OF THE ENVIRONMENT


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***Abstract***

*Intensive industrial use of natural resources has caused significant changes in the distribution of some chemical elements in the surface layer of the aeration zone. First of all, this concerns heavy metals, the accumulation of high concentrations of which in the natural environment is associated with anthropogenic activities. Heavy metals, as a special group of elements, are released due to their toxic effect on living organisms at their high concentrations, significantly exceeding background values. Emissions and discharges of man-made objects with a high content of heavy metals accumulate in soils that are largely susceptible to influence caused by human industrial activity.*



***Keywords:*** *heavy metals, anthropogenic pollution, industrial enterprises, toxic metals, environment, metal smelting, pollutants.*


## INTRODUCTION

The important environmental problem nowaday is the pollution of environmental objects, soils and plants by various anthropogenic pollutants, among which heavy metals (HM) occupy a special place. The accumulation of heavy metals in the natural environment can occur at a high rate, having both technogenic (atmospheric emissions and effluents from industrial enterprises) and agrogenic (chemicals used in agriculture) origin [1].

The environmental problem of our modern century has become the development of industry and the transport complex, which have many negative consequences, affecting the biosphere as powerful sources of pollution [2]. Rapidly development of production makes us think about negative factors and the amount of emissions into the environment [3].

In works devoted to the problems of environmental pollution and environmental monitoring, today there are more than 40 elements of the periodic table by D.I. Mendeleev are classified as heavy metals with the atomic mass of more than 40 atomic units: V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Mo, Cd, Sn, Hg, Pb, Bi, etc. The following conditions play the important role in the classification of heavy metals: their high toxicity to living organisms at relatively low concentrations, as well as their ability to bioaccumulate and biomagnify. Almost all metals that fall under this definition (with the exception of lead, mercury, cadmium and bismuth, the biological role of which is currently unclear) are actively involved in biological processes and are part of many enzymes.

The most powerful suppliers of waste enriched with metals are enterprises for the melting of non-ferrous metals (aluminum, alumina, copper-zinc, lead, nickel, titanium-magnesium, mercury, etc.), as well as the enterprises processing non-ferrous metals.

The concentration of Pb, Zn, Bi, Sn in the dust of metallurgical industries and ore processing plants can be increased in comparison to the content in the lithosphere by several times (up to 10-12), the concentration of Cd, V, Sb - tens of thousands of times, Cd, Mo, Pb, Sn, Zn, Bi, Ag - hundreds of times. Waste from non-ferrous metallurgy enterprises, paint and varnish industry factories and reinforced concrete structures is enriched with mercury. The concentrations of W, Cd, and P are increased in the dust of machine-building plants (Table 1).

The entry of heavy metals into the environment is associated with active human activity. Their main sources are industry, motor vehicles, waste incineration boilers and agricultural production. Industries that pollute the environment with heavy metals include ferrous and non-ferrous metallurgy, extraction of solid and liquid fuels, mining complexes, production of glass, ceramics, electrical engineering, etc. Lead is widely used in the production of batteries, electrical cable sheaths, medical equipment, crystal, optical glass, paints, numerous alloys and the manufactures associated with its production. In agriculture soil contamination with heavy metals is associated with the use of fertilizers and pesticides.

Table 1. Main technogenic sources of heavy metals

| Sources of heavy metals | Elements |
|---|---|
| Non-ferrous metallurgy | Pb, Zn, Cu, Hg, Mn, Sb, W, Co, Cd |
| Ferrous metallurgy | Ni, Mn, Pb, Cu, Zn, W, Co |
| Energy | As, Sb, Se |
| Oil industry | Pb, Cu, Ni, Zn, Mn |
| Coal burning | Sb. As. Cd. Cr. Mo |
| Burning oil | As. Pb. Cd |

Transport is the source of more than half of all emissions into the atmosphere. Boiler houses operating on solid and liquid fuels pollute the environment not only with heavy metals, but also with various oxides. Burning waste is accompanied by the release of a number of heavy metals into the biosphere: cadmium, mercury, lead, chromium, etc. Large cities with diversified industry are characterized by the presence in the environment not of a single pollutant, but of associations of heavy metals, which can have a combined effect on the body, in which both summation of effects and their potentiation can be observed. Dangerous levels of heavy metal pollution occur in many industrialized areas. In addition to anthropogenic sources of environmental pollution with metals, there are also other natural ones, such as volcanic ones. Increased concentrations of toxic metals in surface waters occur as a result of acid rain, which leads to the dissolution of minerals and rocks washed by these lakes. All these sources of pollution cause the increase in the content of polluting metals in the biosphere or its components (air, water, soil, living organisms) compared to the natural, so-called background level. Heavy metals (mercury, lead, cadmium, zinc, copper, arsenic) are common and highly toxic pollutants. They are widely used in various industrial processes, therefore, despite treatment measures, the content of heavy metal compounds in industrial wastewater is quite high. Large masses of these compounds enter the ocean through the atmosphere [2]. For example, lead is a typical trace element found in all components of the environment: rocks, soils, natural water, the atmosphere and living organisms. Finally, lead is actively dissipated in the environment during human economic activity. These are emissions of industrial and domestic wastewater, smoke and dust from industrial enterprises, as well as exhaust gases from internal combustion engines. The migration flow of lead from the continent to the ocean occurs not only with river runoff, but also through the atmosphere. Together with continental dust, 20-30 tons of lead per year enter the ocean.

Currently, open pit mining occupies a leading place in the world extraction of mineral raw materials. Their share is 34% of coal and 97% of the mining industry. As experience of several decades has shown, the disturbances to the earth's surface observed during open-pit mining are the most impressive. Vast territories are allocated for open-pit mining of mineral deposits and are subject to reclamation. In Kazakhstan, over 60 million tons of building material are extracted from the subsoil annually by open-pit mining.

In all industrial regions, there are environmentally hazardous impact zones: waste heaps, dumps, quarries, boreholes, mining waste, which constantly contaminate the soil. With the relatively shallow depth of the quarries being developed, significant areas of soil cover are destroyed.

The area occupied by non-ferrous metallurgy waste storage facilities is about 15 thousand hectares, of which rock dumps occupy 8 thousand hectares, tailings from processing plants - about 6 thousand hectares and dumps from metallurgical plants - more than 500 hectares. The volumes of waste in the ferrous metallurgy and chemical industry are of the same order. The soils of the East Kazakhstan region are contaminated with compounds of copper, zinc, cadmium, lead and arsenic. Toxic waste is dumped in landfills that do not meet sanitary and environmental requirements. Lead anomalies cover the Shemonaikha, Glubokovsky and Zyryanovsky districts. The most disadvantaged zone of decommunization is the triangle between the cities of Ust-Kamenogorsk, Ridder and Zyryanovsk. Soil pollution in the Karaganda region is associated with waste from the mining and metallurgical industries. There are more than 350 landfills for storing of industrial and household waste in the region. Excessive emissions from the Balkhash mining and metallurgical plant led to soil contamination with copper, zinc, cobalt, cadmium and lead.

Thus, in terms of the level of emissions of harmful substances into the atmosphere and water bodies, as well as the formation of solid waste, metallurgy surpasses all raw materials industries, creating a high environmental hazard of its production and increased social tension in the areas where metallurgical enterprises operate. Environmental protection in the metallurgical complex requires enormous costs. Their difference significantly influences the choice of the main technological process. Sometimes it is more expedient to use a technological process that is less polluting to the environment than to control (at huge costs) the level of pollution and organize the fight against this pollution by using traditional technologies. Huge reserves and opportunities for solving environmental problems lie in the complexity of processing raw materials, in the full use of useful components in its composition and deposits.

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# COMPUTERIZED DESIGN OF A MACHINE-BUILT PRODUCT CONSIDERING THE INFLUENCE OF TECHNICAL AND SOFTWARE LEVEL


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***Abstract***

*The offered model it is the model of formation of characteristics of machine-built products of industrial and technical purpose at the stage of design and development with the help of functional subsystem, which takes into account the efficiency of technical and software support, as well as changes in the indicators of operational personnel in the implementation of multiple functions of the product within the framework of constantly improved integrated information technologies. The offered model of forming of descriptions of machine-built products setting is on the stage of planning and development by a functional subsystem, which, within the framework the constantly perfected integrated information technologies, takes into account efficiency of the technical and programmatic providing, and also changes of indexes of operative personnel.*


***Keywords:*** *design, model, engineering products, product, development, automation, process, management*

## INTRODUCTION

Increasing the competitiveness of modern machine-built products depends largely on information support of the processes of design and technological preparation of production [1], which occupies an important place in the general model of the product life cycle (LCC) [2] [3]. The speed, completeness and quality of problem solving at this stage affects the efficiency of manufacturing and satisfaction of customer requirements during product operation. The processes of production preparation are accompanied by the development of large volumes of technical documentation.

Before creating a machine-built product, it is developed in a sign form [4]. The sign information contains specific values of characteristics that determine the objective states of the product at various stages of its existence. At the stage of design preparation, the information received from customers is compared with the characteristics of competitors' products, the results of scientific and technological progress, as well as templates (prototypes) already existing at the enterprise - databases of construction materials, standard or purchased products, components, etc. The designer has access to information about the product or products already designed within a single information space and can borrow units and parts, as well as compare products options and designs. This allows to increase the unification of the company's products, reduce the volume of the manufactured range of component parts and assembly units and, accordingly, to reduce the terms of production preparation as well as the cost of the product and to increase its competitiveness.

As a rule, the criteria for selecting solution options are economic indicators [5, 6] (minimum cost, expenses) or technical characteristics of products [7, 8]. In parallel with a designer, designers, economists, technologists, specialists in engineering calculations and logistics, etc. can work on the same product project. This allows to optimize simultaneously the design by various indicators, debug CNC machining programs and collect all the information within a single information space.

Based on information about the product (composition, materials used, standard and purchased components), technologies used and characteristics of production equipment, machine-built products are manufactured and quality control and industrial testing are performed. Operation processes are related to realization, maintenance and restoration of product quality.

Thus, at present, the speed and cost-effectiveness of bringing new machine-built products of production - technical purpose to the market is actually reduced to the mastering and application of knowledge-intensive computer technologies. However, this requires appropriate models of design organization and product development processes.

*Problem statement*. In accordance with the standard ST RK ISO 9000-2017 design and development is a set of processes that transform the requirements for the object into more detailed requirements for this object.

In a broad sense, design and development of new or modernization of manufactured products is understood as the whole complex, which includes research and development (R&D), experimental design (ED) and experimental-technological works (ETW), economic research, technological preparation of production and pilot production, including standardization, kitting and logistics (MTS) (figure 1).

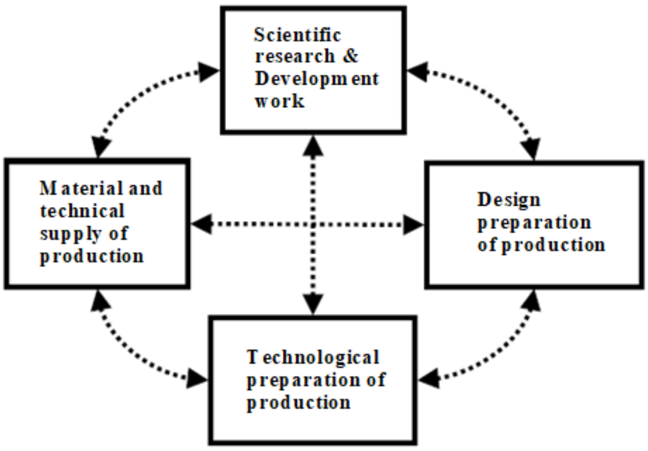

Fig. 1. A set of processes of design and development of products manufacturing

The entire set of product design and development processes can be divided into two categories [9]:

- project management processes, including the description and organization of project activities;

- product-oriented processes, which define the life cycle of the project and deal directly with the specification and production of a new product.

As a result, the tasks of design and development processes are considered in two aspects:

- selection of prospective directions and formation of required parameters of the product;

- selection of the optimal way to deploy in time the processes of creating promising objects, i.e. management of research and development processes.

In the first case it is necessary to ensure a high level of functional characteristics of the designed prospective object, in the second case - the efficient use of resources in conditions of their time limitation. Effective project management is achieved only with complex problem solving in time.

Depending on the design function, the controlling influence on the process is expressed in the form of plans, technical specifications, etc.

The system of product development and production staging [10] in general case provides for the following activities [11] (figure 2):

- development of technical specifications (TOR);
- development of technical documentation;
- manufacturing and testing of product samples;
- acceptance of development results;
- preparation and mastering of production of the product.

Product development is a process consisting of a number of sequentially performed operations (stages) in the course of which the final product - scientific and technical documentation (STD) is created:

- technical proposal;
- preliminary design;
- technical design;
- working design documentation of a prototype (pilot batch).

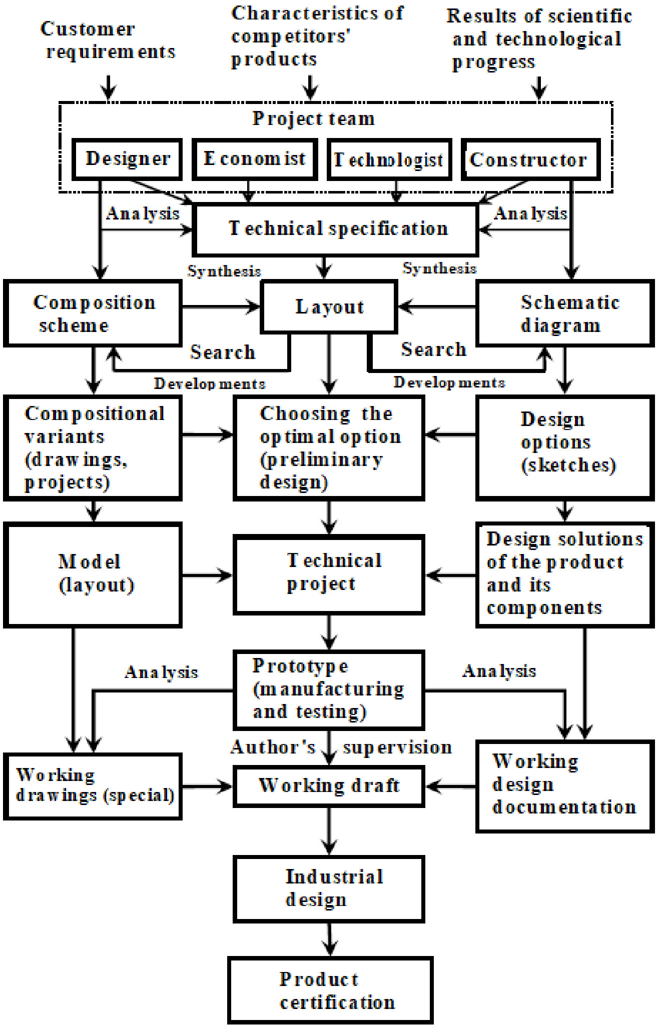


Fig. 2. Structural scheme of works at development of technical project

Modern processes of design and product development are carried out by functional design subsystems ($FSS_D$), which represent software and methodological complexes (SMC) of computer-aided design systems (CAD).

Automation is also subject to the tasks of operational planning and accounting of material resources, such as: calculating the need for raw materials, materials, semi-finished products, component parts under the relevant orders; conclusion of contracts for the supply of necessary products; formation, control and analysis of the supply schedule.

According to [12] CAD PMC is an interconnected set of components of software, information and methodological support of the CAD system (including, if necessary, components of mathematical and linguistic support), necessary to obtain a complete design solution for the design object or to perform a unified procedure.

The functional subsystem of the FPSpi design includes the following elements:

- CAE - Computer Aided Engineering (automated calculations and analysis);
- CAD - Computer Aided Design;
- CAM - Computer Aided Manufacturing (automated technological preparation);
- PDM - Product Data Management;

- SCM - Supply Chain Management;
- CRM - Customer Relationship Management.

The abovementioned elements are integrated automated systems, i.e. the functioning of one of them depends on the results of functioning of the other (others) so that this totality can be considered as a single $FSS_D$.

The effectiveness of the design function is determined by the characteristics of the $FSSD\ Ch$, which, in turn, largely depend on the characteristics of groups of technical, software and operational personnel involved in the performance of this function (figure 3).

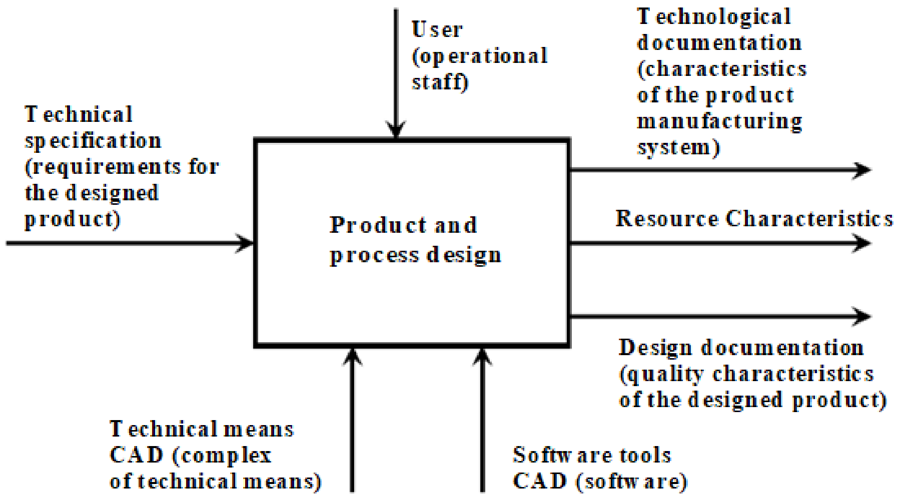

Fig. 3. General scheme of the process of designing and developing a product using CAD tools

The purpose of this work is to develop a model of formation of characteristics of machine-built products of industrial and technical purpose at the stage of design and development with the help of functional subsystem, which takes into account the effectiveness of technical and software within the framework of constantly improving integrated information technologies, and considers changes in the performance of operational personnel in the implementation of multiple functions of the product.

## RESEARCH RESULTS

Structural decomposition, synthesis and multi-criteria selection of alternatives of the functional subsystem of the product (FPSI) (Table 1) is possible on the basis of a generalized structural model, which can be represented in the following form

$$FSS_P = \{\mathrm{H}_P, \Phi_P, Str_P, Ch_{FSS_P}, B_P\}, \tag{1}$$

where $\mathrm{H}_P$ - is a set of structural and parametric characteristics of interaction between $FSS_P$ and its external environment; $\Phi_P$ - a set of FPSI functions; $Str_P$ - is the structure of $FSS_P$; $Ch_{FSS_P}$ - is a set of FPSI characteristics; $B_P$ - the background of $FSS_P$.

The initial information for the process of design and development of the product is the technical specification (TOR) - a document that establishes the main purpose, technical, economic and special requirements for the product ($Re_P$), the scope and stages of development and the composition of design documentation [10]. The specific content of the TOR, the order of its development and approval is determined by the contractor with mandatory coordination with the customer. Formation of requirements in the TOR is based on the results of previous research, including marketing, and experimental work, analysis of patent, scientific and technical documentation, information materials on the latest achievements of domestic and foreign science and technology, scientific forecasting and prospects for further market development, as well as the experience of previous development and operation of similar products.

Design preparation of production may include design of both new products and modernization of previously produced ones. The purpose of this stage is to develop a model of the product being designed. In the process of design, the composition of $FSS_P$, its design, technical, economic and other characteristics $Ch_{FSS_P}$ are determined. An important stage in ensuring the quality of the designed machine-built product is the technological preparation of production, which is a set of interrelated processes that ensure the technological readiness of the enterprise to manufacture products of a given quality level at the established time, output volume and costs. Technological preparation of production is a continuation of the work on the design of $FSS_P$. At this stage, it is established by means of which functional subsystems of manufacturing ($Ch_{FSS_P}$) should be used to ensure the quality characteristics of a given product $Ch_{FSS_P}$.

In general, the structural model of a technological process can be written in the following form

$$Ch_{TP} = F(Str_{TP}^{ME}) \tag{2}$$

where $Ch_{TP}$ - set of output characteristics of the technological process; $Str_{TP}^{ME}$ – structure of a technological process.

Set $Ch_{TP}$ is defined as

$$Ch_{TP} = \{Ch_{LM}, Ch_{Pr}, Ch_R, Ch_{CM}, Ch_{CER}, Ch_M\} \quad (3)$$

where $Ch_{LM}$ – labour intensity of manufacturing; $Ch_{Pr}$ – productivity of technological process; $Ch_R$ – reliability; $Ch_{CM}$ – consumption of material resources; $Ch_{CER}$ – consumption of energy resources; $Ch_M$ – cost of manufacturing.

The structure of technological process represents

$$Str_{TP}^{ME} = \langle ME, \varepsilon^{ME}, Ch_{FSS_P}\rangle \quad (4)$$

where$ME = \{ME^0, ME^1, \dots, ME^{\mu-1}\}$ – setofelementsof$FSS_P$, involved in technological process; $\varepsilon^{ME} = \left\{\varepsilon_1^{ME}, \varepsilon_2^{ME}, \dots, \varepsilon_j^{ME}, \dots, \varepsilon_\mu^{ME}\right\}$ – set of connections between elements ME*;* $Ch_{FSS_P} = \left\{Ch_{FSS_{P_1}}, Ch_{FSS_{P_2}}, \dots, Ch_{X_{FSS_{P_M}}}\right\}$ – set of elements characteristics $FSS_P$.

Table 1. Formation of $FSS_{II}$ characteristics

| № | Stages of characteristic formation |
|---|---|
| 1 | Determination of the product characteristics which guarantee the satisfaction of certain market needs in accordance with its purpose (formation of the product target functions, description of the structure characteristics, systematization, evaluation and selection of solutions on the basis of expertise) |
| 2 | Determination of the importance and value of each single characteristic (identification of the purpose of the $FSS_{II}$, formation, formation of the class of tasks within which the $FSS_P$ variants will be synthesized) |
| 3 | Comparison of indicators of product characteristics produced by the enterprise, its competitors and those demanded by market needs. |
| 4 | Determination of perspective level of product characteristics (formation of $FSS_P$ options) |
| 5 | Establishment of conditions, factors and reasons influencing the relevant characteristics and determining their level (evaluation, and selection and optimization of solutions on the basis of laboratory and operational tests) |
| 6 | Development of the strategic plan of the enterprise to achieve the prospective level of the product quality characteristics (development of manufacturing and control technology) |
| 7 | Ensuring the prospective level of product quality characteristics with minimum costs (coordination of $FSS_P$ variants according to the criteria of design tasks and selection of the most rational one) |

The set of output characteristics of the technological process can be denoted, respectively, by , as follows

$$Ch_{LM} = \sum_{j=1}^{N} Ch_{FSS_{j(LM)}},\ Ch_{Pr} = \sum_{j=1}^{N} Ch_{FSS_{j(Pr)}},\ Ch_R = \sum_{j=1}^{N} Ch_{FSS_{j(R)}},$$
$$Ch_{CM} = \sum_{j=1}^{N} Ch_{FSS_{j(CM)}},\ Ch_{CER} = \sum_{j=1}^{N} Ch_{FSS_{j(CER)}},\ Ch_M = \sum_{j=1}^{N} Ch_{FSS_{j(M)}} \quad (5)$$

Thus, at the stage of technological preparation the problem of selecting the optimal characteristics of the functional subsystem of product manufacturing $Ch_{FSS_P}$ occurs.

As a rule, in mechanical engineering technology, when drawing up a technological process, it is common to divide each product into executive surfaces. The technological process is designed based on a certain sequence of $FSS_P$ that provide the properties of these surfaces. Different $FSS_P$ can be used to manufacture the same product with the same initial and final state properties. In this regard, the designed manufacturing processes are usually variants corresponding to each of the considered $FSS_P$.

Thus, at the stage of technological preparation the problem of selecting the optimal characteristics of the functional subsystem of the manufactured product occurs.

As a rule, in mechanical engineering technology, when drawing up a technological process, it is common to divide each product into executive surfaces. The technological process is designed based on a certain sequence, which provide the properties of these surfaces. The production of the same product with the same properties of the initial and final state different sequences can be used. In this regard, the designed technological processes, as a rule, have options, corresponding to each of the considered.

At the stage of MTS it is established by means of which material (raw materials, materials, purchased semi-finished products and components of products) and energy (electricity, heat, water, etc.) resources will be realized the required values of $Ch_{FSS_P}$, with the corresponding characteristics of $Ch_{FSS_P}$. The main purpose of the functional subsystem $FSS_j$, which implements the MTS management, is the operational provision of production needs in material resources at minimum costs of their acquisition, transportation and storage.

Cooperation with suppliers and partners at this stage provides various opportunities: optimization of the quantity, monitoring, involvement in the design and development of the overall product strategy, etc.

Schematically, the interaction of design and development processes of production and technical products is presented in figure 4. The design of a complex technical system is an iterative decision-making process to define a set of functional subsystems $FSS_j$,capable of performing all the required functions with the subsequent definition of a set of means $(ME_{\text{КТС}j}, ME_{\text{ПО}j}, ME_{\text{ОП}j})$ that make up the specified subsystems.

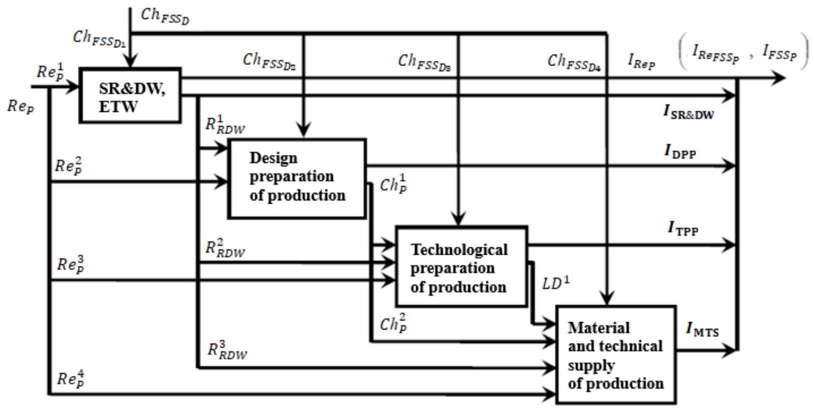


Fig. 4. Structural scheme of design and development processes interaction for the production with the technical purpose:
$Ch_{FSS_D}$ - characteristics of the functional design subsystem (characteristics of $ME_{\text{КТС}}$, $ME_{\text{ПО}}$, $ME_{\text{ОП}}$); respectively)
$Ch_{FSS_P}$ – characteristics of the functional subsystem of the product manufacturing;
$I_{FSS_{\text{И}}}$–information about characteristics of the functional subsystem of the product;
$I_{Rep}$, $I_{SR\&DW}$, $I_{DPP}$, $I_{\text{TPP}}$,$I_{MTS}$–set of characteristics $Ch_{FSS_P}$, $Ch_{FSS_{PP}}$, written in TOR and realized at the stages of SR&DW, DPP, TPP, MTS;
$Re_P^1$,$Re_P^2$, $Re_P^3$, $Re_P^4$ – set of requirements for the product, which should be followed at the stages of SR&DW, DPP, TPP, MTS respectively;
$R_{RDW}^1$,, $R_{RDW}^2$, $R_{RDW}^3$ – results of SR&DW used, accordingly at the stages of DPP, TPP, MTS; $Ch_P^1$, $Ch_P^2$ – set of data of DPP, necessary for TPP, manufacturing, control, acceptance, delivery, operation of the product, including repairs;
$LD^1$ - a set of data that determine the technological effects during the manufacturing of the product.

The transformation function can be mathematically represented by the following expressions

$$\left.\begin{aligned} &\varphi_{SR\&DW}\colon Re_P \rightarrow \text{P}_{SR\&DW}\ ; \\ &\varphi_{DPP}\colon \text{P}_{SR\&DW} \rightarrow Ch_P\ ; \\ &\varphi_{\text{TPP}}\colon Ch_P \rightarrow Ch_{FSS_{PP}}\ ; \\ &\varphi_{MTS}\colon Ch_{FSS_{PP}} \rightarrow Ch_{\text{P}}\ ; \end{aligned}\right\} \qquad (6)$$

where $\varphi_{SR\&DW}$ – is the mapping (transformation) of the requirements for the product $Re_P$ into results SR and/or DW and OTP $\text{P}_{SR\&DW}$; $\varphi_{DPP}$ – is the mapping (transformation) at the stage of DPP of the results $\text{P}_{SR\&DW}$ into characteristics of the product $Ch_P$; $\varphi_{\text{TPP}}$ - is the mapping (transformation) at the stage TPP of the product characteristics $Ch_P$ into characteristics $Ch_{FSS_{PP}}$; $\varphi_{MTS}$ – is the mapping (transformation) at the stage MTS of characteristics $Ch_{FSS_{PP}}$ into characteristics of resources used $Ch_{\text{P}}$.

Complex of technical means is a set of technical means of collection, accumulation, processing, transmission, output and presentation of information in solving design tasks, interconnected by unified management. CTS consists of: means of program data processing, preparation and input, display and documentation, archive of design solutions, data transmission.

Means of program data processing are represented by processors and memory devices, i.e. personal computers (PC), where data transformations and program control of calculations are executed. Means of data preparation, input, display and documentation serve for user communication with PC. Means of project solutions archive are represented by external storage devices - servers. The means of data transfer (network) are used to organize connections between geographically dispersed PCs.

Currently there are two main forms of technical support organization (forms of using technical means): centralized and partially or fully decentralized. Centralized technical support is based on the use of database servers and applications in the information system. Decentralization of technical means assumes implementation of functional subsystems on PCs directly on automated workplaces (AWP). Partially decentralized approach is considered promising - organization of technical support on the basis of distributed networks consisting of PCs and servers for storing databases common for any functional subsystems (figure 5).

According to [13] software is a set of programs of information processing system and program documents necessary for their operation. A set of programs provides processing or transfer of data and is designed for multiple use and application by different users. According to the types of functions performed, software is divided into general and special.

The organizational scheme of the functional subsystem of $FSS_{\text{ПР}}$ design contains (figure 5): server part (DBMS server with necessary application servers), regulations of interaction and access to information and users of

$FSS_{ПР}$in the local network with automated necessary workstations for obtaining the results of R&D and/or S&D, OTR, CPT, TPP, MTS, etc.

Common software is a set of software tools designed to organize the computing process and to solve frequently encountered information processing tasks, which are developed out of connection with the given automated system. It serves to expand the functionality of the PC, control and manage the data processing process.

Special software is a set of programs developed during the creation of this CAD.

CAD operational personnel includes users of technical means and software: designers, technologists and operating personnel, who realize maintenance of CTS and software.

In this case, a single information space is formed, where an electronic model of the product can be created and maintained throughout its entire life cycle, and the process of product creation covers parallel of both design and technology, which allows to combine all the work at the stages of CPP, TPP and MTS. In computer-aided design it is obligatory to use all software and algorithmic software. The $FSS_P$ and $FSS_{PP}$ databases are used by both the developers of the main product and the developers of component suppliers.

Development databases exist in the form of components at suppliers and/or in the form of concepts already realized earlier at the enterprise itself. The organizational chart of the functional subsystem of $FSS_D$ design contains (figure 5): server part (DBMS server with necessary application servers), regulations of interaction and access to information and users of $FSS_D$ in the local network with automated necessary APMs for obtaining the results of R&D and/or R&D, OTR, CPR, TPP, MTS, etc.

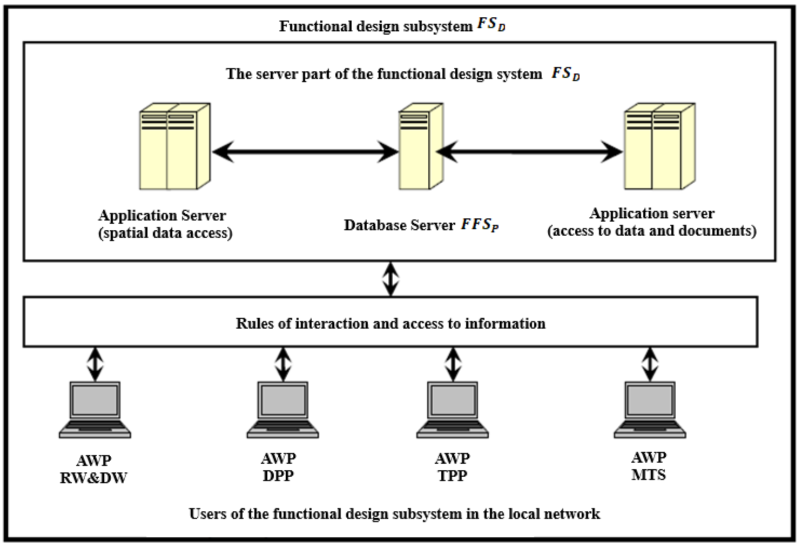


Fig. 5. Organizational scheme of the functional subsystem of the design of the FPS_PR products

Generic software is a set of software tools designed to organize the computing process and solve common information processing tasks, which are developed outside the connection with the given automated system. It serves to expand the functionality of the PC, control and manage the data processing process.

Special software is a set of programs developed during the creation of this CAD.

CAD operational personnel includes users of technical means and software: designers, technologists and operating personnel, who work in the sphere of maintenance of CTS and software.

In this case, a single information space is formed, where an electronic model of the product can be created and maintained throughout its entire life cycle, and the process of product creation covers parallel design of both design and technology, which allows to combine all the work at the stages of CPP, TPP and MTS. In computer-aided design it is mandatory to use all software and algorithmic software. The $FSS_P$ and $FSS_{PP}$ databases are used by both the developers of the main product and the developers of component suppliers.

Development databases exist in the form of components from suppliers and/or in the form of concepts already realized earlier at the enterprise itself.

At the manufacturing stage, the information (integrated result of CPT, TPT and MTS processes) included in the design and process documentation is transformed into product characteristics by means of technological effects.

## CONCLUSIONS

The model of formation of characteristics of machine-built products of industrial and technical purpose, working in the automated mode at the stage of design and development, which with the help of functional subsystem takes into account the influence of the level of technical and software, as well as changes in the indicators of operational personnel in the implementation of multiple functions of the product at all stages of its life cycle, is proposed. The interconnected chain of processes of design, technological preparation of production and logistics within the framework of constantly improving integrated information technologies is considered.

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# MODERN ADDITIVE MANUFACTURING TECHNOLOGIES

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***Abstract***

*Cleaner production in a sustainable and customized industrial environment has gradually become the focus of attention in industrial manufacturing. Additive manufacturing is a new, rapidly emerging technique in the industrial sector. This is the process of creating parts by adding layer by layer material, hence it is called as 'Layer Manufacturing Process'. This process is also called 'Rapid Prototyping' or '3D Printing'. This is a tool-less manufacturing method that produces parts in less time and with high precision. This process provides freedom for designing the parts and their complexity. Additive manufacturing has many advantages over conventional manufacturing processes like low production cost, no residual stresses, no wastage of material, etc. Nowadays, so much research work is going on in this additive manufacturing field. This manufacturing technology is going to replace the conventional manufacturing techniques in the upcoming days. In this paper, we discuss about history of additive manufacturing and the various additive manufacturing methods, its principles, applications, advantages, and challenges to industrial use.*

***Keywords:*** *additive manufacturing, 3D printer, additive technologies, materials, methods, processes, product*

## INTRODUCTION

Thanks to new technologies, manufacturing optimization can be more present than ever during the design stage. New software of CAD, simulation, parametric design or optimization are some of the new tools that constantly change the productive context. In addition, additive manufacturing technologies remove borders of traditional manufacturing processes, and the number of materials, products and industries in which they find application keep growing every day [1,2].Additive manufacturing is defined as 'The addition of material layer by layer to create components from 3D data [3-4]. This is a layer-dependent manufacturing process for creating 3D components from CAD data without using any tool or fixture [5]. Additive manufacturing or '3D Printing' builds geometrically complex objects (possibility to create almost any shape which is difficult to machine) by layers of material, each layer printed on the top of the other layer. Additive manufacturing is the commonly used manufacturing technique creating parts with high accuracy and minimum manufacturing time [6]. Additive manufacturing technology mostly uses wire and Powder as feedstock material and is melted by heating and then cooled to form a component. Additive manufacturing technology has many advantages over conventional or subtractive manufacturing processes [7]. Conventional manufacturing methods like subtractive manufacturing, forming processes, etc. cannot create any structures. Along with these subtractive manufacturing processes has the disadvantage of forming waste material called scrap during maufacturing. However, additive manufacturing process can create three- dimensional parts with any geometrical shape withoutany secondary process required and without forming any scrap or waste [8].

## METHODOLOGY AND RESEARCH RESULTS

The inventions of additive manufacturing (AM) have been a long process. First key components for AM, photo resins, were invented in 1950's by DuPont. Laser technology came along with first experiments of curing photo resin in 1960's by Battelle Memorial Institute. In 1970's Dynell Electronics Corporation called their technology as solid photography. A name that helped the public to visualize the process in a similar way as 3D printing is used currently.

Stereo lithography can be claimed to have emerged in 1980 when Japanese Hideo Kodama in Nagoya Municipal Research Institute researched and published his work in paper "Automatic method for fabricating a three-dimensional plastic model with photo-hardening polymer" [10]. He published three papers in the field of additive by 1982. However, he did not have financial means to continue and patent his research. In the same period researchers in USA and Europe were working in the same field achieving their first publications in 1984.

A commercial success was achieved in 1987 with stereo lithography apparatus (SLA) that was commercialized SLA-1 by 3D Systems. Other technologies followed as selective laser sintering (SLS) in 1992 by DTM company (now part of 3D systems). In 1994 Electro Optical Systems (EOS) developed direct metal laser sintering (DMLS) platform called EOSINT [9].

A photo curable resin was the first material to be used in additive manufacturing and more followed in 1980's and 1990's. In 1999, Fraunhofer collaborated separately with Fockele and Schwarze to make steel powder based selective laser melting (SLM) with steel powders and with Röders in controlled metal build up (CMB) technology. Also in 1999, the first colour plastic 3D printer was revealed.

In the year 2000, direct metal deposition (DMD) as blown powder method was invented. It took an advance of diode laser technology and the fact that diode laser wavelength can be bend into an optical fibre and the power of laser transferred more precisely than with conventional CO2 lasers. Diode lasers replaced the CO2 lasers at a fast pace in new machines. In 2001 Concept Laser released hybrid additive manufacturing machine with SLS and computer numerically controlled (CNC) cutting in one [9].

In 2005, an open source RepRap-project (replicating rapid prototyper) was started in University of Bath by Dr Adrian Bowyer. He created an open source project to have self-replicating and evolving machine for everybody learn and copy from. In addition to that software solutions were developed in open source to accommodate RepRap hardware. The technology uses a tubular filament that is heated by extrusion nozzle and it was called Fused Filament Fabrication (FFF). Thereafter a name 3D printing was created. The project was soon copied and utilized in maker communities due to its open nature. It brought additive manufacturing technology to the customers with cheap and affordable equipment [11].

Electron beam melting (EBM) became available to public in 2006 when Arcam released the first commercial machine with electron beam as energy source. However the history of the method is longer as the first patent regarding to 3D models made by electric current came in 1993 [12] from Sweden. This eventually lead the initial research evolving into a company Arcam. Arcams industrial pilot phase was in 2002 when its first clients received their first machines [13].

Since then, dozens of AM processes have been adopted by the industry for prototyping and manufacturing of polymer, metal, and ceramic parts [14–15]. These include parts for automotive, aerospace, and medical industries, as well as jewelry, tooling, and even art and museum displays. ISO/ASTM 52900 provides some guidance to the cornucopia of AM processes available today. Specifically, it outlines seven categories of AM processes: material extrusion, binder jetting, sheet lamination, vat photopolymerization, material jetting, directed energy deposition (DED), and powder bed fusion (PBF) (figure 1).

Material extrusion (figure 1.1a) refers to AM processes that selectively dispense a filament material through a nozzle or an orifice, such as Fused Deposition Modeling (FDM) of thermoplastic materials [16]. Binder jetting (figure 1.1f) describes processes that involve selective deposition of a liquid bonding agent onto powder materials to create a green part that can be later sintered together, with examples including Digital Part Materialization [17,18] and Digital Metal [19,20]. Sheet lamination (Figure 1.1e) describes layer-by-layerbonding of sheets of material to create a 3D object, from laminating paper using glue [21] to Ultrasonic Consolidation (UC) of metal sheets [22].

In vat photopolymerization (figure 1.1), a liquid photopolymer is selectively cross-linked using a light-activated process, which can be controlled by a laser source in stereolithography (SLA) and two-photon lithography (TPL) and by UV light shaped using Digital Light Processing (DLP) [23,24]. Material jetting (figure 1.1b) refers to selective deposition of droplets of build material, as opposed to a bonding agent in binder jetting [25]. Directed energy deposition (DED) (Figure 1.1c) locally fuses materials using focused thermal energy, such as laser-driven consolidation of powder in Laser Engineered Net Shaping (LENSⓇ) [26]. Finally, powder bed fusion (PBF) (figure 1.1g) describes beam-based selective thermal fusion of regions of a powder bed, such as powder melting using a laser source in Selective Laser Melting (SLM) or a focused electron beam in Electron Beam Melting (EBM) [27,17]. A detailed review of these AM processes can be found in [14–15].

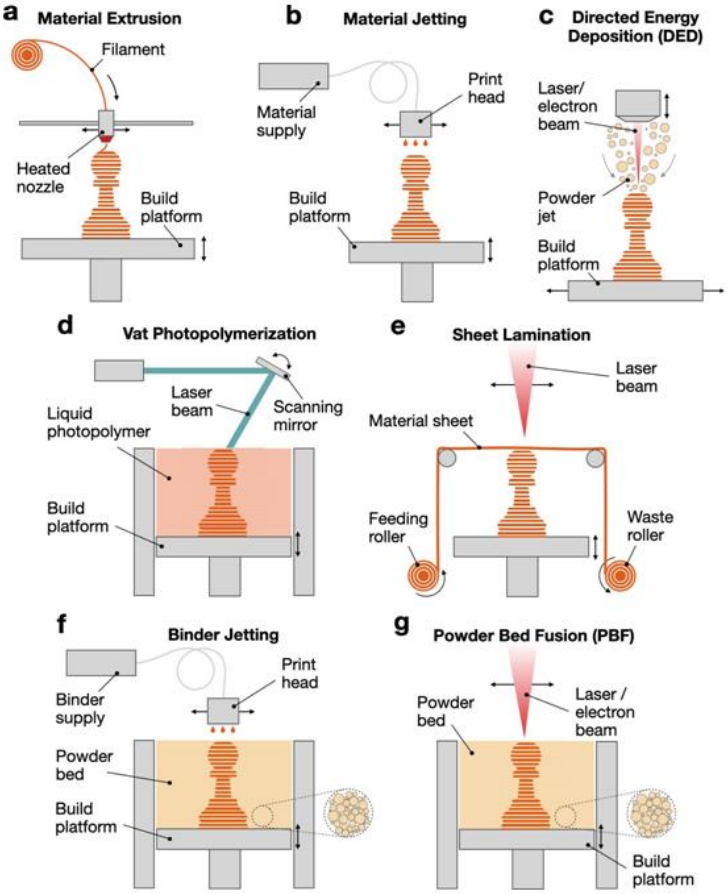


Fig. 1. Established AM processes:
a - Material Extrusion; b - Material Jetting; c - Directed Energy Deposition (DED);
d - Vat Photopolymerization; e - Sheet Lamination f Binder Jetting; g - Powder Bed Fusion (PBF)

Latest developments are the AM moving to cloud-based services, where it's possible to make CAD model; prepare and slice it for printing; send it to a printer. The standardization has brought dental products and aerospace products to the printers. GE has created leading edge aviation propulsion (LEAP) engine that has 19 AM nozzle parts made from Inconel. The nozzle is designed to replace a twenty-part assembly and give weight savings. AM parts are moving from non- structural class in aviation to structural class with the development of process and quality verification. Fabrication laboratories for home makers have got popular with fabrication cafes where one can have a coffee and can fabricate one's own design while waiting. The limits of additive come closer to the people, since the key patents are expiring. [28].

Metal AM is gaining increased attention; the global market demand has surpassed £1.8bn in 2019 [29], and is expected to grow to £5.3bn by 2024 [30]. AM is a key low-carbon manufacturing technology incorporating net-shaping whilst avoiding complex process chains [31]. As a result, it has been promoted to combat greenhouse gas emissions [32]; its implementation will result in energy savings of 5-25% in the aerospace sector and 4- 21% in feedstock and transportation. Because of its geometrical and production versatility, AM will help to simplify design and manufacturing processes. AM has demonstrated its dominance in producing complex-structured components to meet urgent demands in the recent effort to resolve the COVID-19 crisis. Furthermore, because of its versatility in prototyping and remote manufacturing, AM is a vital technology for accelerating the growth of Internet of Things. AM is at the forefront of industrial growth because of these exciting features. This manufacturing technique is appealing for a variety of applications, including aerospace, oil, gas, marine, automotive, biomedical and nuclear, due to advantages such as component design freedom, component complexity, light weighting, tool less nature, part consolidation, design for feature, and less material waste. However, if the processing is not optimized, the performance of AM components may be inferior to their cast or forged counterparts [33]. Moreover, many high-performance alloys are not amenable to most AM techniques because of the repeated rapid melting and solidification inherent to this manufacturing processes [34]. To overcome the performance limitations and to take advantage of the alloy design opportunities provided by AM technology, a new generation of alloys suitable for AM is needed. In addition to this, optimizing process parameters and microstructure evolution during AM can lead to improved mechanical and corrosion properties, among other benefits.

## CONCLUSIONS

The leading-edge research related to product designing, materials used, and manufacturing processes may advance the manufacturing industry. Based on the increment in product complexity, the reisademand to develop a new and innovative manufacturing technique. In this paper, a comprehensive literature review on various 3D printing techniques has been performed. The execution of all types of 3D printing techniques has been explained along with their benefits and limitations based on working principle and materials used.

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## ALTERNATIVE TRANSPORT

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***Abstract***

*The relevance of the use of hydrogen ($H_2$) in transport as an alternative energy source is due to the desire to reduce emissions of $CO_2$ and other harmful substances into the Earth's atmosphere. The use of HC2 as an energy carrier has many not only positive aspects, but also negative ones. Among the negative ones, the fire and explosion hazard of the $H_2$ mixture with air, called explosive gas, stands out. Some experiments show greater fire safety of hydrogen electric vehicles compared to gasoline cars. An important link in the provision of technology High-pressure hydrogen tanks are safe, given the ability of $H_2$ to penetrate metals. The technology of refueling the tank with hydrogen, as well as the standards of refueling pistols and car necks and other safety measures are essential. Safety improvement is promoted by research on hydrogen passenger transport, which is currently ongoing. The use of modern technologies can significantly reduce the fire and explosion hazard of using $H_2$ in transport.*

***Keywords:*** *fire hazard, explosion hazard, safety, hydrogen, fuel cells, electric vehicles*

## INTRODUCTION

Since the end of the XIX century, the content of carbon dioxide and other harmful substances (explosives) in the Earth's atmosphere has been continuously increasing, especially in megacities. A considerable part of this pollution is caused by car exhaust gases. Recently, there has been a tendency to switch to electric vehicles due to the appearance of lithium batteries.

But there is not enough lithium on Earth, so it is growing in price, and therefore the prices of lithium batteries and electric vehicles cannot decrease.

In addition, electric vehicles still have insufficient power reserve.

Therefore, scientists, developers and technologists are looking for alternative ways to store energy on vehicles. One of them is the use of hydrogen fuel cells (TE).

The use of hydrogen as a fuel in transport with TE is associated with a certain degree of danger. Let's consider its main properties.

Basic physical and chemical properties of hydrogen.

Hydrogen has a unique set of properties that determine its widespread use in various fields of industry, but also generate a number of technical problems [1]. $H_2$ is the most common element in the universe and one of the most common on Earth. The main sources of $H_2$ on Earth are water and organic compounds, including oil, natural gas and biomass [2].

The ability of hydrogen to enter at elevated temperatures

In catalytic hydrogenation reactions, it is widely used in the chemical, petrochemical and food industries, as well as in a number of other industries. The reducing properties of $H_2$ are used in chemical technology, powder metallurgy, metalworking, mechanical engineering, microelectronics [3].

Among the known gases, hydrogen has the lowest viscosity and the highest thermal conductivity [2]. Thanks to this, H2 is used to reduce friction and cooling in moving parts.

But the low viscosity of $H_2$ increases the likelihood of its leakage through the seals, which tightens the requirements for the quality of hydrogen gas equipment.

## EXPERIMENTAL METHODS

Hydrogen is classified as combustible gases with increased fire and explosion hazard. It has wide concentration limits of grange and detonation, high flame propagation velocity, and low ignition energy [2]. At the same time, the low density and high diffusion rate of H2 contribute to a rapid decrease in its concentration in open areas and in ventilated areas. In addition, H2 has a sufficiently high lower detonation limit, which significantly reduces its explosiveness in real conditions.

Disadvantages associated with the chemical activity of $H_2$:

- When mixed with oxygen, it forms an explosive mixture [4];
- when gorenje flame cannot be detected with the naked eye [4];
- with significant leaks, hydrogen destroys the ozone layer and
- disrupts photochemistry in the atmosphere [4];
- $H_2$ increases the fragility of metal parts [4].

The danger of using hydrogen is associated with three more factors:

- high volatility of $H_2$, due to which it penetrates through very
- small gaps [5];
- High penetrating power;
- Easy to ignite.

Researchers at the University of Miami (USA) conducted an experiment to test the consequences of depressurization of the fuel tank (or fuel supply system) and ignition of fuel on cars filled with gasoline and hydrogen. On a hydrogen car, there was practically no thermal effect on the structure and passengers (Fig. 1 a), and the gasoline car (Fig. 1b) was actually destroyed, as it turned out to be in the flame of fuel burning on the ground [6].


Figure 1. Experiment to check the consequences of depressurization of the fuel tank of hydrogen (a) and gasoline (b) cars

## RESULTS AND DISCUSSION

Potentially the weakest link of safety in passenger transport are high-pressure $H_2$ storage tanks (Fig. 2). To date, hydrogen technologies developed by Toyota are recognized as one of the safest in the world. Toyota has created a number of hydrogen cars. Carbon fiber hydrogen cylinders have been subjected to extensive crash tests more than once, including frontal, side and rear impacts [7].


Figure 2. High pressure tank

Toyota has made its tanks bulletproof. Their walls made of heavy-duty fiber withstand shots from large-caliber weapons [8]. The frame of the fuel cell block protects the fuel cells by absorbing impacts from road surface irregularities [7].

Features in the design of hydrogen fuel systems, which pay special attention to.

- The H2 supply unit is made according to the highest safety standards. In all critical places, safety parts and elements with appropriate operating permits are used.

- Fuel cell modules are located in a sector with a controlled ventilation system and an explosion-proof fan.

The presence of gas leaks is monitored by special sensors. Catalysts oxidize the escaping hydrogen in emergency situations. Other elements are located in the sector with air blowing.

- The cylinder nozzle has an internal pressure marking.

With the help of a lever, a tight and reliable connection of the cylinder line to the connection connector is made. There are also proposals to use detonation inhibitors of a mixture of hydrogen and air [9], as well as oxidation catalysts $H_2$ with air to prevent its accumulation in fire-hazardous concentrations [10, 11].

## CONCLUSIONS

The use of hydrogen fuel cells has both pros and cons. Among the disadvantages should be noted the fire and explosion hazard of hydrogen on board the vehicle. But the current level of development of science and technology can significantly reduce the likelihood of this danger while observing the appropriate safety measures.

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# IMPROVING THE MANAGEMENT OF RESOURCES AND PROCESSES OF THE ENGINEERING AND TECHNICAL SERVICE OF ROAD TRANSPORT ENTERPRISES IN MODERN CONDITIONS

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***Abstract***

*Road transport in the Republic of Kazakhstan, due to geographical conditions, plays a crucial role in the implementation of freight and passenger transportation. The role and importance of road transport in the country's transport system is constantly increasing. The development of markets for goods and services, small and medium-sized businesses objectively expands the scope of application of truck transport, which is due to its adaptability to market conditions.*

***Keywords:*** *transport, motor transport companies, technical operation of cars, maintenance, technical condition, engineering and technical service*

## INTRODUCTION

The pace of increasing the fleet of personal and commercial vehicles in cities and rural areas allows us to talk about mass motorization. The total number of cars of different types in the republic exceeded one million units.

The main problems of road transport development in the Republic of Kazakhstan can be divided into several types:

1. Systemic: the incompleteness of the processes of reform and state regulation, including establishing uniform "rules of the game" in the market of motor transport services, rules; the process of decentralization of motor transport management in conjunction with the changes in transport legislation and the taxation system led to the emergence of a spontaneous and poorly managed transport services market, which led to a deterioration in performance indicators and the quality of the work of vehicles; weakening of the role of the most important regulators in the implementation of state policy on motor transport (licensing, transport supervision and certification of services).

2. Organizational: insufficient development of transport and logistics centers, terminals, logistics services; insufficient interaction of motor transport with other modes of transport using new information and navigation technologies; weak information and methodological support and insufficient protection of the interests of small and medium-sized businesses in the motor transport complex; there is practically no institute of self-regulation of motor transport activities.

3. Financial: limited opportunities to use financial and credit mechanisms to replenish working capital and upgrade rolling stock due to its high cost and, as a rule, the lack of sufficient collateral for banks.

4. Technical: lack of modern vehicles that meet international environmental standards; inefficient system of technical operation of cars.

At the same time, the potential opportunities for the development of road transport are quite large. The geographical position of the Republic of Kazakhstan in the Central Asian region creates favorable prerequisites for the use of existing transport corridors as transit; their further development is seen precisely to maximize transit and provide high-quality services.

One of the ways to increase the commercial success of motor transport is to increase the technical capabilities of the car by reducing losses due to failures, i.e. sufficient operational reliability of cars provided by the engineering and technical service of motor transport enterprises.

In modern conditions, the level of material, technical and technological base of motor transport enterprises does not meet the required parameters. The development of the design of modern cars has led to the fact that ensuring their operability by their own owners is fraught with serious problems. There are shortcomings in the system of accounting and planning the operation of cars, as well as maintenance and repair negatively affects the performance of parks.In addition, the management of transport enterprises often downplay the importance of timely maintenance of cars. Therefore, in order to save money, they operate it without timely monitoring of the condition, often to the point of failure, so they began to save. In the existing enterprises of motor transport, the cause of car downtime is mainly malfunctions due to the deterioration of cars and the low level of organization of maintenance and repair.

With the transition to market conditions, the system of technical operation in the ATP was subjected to the negative impact of the transition period and significantly reduced its potential and resources. For example, the production areas of repair units have been reduced, the equipment fleet and the staff of qualified personnel have been reduced.The system of personnel training and spare parts supply has undergone significant changes.

## EXPERIMENTAL METHODS

The situation is getting worse due to the expansion of the nomenclature of the fleet of cars and the spread of age composition. It would be logical for cars of different groups to use and different strategies THEN and R. While state-owned cars must be serviced according to the regulations. Technical operation of cars should be carried out on the basis of factory instructions, regulatory documents, recommendations, norms, rules, etc. However, adjustment of modes of technical measures depending on the conditions of use of cars and age is not provided in them enough.

Let's consider the state of the maintenance and repair system on the example of a specific enterprise - a carpool of the Department of Health of Shymkent. The characteristics of the list fleet and technical condition are given in Table 1.

Table 1 - Quantitative characteristics of the park

| Name | 2016y. | % | 2017y. | % | 2018y. | % |
|---|---|---|---|---|---|---|
| Number of cars: | 139 | 100 | 145 | 100 | 139 | 100 |
| Including: passenger cars | 57 | | 57 | | 57 | |
| minibus | 71 | | 77 | | 71 | |
| cargo | 11 | | 11 | | 11 | |
| Receipt of transport: | | | | | | |
| new ones were purchased from them: | 8 | | 6 | | 0 | |
| Number of serviceable cars | 90 | 64,7 | 93 | 64,1 | 87 | 62,6 |
| Including a special san machine | 47 | | 47 | | 42 | |
| Of them serviceable | 36 | 76,2 | 36 | 76,6 | 29 | 69,1 |
| Number of autos that have passed the service life (according to the norms.I'll run) | 92 | 69,7 | 106 | 73,1 | 112 | 80,6 |
| Including SSM | 22 | 52,4 | 26 | 53,1 | 28 | 65,1 |

The analysis of the above material showed the presence of the following unfavorable factors: a steady decline in the supply of new cars, the aging of the fleet due to the development of the resource of cars, when the share of cars subject to write-off increased in three years from 69.7% to 80.6%. This has led to a relatively low technical readiness coefficient of about 74% on average.

Another negative factor is the shortage of qualified repair workers. The staffing of repair sites by specialists is on average 75%. At the same time, the average monthly salary for 3 years has increased, which is below the average monthly level in Shymkent also does not contribute to the consolidation of personnel. There is no motivation to study and improve their skills. According to the estimates of the engineering and technical personnel, the equipment for maintenance and repair is about 50%. In addition, it is physically and mentally worn out. The availability of production areas is above -70%. In the structure of the fleet, along with cars manufactured in the Russian Federation (GAZ, VAZ, UAZ), there are more modern cars (TOYOTA, MERSEDES, DEU) that require specialized maintenance and especially diagnostics. Therefore, some of the work is carried out by third-party organizations. The complex of these negative factors leads to an increase in the total costs of spare parts and materials for maintenance and repair of cars. Table 2 shows the dynamics of the growth of costs for vehicles of the motor depot of the Department of Health of the city of Shymkent.

The unfavorable situation with the engineering and technical service of the ATP continues to worsen - the growth of the car fleet in the republic continues without increasing the potential of ITS.Thus, there is a need to improve it.It should be noted that one of the reasons for the problems that arise is the lack of a scientifically sound methodology for creating an adaptive ITS that can be organized in an optimal way, both for an individual car and for a specific motor transport company, to respond adaptively depending on various operational factors.

Table 2 - Total costs of spare parts and materials

| Name | Amount by year, thousand tenge | | | |
|---|---|---|---|---|
| | 2016 | 2017 | 2018 | average annual |
| Spare parts costs by car | 3950,8 | 4424,2 | 4798,5 | 4391,2 |
| On average, 1 list a in that. | 28,4 | 30,5 | 34,5 | 31,1 |
| On average, 1 serviceable car. | 43,9 | 47,9 | 55,2 | 49,0 |

In the available theoretical developments, it is proposed to improve only individual processes of technical operation (TO), but no comprehensive solution is given. Thus, there is a need to use a logistics approach to solve the problems of improving the technical operation of cars.

Solving the problem of effective management of technical operation of cars in Kazakhstan based on the introduction of logistics principles will increase the country's GDP and investment attractiveness, create additional jobs, form a unified information space, reduce transportation costs, accelerate the delivery and turnover of material resources and goods, reduce the need for warehousing.

Automobile transport in Kazakhstan has historically occupied a leading place in the transport system. It accounts for more than 95% of all domestic, transit and international traffic. At the same time, the role and importance of road transport is constantly increasing. The development of markets for goods and services, small and medium-sized businesses objectively expand the scope of application of truck transport, which is due to its adaptability to market conditions. In addition, the pace of increasing the fleet of personal and commercial vehicles in cities and rural areas creates an additional burden on the ITS of existing road transport enterprises.

The modern fleet of domestic vehicles is distinguished by heterogeneity, heterogeneity and severe wear.The state of road transport is the result of recent reforms in the political, economic and social spheres. There is an incompleteness of economic processes in the creation of a new economic system: adjustments of economic law, changes in the structure of production, domestic and international economic relations. All this makes the working conditions of vehicles unstable.The technical policy in the field of car operation has not changed much, it has remained at the level of the 80s of the last century. Differences in a significant increase in resource mileage.The reason for this is the improvement of the design of cars and the quality of operational materials. Thus, the ratio of costs and labor intensity of production and operation of cars has changed: the cost of operating cars has increased more significantly.

Therefore, the need to improve ITS has matured. Among the main reasons for the problems that arise is the lack of a scientifically sound methodology for creating an adaptive ITS that could adapt both to an individual car and to a specific motor vehicle enterprise. At the same time, quickly adjust depending on internal and external conditions.

## RESULTS AND DISCUSSION

Road transport is the most flexible and mobile mode of transport. On the other hand, it is the most labor-intensive in Kazakhstan: more than 70% of the personnel employed in transport work on road transport. In addition, motor transport is the leader in the consumption of petroleum fuels.It is difficult to ensure a high level of reliability of the car during operation without a methodology for managing the maintenance and repair system. The market economy should develop with the harmonious development of various modes of transport, with the predominant role of road transport. In this paper, the problems of improving the technical operation of cars are proposed to be solved using modern research methods - system analysis, modeling of the processes of TE organization and management of the technical condition of cars, information technology.

Technical operation (as a process) is considered as the main period of the life cycle (LC) of the car, during which it implements its functions, bringing benefits. On the other hand, technical operation (as an element), considered as a subsystem of the ATP, significantly affects its effectiveness.In addition, the technical operation itself is considered as a complex system that depends on the structure and interaction of the elements that make up it.

Technical and commercial operation have a number of specific qualities:

- mutual complement in the performance of their functions;
- the specifics of technical operation, consisting in the need to create a special base, technology, methods of organization and management of production. At the same time, technical operation changes the functional qualities of cars, and commercial operation changes the quality and location of cargo or passengers;
- each subsystem has its own performance indicators;
- the contribution of technical operation to the efficiency of road transport is significant (in the increase in traffic volume up to 25-27%, in reducing the cost of transportation up to 22-26%, in increasing labor productivity up to 20-23%);
- relative structural and organizational independence of each of the subsystems;
- The desire of each of the subsystems for full economic independence, up to the separation and creation of separate structures. For example, in a number of Western countries there are rental companies that are engaged in storage, technical operation and provide cars for rent;
- adaptability to the type of transportation and type of rolling stock, as well as the general scientific theory and methodology of ensuring the functionality of rolling stock of road transport.

The efficiency of technical operation as a subsystem of road transport is set by a set of complex indicators.An increase in the efficiency indicators of technical operation leads to an improvement in the efficiency indicators of road transport as a whole. This shows the consistency of these processes.

## CONCLUSION

1. With the transition to a market economy, the system of technical operation in the motor transport company has significantly lost resources and reduced its potential. The material, technical and technological bases of the motor transport company are not adequate to the fleet of cars, the system of accounting and planning of maintenance and repair is imperfect. The areas of repair shops have been reduced, the equipment fleet has aged, there is a shortage of qualified personnel. The systems of training repairmen and centralized supply of spare parts and materials were disrupted.

2. The efficiency of an automobile transport enterprise is determined by the interaction of three main subsystems: the automobile fleet, technical and commercial operation. At the same time, each of the subsystems has its own goals, indicators and performance results.

3. The purpose of functioning technical operation of cars is to provide the required level of performance of the vehicle fleet, which is characterized by a system of coefficients.

4. To characterize the efficiency of subsystems of technical operation, private indicators are used: the coefficient of technical readiness, the time to failure, the time to work for one case of downtime during working hours, the duration of downtime, etc.

5. Existing theoretical studies offer methods of improvement for individual processes of technical operation, but do not suggest a comprehensive solution. Thus, there is a need to use a logistics approach to solve the problems of improving the technical operation of cars.

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## FEATURES OF THE APPLICATION OF SURFACE HARDENING METHODS FOR MACHINE PARTS

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***Abstract***

*Modern methods of increasing the strength and durability of machine parts can be divided into two large groups. These are methods aimed at strengthening parts throughout the body and methods for hardening the surfaces of parts intended to work in friction pairs and other compounds. A comparative analysis of methods for surface hardening of parts showed that the choice of hardening method is justified taking into account several circumstances. Basically, these are the specifics of the geometry of the parts, operating conditions, as well as the ability of the enterprise to purchase this or that equipment to organize the required technological process. The article as a whole is devoted to the substantiation of the low-temperature process of surface hardening of parts intended to operate under conditions of friction, corrosion and variable loads leading to fatigue damage. The features of liquid carbonitriding of small parts are considered. The results of studies of the influence of carbonitriding time and temperature on the depth of the hardened layer, its structure and operational characteristics: hardness, wear resistance, fatigue strength are presented.*

***Keywords:*** *hardening, , surface, hardness, wear resistance, durability, carbonitriding.*

## INTRODUCTION

Currently, mechanical engineering uses various methods to increase the strength and durability of machines under various operating conditions. It is known that the operational characteristics of parts are determined by the design features of the unit or part, the tribology characteristics of the material, surface roughness, surface properties, the presence of residual stresses, etc. All these measures are aimed at ensuring the safe operation of products when wearing parts of friction pairs within the limits of limited wear of surfaces under influenced by operating conditions and loads. A review of the current state of the influence of tribology problems on the reliability and durability of rubbing parts showed that an important aspect is the study of the influence of surface conditions on the reliability of wear parts of machines. One of the areas of such research is the study of the peculiarities of using methods for hardening the surface of various parts, of which there is a very large variety in mechanical engineering, both in design and purpose.

Historically, the period of using chemical-thermal treatment of parts made of steel and cast iron to saturate the surface with carbon and nitrogen goes back more than a hundred years. However, the problem of creating parts with ideal performance properties has not yet been completely solved to this day. The process of saturating the surface layer of parts with carbon and nitrogen in various environments is usually called nitrocarburising or carbonitriding. This method in many cases can be more effective than surface hardening, carburizing or chrome plating of parts subject to corrosion and mechanical wear under various loads.

The main purpose of carbonitriding is to increase the hardness and wear resistance of the surface layer of steel and cast iron products. The hardening technology involves preparing products by heating cyanide or cyanate salts in a melt at a temperature of 550-750 0C, holding for a certain time, usually 4 - 6 hours, and further cooling. During processing, the surface of steel or cast iron products is saturated with nitrogen and carbon. When alloying austenite with nitrogen, the temperature of the $\alpha \leftrightarrow \gamma$ transformation decreases, which allows the saturation process to be carried out at lower temperatures. At the same time, in the presence of nitrogen, the diffusion mobility of carbon in austenite increases sharply. The growth rate of nitrocarburising and cemented layers is almost the same, although the nitrocarburising temperature is much lower. Lowering the saturation temperature without increasing the duration of the process makes it possible to reduce the deformation of the processed parts and reduce the heating of the furnace equipment.

Sometimes air blowing is used to intensify the liquid nitrocarburising process. The duration of exposure at the heating temperature in the melt ranges from several minutes to several hours, depending on the required depth of saturation of the surface with nitrogen and carbon. As a result, at a melt temperature of 530 - 570 ° C, and a holding time of 5-30 minutes, the wear resistance and durability of steel increases by 1.5 - 4 times.

Another particularly important area of research is the development of a methodology for justifying the use of one or another method of surface hardening and modeling the processes of structural transformations in the surface layer of hardened parts, as well as methods for predicting the durability of their work [1].

## MATERIALS AND METHODS

Research to improve the durability of various parts, including gears, tools, shafts, valves, drill pipes and their tool joints, was carried out to develop methods for predicting the durability of structural materials and mechanical engineering products operating under conditions of static and repeatedly variable loads, using theoretical and experimental research and non-destructive testing methods.

The use of structural research methods makes it possible to evaluate the properties of the surface layer after chemical-thermal treatment, its macro- and microstructure. It is known that the amount of wear that causes failure or replacement of parts reaches 1 mm, but the main cause of failure is wear of 0.15...0.30 mm. Therefore, the main goal of technological hardening methods is to increase the hardness and roughness of the surface layer.

During surface hardening, changes occur in the structure, leading to an increase in hardness, strength, wear resistance and the appearance of residual stresses. Methods and forms of research include scientific, theoretical and experimental substantiation of the developed forecasting methods and destruction models. Experimental research methods comply with current standards for destructive methods of mechanical testing of steels and alloys, as well as non-destructive testing methods, in accordance with the standards. Physics and chemical aspects of the processes of initiation and development of corrosion-mechanical damage are studied to identify the influence of the structure and microstructure of materials on their strength characteristics and deformability. To determine the ultimate effort, i.e. bearing capacity of structural elements, the characteristics of the resistance of materials to plastic deformation (yield or creep limits) and destruction (strength limits), critical deformations or crack depths, the number of cycles or the time required for crack formation are used [2-4].

The studies were carried out on the basis of testing samples using standard methods. The samples were tested by the Rockwell hardness method. Impact strength was determined using a pendulum impact tester. The chemical composition, mechanical properties, and residual stresses were measured. Measurements of hardness, micro hardness and thickness of the hardened surface layer of the material were carried out using a hardness tester model HBRVU - 187.5, according to the Brinell, Rockwell and Vickers scale.

The hardness tester circuit diagram uses multi-stage test load and various types of indenters to measure and determine the hardness of the metal material of the test piece. It is also suitable for determining the hardness of carbide, carburized and chemically treated layers. The model HBRV - 187.5 (HBRVU - 187.5) of the device uses a rotational type of mechanism for changing the load, as well as an optical system for indicating measurements and installing a measuring microscope, which is mounted on the body of the device [2].

In the process of studying mechanical properties, hardness measurement is the easiest, most economical and fastest way; it is also used to determine the quality of a product during the production process. Since the hardness of metals is related to other mechanical properties, therefore, on the basis of hardness, such properties of metallic materials as strength, fatigue, toughness, wear and internal damage can be approximately determined. Following the constant development of scientific technology, various requirements are placed on hardness testers.

They usually relate to the accuracy of measurements, as well as the possibility of conducting various types of tests on the hardness of various materials.

## EXPERIMENTAL AND THEORETICAL PART

Under various operating conditions of machine parts, wear resistance is achieved by methods of nitriding, surface saturation with carbon, or their combined saturation, called nitrocarburization. The advantage of surface hardening is the possibility of obtaining products with high hardness and wear resistance of the surface layer with a corresponding hardness of the core of the part, determined by the operating conditions of the product as a whole. It is known that the depth of the worn layer in rubbing pairs of products is 0.2-0.3 mm, sometimes up to 1 mm. Therefore, hardening to a sufficient depth makes it possible to reduce the time and energy costs of surface hardening compared to bulk hardness [3].

Chemical-thermal treatment is a treatment consisting of a combination of thermal and chemical effects in order to change the composition, structure and properties of the surface layer of a part in the required direction. The wear resistance and hardness of a part depends to a large extent on the chemical composition of the surface layer, structure, and its corresponding mechanical properties. By influencing the surface layer, it is possible to change the properties of the part as a whole, while simultaneously meeting the requirements for strength and durability along the main section of the part, with an increase in hardness, wear resistance and contact strength of the surface. Increased strength, hardness and wear resistance are achieved by hardening parts using one of these surface layer hardening methods.

As was discussed earlier [1, 2], during high-temperature nitriding, the metal is saturated to a greater extent with carbon than with nitrogen, and during low-temperature cyanidation, it is saturated to a greater extent with nitrogen than carbon. Low-temperature nitriding is used for high-speed steels in order to increase the wear resistance of the tool and is carried out after a full cycle of heat treatment of the tool at 500-600°, this ensures very high hardness and wear resistance [1]. Hardening of parts of threaded connections of drill pipes is increasingly used in molten cyanide salts at temperatures of 500-680 $^0$C, and is called carbonitriding.

The advantage of liquid carbonitriding, as a type of chemical-thermal treatment, which is the diffusion saturation of the surface of steel and cast iron parts with nitrogen and carbon in molten salts, is the formation of carbonitrides and nitrides of iron and alloying elements. The thickness of the strengthened layer is from 0.2-0.3 mm to 1 mm. The duration of the process can vary from 5 - 90 minutes to several hours. Carbonitriding provides: 2-5 times increase in surface hardness; 2-10 times increase in wear resistance; 30-80% increase in fatigue strength; 50-200 times increase in corrosion resistance; reduction of friction coefficient by 1.5-2 times; elimination of scuffing and tongs in friction pairs [2,3]. At the same time, the cost of liquid carbonitriding accounts for 10-20% of the total cost of manufacturing parts. The hardened layer is relative to the bindings, which excludes its spalling and peeling during work.

Increased wear resistance by nitriding of parts with high wear resistance and heat resistance up to 500 ° C [7]. The carbon-rich surface layer is good at tempering and tempering, whereby the surface hardness of the cemented part increases dramatically. Wear resistance and fatigue strength are increased. Working elements of machines, which experience increased soil pressure, can be protected against action of abrasive particles by application of wear-resistant alloys on friction surface.

Figure 1 shows the dependence of abrasive wear of metals on their hardness. With an increase in the hardness of the material of the parts, their linear wear decreases. With a hardness of 225... 450 kg/mm2, a slight decrease in the value of linear wear occurs [8].

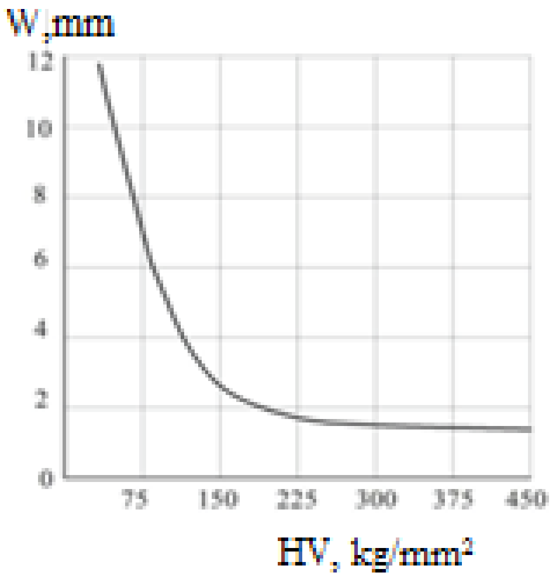



Fig.1. Effect of hardness on abrasive wear intensity [8]

The advantage of carbonitriding is the possibility of strengthening after finishing operations (grinding, polishing, honing, etc.), since after processing the initial surface cleanliness and dimensional accuracy of the parts are preserved. The reinforced parts are delivered to the assembly without additional rework [3]. Carbonitriding compared to cementation and nitriding has significant advantages in terms of saturation intensity, operational characteristics of the strengthened layer, stability of the geometry of the parts [1].

By varying the time and temperature of the carbonitriding process, surface strengthening to a given depth can be obtained while adjusting the structure and composition of the surface layer [1], as shown in Figure 2.

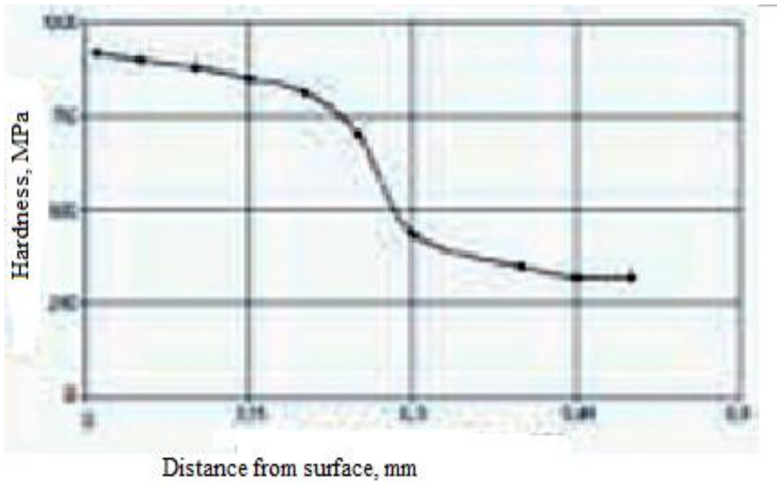



Fig.2. Change in hardness of the deposited layer of steel 25Kh1MF in depth after carbonitriding at 570$^0$C for 3 hours

According to [2], in order to increase the wear resistance of steels, it is necessary to determine the optimal carbonitriding temperature, which has a determining effect on the wear resistance and fatigue properties of the products. Moreover, an increase in the carbonitriding temperature from 550- 6500S to 7500S does not lead to an increase in wear resistance, but rather vice versa [1], as shown in Figure 3.

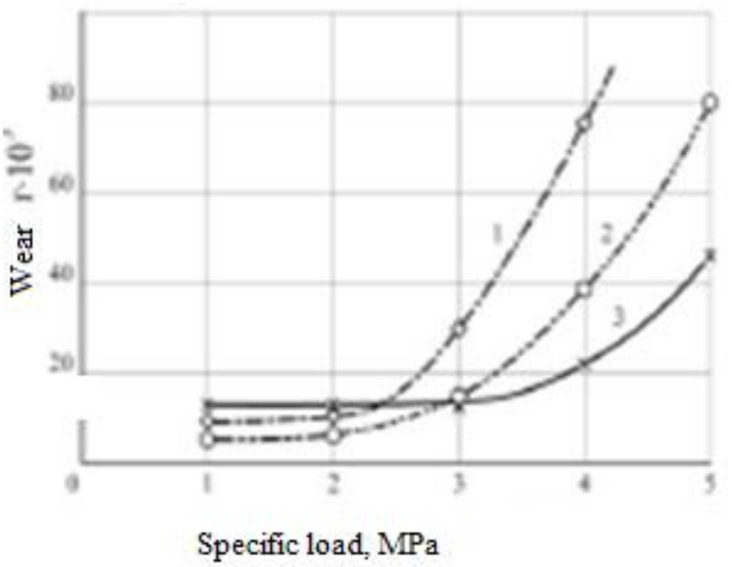



Fig.3. Effect of carbonitriding temperature on steel wear resistance (1 - 550$^0$C; 2- 650$^0$C; 3 - 750$^0$C)

The main drawback of cementation is the considerable time consumption, cumbersome equipment, as well as the low productivity of the process [2]. Therefore, cyanidation is used to increase wear resistance and corrosion resistance of high-load parts. The cyanidation process, compared to the cementation process, requires much less time to obtain a layer of a given thickness, is characterized by significantly less deformation and warping of parts of a complex shape. Low-temperature cyanidation is used to increase wear resistance, is carried out after a full cycle of heat treatment of parts at 500-600 °, which ensures high hardness and wear resistance.

Relative wear resistance during nitriding varies along the curve with maximum, which corresponds to 620 ° and 660 ° and is equal to 2.5 and 3.0 for alloys Fe + 1% Cr and Fe + 4% Cr, in accordance with Figure 4 [1].

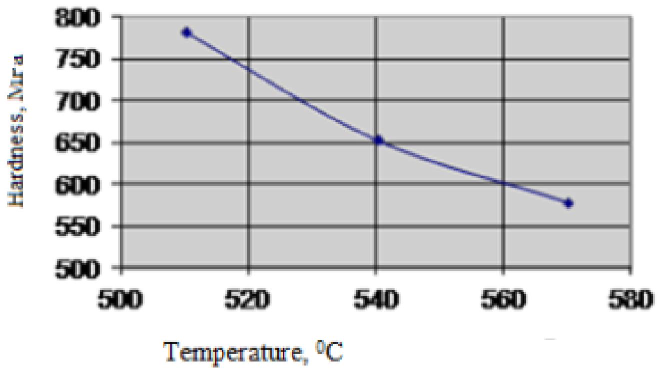
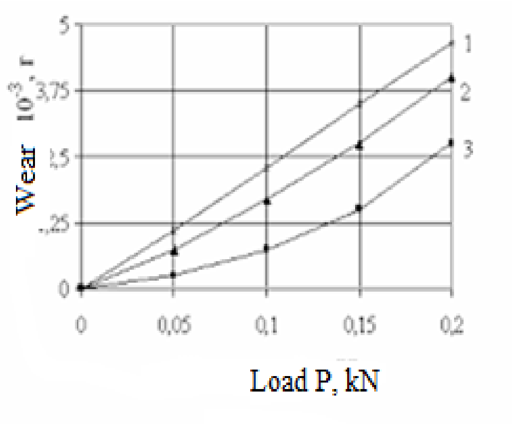



Fig.4. Influence of temperature on hardness of treated surface (40X steel) [1]

At the same time, carbonitriding of steel 45, as shown in Figure 5, reduces wear by 1.2-1.3 times. Replacing 45 steel with 38Kh2MYuA steel reduces wear by 1.5-2 times. [3]




1 - steel 45 after improvement; 2 - steel 45 after carbonitriding; 3 – 38Х2МЮА steel after improvement

Fig.5. Effect of applied load on wear intensity [2]

This reduction can be explained in terms of the formation of the hardened layer and the distribution of the near-surface layer structure, as shown in Figure 6.

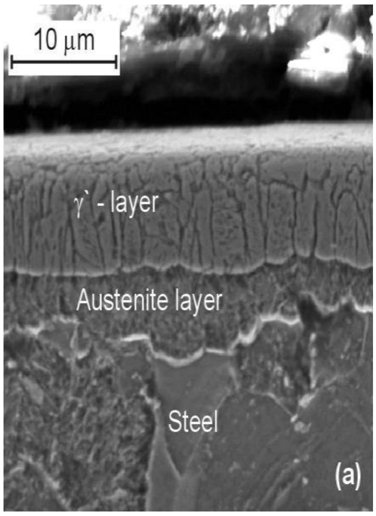



Fig.6. Surface layer structure [8]

After carbonitriding of carbon and low-alloy pearlite steels, a reinforced layer consisting of two zones is formed on the surface of the parts (Fig. 7). The upper zone up to 15 µm thick according to X-ray diffraction analysis is Fe type carbonitride (N, C) or Fe type 3 oxycarbonitride (N, C, O) depending on the steel composition. Under the carbonitride layer is a diffusion zone (heterophasic layer) consisting of a solid solution of carbon and nitrogen in iron with inclusions of carbonitride phases, the hardness of which is significantly higher than the hardness of the core and smoothly decreases from surface to base. As the alloying of structural steels increases, the surface hardness increases significantly, the thickness of the strengthened layer decreases.

When austenite is doped with nitrogen, the α↔γ - conversion temperature decreases, which allows the saturation process to be carried out at lower temperatures. At the same time, in the presence of nitrogen, the diffusion mobility of carbon in austenite increases sharply. The growth rate of the nitrocarburising and cemented layers is substantially the same, although the nitrocarburising temperature is almost 100 C lower. Lowering the saturation temperature without increasing the duration of the process allows reducing the deformation of the processed parts, reducing the heating of the furnace equipment.

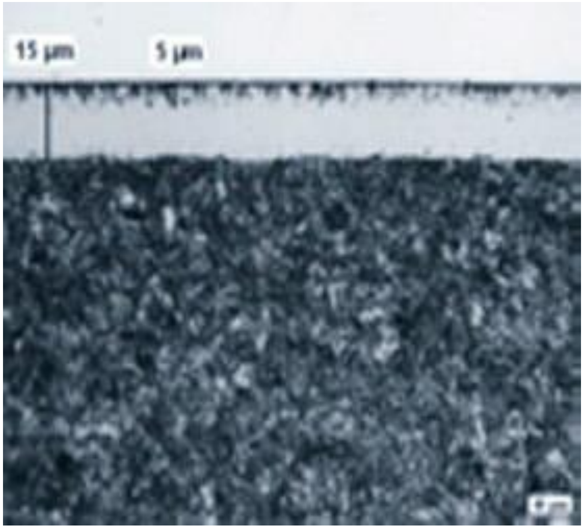
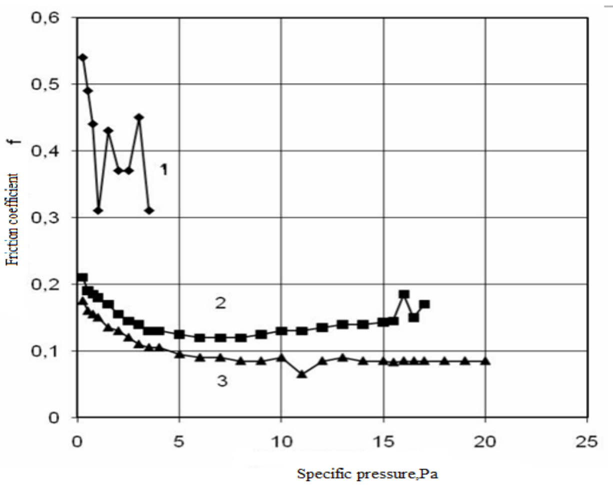



Fig.7. Structure and depth of the hardened layer [4]

An important advantage of carbonitriding is the preservation of the initial roughness and dimensional accuracy of the parts after processing, which allows this method to be used after finishing machining operations (polishing, grinding, honing, etc.). Almost all grades of steel and cast iron can undergo carbonitridings, and the greatest effect is manifested in the case of increasing corrosion resistance and facilitating assembly and disassembly after prolonged operation of threaded joints and other parts of machines that work for a long time in corrosive environments. This technology has significant advantages over traditional cementation and nitriding processes in terms of saturation intensity, performance characteristics of the strengthened layer, stability of the geometry of the parts [6]. When carbonitriding is used for stainless steels, the saturation rate of the surface layer with nitrogen and carbon is higher than in gas media, resulting in a high hardness carbide layer with high tribology properties. The coefficient of friction in the pairs of contacting parts is significantly reduced. Comparative data on wear resistance and friction coefficient for 08Kh18N10T steel are presented in Figure 8.




1 - quenching 1150 ° C, 2 - nitriding 620 ° C, 35 h, 3 - carbonitriding 570 ° C, 12 h
Fig.8. Effect of specific pressure on the coefficient of friction of steel 12X18N10T at contact friction [4]

Thus, the advantages of carbonitriding make it possible to recommend it to increase wear resistance and increase the durability of machine parts operating under friction and wear conditions (gears, shafts, bushings, sleeves, cams, threaded connections, etc.); increasing resistance of die and cutting tools; increasing corrosion resistance and facilitating assembly and disassembly after long-term operation of metal ware (bolts, nuts) and other parts of machines operating for a long time in corrosive environments.

## RESULTS AND DISCUSSION

The problem of ensuring the guaranteed service life of the equipment is solved at the design stage, when making design and technological decisions, as well as during operation in the form of a comprehensive system for monitoring the technical condition and diagnosing equipment, in particular models of functioning and reliability of monitoring objects, subsystem for collecting initial data and evaluating diagnostic signs [5-10]. Let us present some results of the development of criteria for assessing the effectiveness of the use of carbonitriding, considerations for models for predicting the durability of hardened parts. Studies of hardness distribution along the hardened layer depth showed a significant decrease in microhardness, and at a depth of about 0.5-0.6 mm, microhardness almost halves [9, 10]. For tested materials (steels 40 and 40X) of threaded joints of drill pipes, brittle failure of locking joints is an urgent problem [2]. Corrosion wear, abrasive wear, fatigue - all these phenomena are realized during the operation of these compounds.

Based on the results of the above data and graphs (figures 1-8), the depth of the surface layer due to diffusion can be represented by a temperature-time relationship, such as:

$$\delta = K\sqrt{t}\ , \tag{1}$$

where δ - is the depth of the strengthened layer, K - is the coefficient taking into account the features of steels and the carbonitriding process, t - is the time.

According to (1), the required depth of the hardened layer can be obtained by setting the carbonitriding time.

However, we see a more interesting method for predicting durability, based on a phenomenological approach to the process of strengthening the surface.

Process modeling will be carried out taking into account the influence of optimal processing modes on hardening processes, presenting the generalized parameter K as a function of several parameters:

$$K=f(HB.,\ R_a.,\ h.,\ E.,\ \sigma_В\ \sigma_к,\ \delta\ ,\ KCV)\ , \tag{2}$$

where HB is Brinell hardness, $R_a$- surface roughness, μm; h - hardened layer depth, E - normal elastic modulus, MPa;, $\sigma_В$ - ultimate strength, $\sigma_к$ - limit of contact endurance, δ - deformation hardening, KCV - impact strength.

Endurance limit of part with hardened surface layer with hardness HB can be predicted from the design yield strength. In turn, the yield strength can be calculated from the results of the hardness determination, in the form of a linear dependence, as shown in [2]:

$$\sigma_{0,2} = 3{,}1647 \cdot HB - 157{,}08\ \ (MPa) \tag{3}$$

Thus, a hardness parameter is used to predict wear resistance, in the absence of experimental data on wear resistance.

To take into account the increase in hardness and the simultaneous decrease in the plasticity of the surface layer of the part, consider the coefficient of assessment of the hardening of the surface layer due to the increase in hardness:

$$К_1=\frac{HV_{обр}}{HV_{исх}}, \tag{4}$$

and reducing the impact strength of the article in the total volume:

$$К_2=\frac{KCV_{исх}}{KCV_{обр}}\ . \tag{5}$$

When determining the $К_2$ it should be taken into account that the $KCV_{обр}$ should be determined on samples, the V-shaped notch in which should be mowed after all heat treatment modes in order to avoid the influence of structural changes in the mechanical notch area.

A generalized parameter that takes into account the change in the deformation capacity of the product during carbonitriding and an increase in the hardness of the surface layer is presented in the form of a product

$$P=К_1{}^m\ К_2{}^n\ =\ \left(\frac{HV_{обр}}{HV_{исх}}\right)^m\ \ \left(\frac{KCV_{исх}}{KCV_{обр}}\right)^n. \tag{6}$$

The proposed parameter structure assumes that $К_1$ and $К_2$ practically will always be greater than or equal to one, as a result of which the parameter p ≥1 based on the interpretation of the physical sense by definition.

At the second stage, the prediction consists in calculating the durability of the joint parts based on the assessment of the process of origin and development of static and fatigue cracks.

The relationship between wear resistance and mechanical properties of the surface layer is almost most often established experimentally. As a generalized parameter, a coefficient p is proposed, to determine which it is necessary to consider the joint effect of the above (equation 2) parameters.

The generalized criterion for evaluating the carbonitriding efficiency can be represented as a function of the hardness and strength of the individual core of the part and the surface hardened layer. The following approach can be used as a parameter that takes into account the influence of the carbonitriding process mode. Since the high hardness elastic layer is more brittle, it is more likely that cracks will occur with a length $l_{кр}$ equal to the depth of the hardened layer. For example, we consider parts in the form of a thick-walled pipe with an external thread on one side and an internal thread on the second. The critical length of a crack with a length of $l_{кр}$ is presented as follows:

$$K_{1C} = \sigma_{0,2}\sqrt{\pi}l_{kp} \quad (7)$$

In turn, a number of approaches are known to express the critical stress intensity coefficient through toughness and yield strength. In general, this dependence has the form [2]:

$$\left(\frac{K_{1C}}{\sigma_{0,2}}\right)^2 = A\left(\frac{KCV}{\sigma_{0,2}} - B\right) \quad , \quad (8)$$

where $K_{1C}$ is the critical stress intensity factor, $\sigma_{0,2}$- the yield strength in our case of the core of the material of the part, $KCV$ is the impact strength, A and B are the empirical coefficients.

We determine from this expression $K_{1C}$ and replacing the yield strength with an expression similar to equation (7) in the general form expressing the relationship of the yield strength with hardness, after the transformations we obtain the equation;

$${K_{1C}}^2 = \alpha\,(KCV) - \beta\,(HRC)^2 + C\,, \quad (9)$$

where the α, β, and C coefficients are empirical coefficients determined during sample testing before and after carbonitriding.

These coefficients reflect the relationship of the deformable volume at the top of the crack with the hardness, ductility and toughness of the material under study.

The obtained equation and its structure suggest the following explanation for the change in crack resistance of parts after carbonitriding in order to increase wear resistance and hardness of the surface layer. As can be seen from the structure of equation (5), the stress intensity factor correlates with the impact strength and the change in yield strength with the hardness of the material. In equation (6), said coefficients reflect the relationship of the deformable volume at the top of the crack with the hardness, ductility and toughness of the material under study.

## CONCLUSION

The studies made it possible to develop a method for calculating parameters for evaluating the effectiveness of surface strengthening. Generalized criterion for prediction of wear resistance of parts after carbonitriding is used as design parameters. Studies were carried out on parts made of 40Kh and 40KhM steels reinforced by carbonitriding. Carbonitriding has been found to increase wear resistance and fatigue strength. Equations have been developed to determine the surface depth of the reinforced steel layer 40 and 40Kh from the temperature and time of exposure during carbonitriding. Hardness of hardened layer of steel 40 and 40Cr was determined and method of hardness and microstructure determination was evaluated. Studies have made it possible to establish optimal conditions of surface hardening. Carbonitriding to obtain high wear resistance and fatigue resistance of the considered steel parts such as shaft and bushing. Equations have been developed to determine the wear resistance and durability of reinforced parts based on a generalized criterion that takes into account the hardness and toughness of the base material and surface layer. The most effective method of increasing the durability of mating parts is surface strengthening during carbonitriding. For comparative evaluation of process parameters of carbonitriding it is proposed to use generalized parameter taking into account increase of surface layer hardness and decrease of impact strength in total volume of parts.

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# THE FIRST BASIC SCHEDULE FINDING METHOD OF TRANSPORT PROBLEMS

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***Abstract***
*The transport task is a special form of searching for an optimal cargo transportation plan with minimal costs. With the help of a transport task, you can find the optimal cargo transportation plan, while spending the minimum amount of costs.*

## INTRODUCTION

To solve the transport problem, we must first find the first solution, which is called the support solution. The first of the transport problems is often found by the methods of the northwest corner, or the minimum tariff (the smallest element), etc. In this report, we will show you how to find the first support solution using the minimum tariff method. According to this method, we start the delivery (distribution) of goods to the reception point from the grid with the lowest tariff. Then we fill in the remaining cargo in accordance with the increase in the tariff for unfilled grids. Here we send from the point of departure to the point of receipt, depending on the amount of cargo he receives.

We continue this process until all cargo remains at the points of departure, and the points of receipt receive the necessary cargo. If the number of non-empty grids in the cargo distribution is less than ( n+m - 1), then we fill these grids with a fixed 0. Such grids are called conditionally empty grids.

Let's explain how to find the first reference plan for transport accounting by solving the following example.

## EXPERIMENTAL METHODS

Warehouses A1, A2, A3 have loads of 90, 400, 110 tons uniformly. These cargo should be delivered to stations B1, B2, B3 in accordance with their needs of 140, 300, 160 T. If the unit cost required to deliver the cargo (as a conventional unit) is in the form of the following cost matrix:

$$\mathbf{D} = \begin{pmatrix} \mathbf{2} & \mathbf{5} & \mathbf{2} \\ \mathbf{4} & \mathbf{1} & \mathbf{5} \\ \mathbf{3} & \mathbf{6} & \mathbf{8} \end{pmatrix}$$

If this data is provided, they must be organized for transportation in such a way that the minimum cost of delivery is incurred. That is, it is necessary to build a mathematical model of the problem and find the smallest value of the target pound that satisfies the specified conditions (at the price of the transfer).

Solution: we determine whether the first issued Transport report is an open or closed report:

$\Sigma a_i = a_1+a_2+a_3 = 90+400+110=600$ tons

$\Sigma b_j = b_1+b_2+b_3 = 140+300+160=600$ tons

Therefore, since $\Sigma ai = \Sigma bj$, a given transport account is a closed account.

We find the first support solution by the least rate (smallest element) method.

For convenience, we write down the given in the form of the following table-1. We call it a transportation table.

Table 1. Transportation table.

| Bj<br>$A_i$ | $B_1$ | $B_2$ | $B_3$ | Reserve |
|---|---|---|---|---|
| $A_1$ | 2 | 5 | 2 | **90** |
| $A_2$ | 4 | 1 | 5 | **400** |
| $A_3$ | 3 | 6 | 8 | **110** |
| **Need** | **140** | **300** | **160** | $\Sigma a_i = \Sigma b_j$ |

We fill in the empty grids of this table according to the minimum tariff (minimum element) method. According to the principle of this method, the first filling grid is A2B2, because sending goods from this station A2 to point B2 is the cheapest 1 sq. Therefore, we write 300 in this grid. Formulating in the same way, we fill in other grids. As a result, we get the following transport table (Table-2):

**Table 2**. The following transportation table.

| 6 Bj $A_i$ | $B_1$ | $B_2$ | $B_3$ | Қор |
|---|---|---|---|---|
| $A_1$ | 2 **90** | 5 | 2 | **90** |
| $A_2$ | 4 | 1 **300** | 5 **100** | **400** |
| $A_3$ | 3 **50** | 6 | 8 **60** | **110** |
| Need | **140** | **300** | **160** | $\Sigma a_i = \Sigma b_j$ |

## RESULTS AND DISCUSSION

Number of filled (non-empty) cells in the last table m+n-1= 3+3-1=5, hence the non-arising condition is met. We write the first support solution found as the matrix below:

$$\mathbf{X_1} = \begin{pmatrix} 90 & 0 & 0 \\ 0 & 300 & 100 \\ 50 & 0 & 60 \end{pmatrix}$$

Transportation costs for this first rack solution:

$F(X1) = 90\cdot2+300\cdot1+100\cdot5+50\cdot3+60\cdot8 = 1610$ (conditional unit).

## CONCLUSION

So we found one supporting solution to the transport problem using the minimum tariff method. Is the solution found the most effective solution? Or is it not effective? To answer these questions, we can use the method of potentials. If we produce a given report using it, so to speak, "manually", then it takes a lot of money and time to produce a large number of reports. Therefore, it is necessary to use methods that quickly solve such problems. One such approach [1] is given in this specified article.

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UDC 785.6

# INSTALLATION WITH MOTOR-DRIVEN COMPRESSOR HEAT PUMP FOR DRYING AND COOLING OF THE MATERIAL

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***Abstract***

*This article describes drying processes in an installation with a motor-driven heat pump compressor, occurring with the participation of capillary-porous materials (nicotinic acid, naphthalene, etc.), which play an important role in chemical technology, since they are a necessary part of many industries and significantly affect the quality of products.*

***Keywords:*** *drying processes, fluidized bed, chemical technology, heat exchanger, heat pump, material humidity.*

## INTRODUCTION

In the technology of processing capillary-porous materials, one of the important tasks is drying and cooling the material to a humidity determined by the drying regulations and to a temperature that ensures its long-term storage. As studies conducted by the authors of a number of papers [1-2] have shown, when the temperature drops to 8-100C, the intensity of physiological and biochemical processes occurring inside the material decreases, and consequently, the duration of storage of the cooled material increases.

The main energy costs in this case fall on heating the drying agent and cooling the cooling air. It is possible to increase the energy efficiency of drying units, in particular, when using heat pumps (TN) as heat and cold generators. Heat pumps also make it possible to utilize secondary energy resources of chemical enterprises, to create rational schemes for the integrated use of heat and cold obtained in drying units.

The introduction to the motor compressor circuit allows you to additionally include heat exchangers for heating drying agents. [5-6]

The introduction to the motor compressor circuit allows the use of a heat pump drying unit in areas where there is an insufficient limit of electricity required to drive a heat pump compressor from an electric motor.

## MATERIALS AND METHOD

Experimental studies have been carried out to identify the main regularities of the drying and cooling processes of capillary-porous materials in TNCS with a dryer and cooler in dense and PS. The dried material used nicotinic acids, naphthalene, etc. Based on the known literature data, the operating parameters of the drying and cooling process were selected to preserve the quality and integrity of the material [1-4].

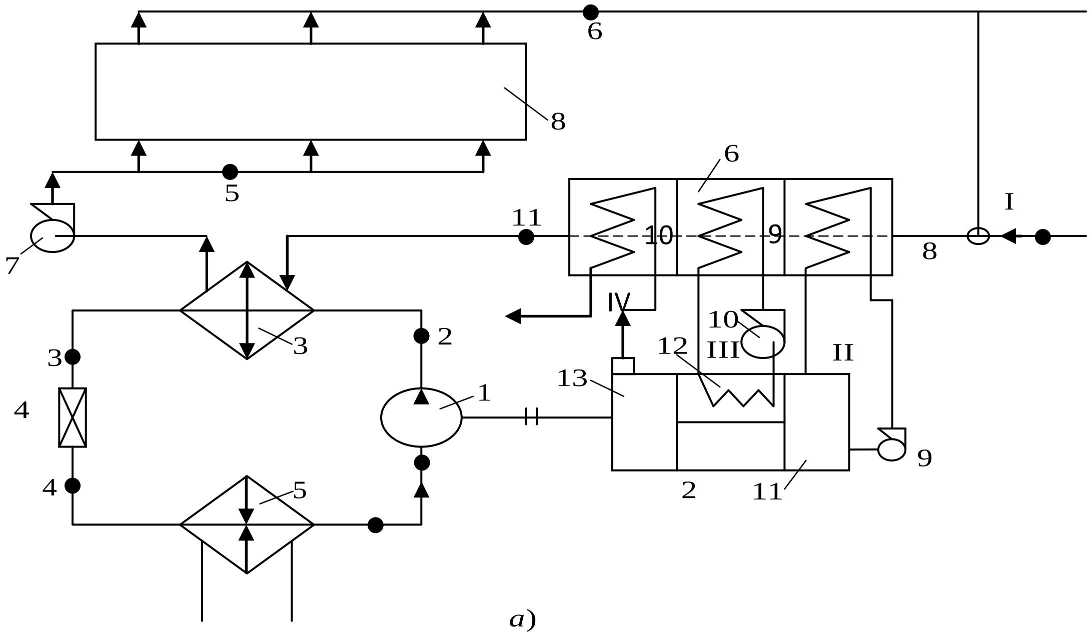
Figure 1a shows a diagram of a motor-driven heat pump drying unit, which consists of the following main elements: a compressor refrigeration machine, including a compressor 1, an internal combustion engine 2 (or diesel), a condenser 3, a control valve 4, an evaporator 5; the drying agent preparation circuit with its partial circulation, in which the following are sequentially installed: a mixing unit 1 of the recirculated flow of the drying agent with atmospheric air, a three–section heat exchanger 6 for preheating the drying agent due to the recovery of heat removed by lubricating oil from the internal combustion engine, a condenser of a refrigerating machine - a heater of the drying agent 3, a fan 7, a drying camera 8; two closed II, III and one open IV heat recovery circuits, closed circuit III is included in the engine cooling system and contains a heat exchanger 6 and a water pump 10, and open circuit IV is included in the exhaust gas line of the internal combustion engine and contains a heat exchange surface and an exhaust pipe.

The air heated by condensation of the working substance from the apparatus 3 by the fan 7 is sent to the dryer 8, where it is humidified. The spent drying agent is removed from the apparatus 8, partially discharged into the atmosphere. The remaining part of the drying agent is mixed with atmospheric air, due to which it is dried and sent for preheating to a three-section heat exchanger 6.

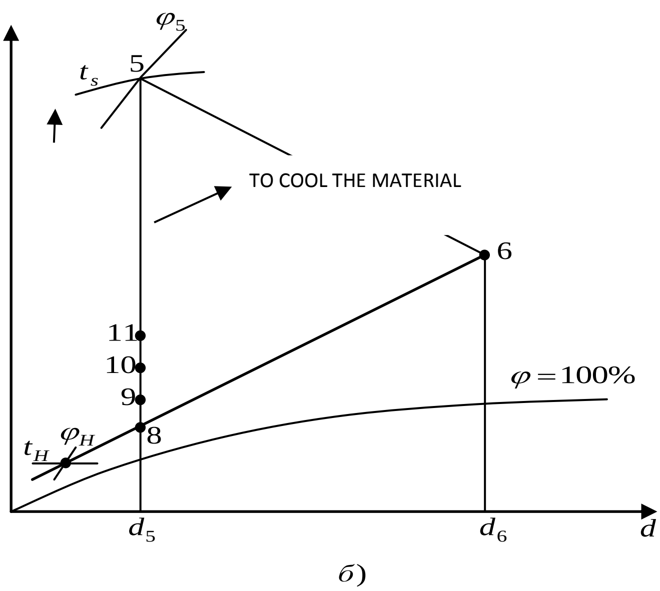
Heating of the drying agent in the heat exchanger 6 is carried out by recuperating the heat removed when cooling the lubricating oil of the internal combustion engine (right section of the apparatus 6), by recuperating the heat removed when cooling the engine with water (middle section of the apparatus 6), as well as by recuperating the heat of the exhaust gases of fuel combustion (left section of the apparatus 6). Lubricating oil from the lubrication system II is directed by an oil pump 9 to the right section of the three-section heat exchanger 6, where it is cooled by heating the drying agent and returned to the lubrication system (closed circuit II). Water from the engine cooling system 12 is directed by a pump 10 to the middle section of the three-section heat exchanger 6, where it is cooled by heating the drying agent and returned to the engine cooling system 12 (closed circuit III), the exhaust gases of the three-section heat exchanger 6 are cooled by heating the drying agent and discharged into the atmosphere (open circuit IV). The drying agent preheated in the three-section heat exchanger 6 is heated to the required temperature in the heat pump condenser 3 and sent back to the dryer.

The cycle of the heat pump of the proposed drying plant in diagram *i-d* is shown in Figure 1b, here process 8-9 is heating of the drying agent in the right section of the three–section heat exchanger due to the recovery of heat removed from the engine by lubricating oil, process 9-10 is heating of the drying agent due to the recovery of heat removed from the engine by the cooling system; process 10-11 is heating drying agent due to heat recovery of engine exhaust gases, process 11-5 heating of the drying agent in the heat pump condenser; process 5-6 – humidification of the drying agent when mixed with a fresh portion of atmospheric air, drying of the drying agent used in the dryer; process 7-8 – changing the parameters of a fresh portion of the drying agent when mixed with recirculated air.

The use of recovered heat for preheating the drying agent can significantly reduce the load on the heat pump condenser, which significantly increases the efficiency of the system. Thus, the specific load on the heat pump condenser without preheating due to heat recovery is a segment 8-5, Figure 1b, and in the proposed system a segment 11-5. Reducing the load on the capacitor is proportional to the segment 8-11.




*a*)




*б*)

Figure 1 - A diagram of a TNU with a motor drive and its image in the *i-d* diagram

## RESULTS AND DISCUSSION

During the development of the installation , the calculation of the amount of heat removed from the internal combustion engine was determined using the ratios:

Exhaust gases
$$Q_r = \frac{q_r \cdot G_r \cdot h_u}{100}$$
(1)

where $q_r$ - 25-45% for diesel engines without blowing;

$G_r$ - 25-40% for supercharged diesels;

$h_U$ - 42,5 J/kg – calorific value of fuel;

$G_T$ - fuel consumption (according to diesel characteristics).

$$G_T = \frac{N_e \cdot g_e}{10^3} \qquad (2)$$

where $N_e$ - power;

$g_e$ - specific fuel consumption.

With the flow of liquid circulating in the cooling system $Q_W = q_W \cdot N_{eN}$
(3)

where $q_W$ - the amount of heat removed per unit of engine power $N_{eN}$ - diesel power.

The flow rate of the fluid circulating in the system $G_W = Q_W / C_W \left(t'_W - t''_W\right)$ (4)

where $C_W$ - heat capacity of the circulating liquid;

$t'_W - t''_W$ - 5÷10 °C – the temperature difference between the coolant coming out of the engine and entering the engine.

With lubricating oil flow $Q_M = (0{,}015 \div 0{,}030)\ h_H \cdot G_T$ (5)

where $C_M$ – the heat capacity of the oil.

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UDC 621.577

# HEAT PUMP PLANT FOR DRYING AND COOLING MATERIALS WITH A THREE-STAGE COMPRESSOR


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***Abstract***

*For drying and cooling of some materials it is required to heat the material to 80 ° C and to cool the material down to 10 ° C through the layer of material to reduce its moisture content. The use of a heat pump for drying and cooling a capillary-porous material has several advantages over existing methods. The maximum temperature of heating of the drying agent is determined by the conditions for maintaining the quality of the material when it is in contact with the drying agent for a long time, and the temperature of the cooling air is determined by the conditions for increasing its storage time, as is the case with drying and cooling using a heat pump.*



***Keywords:*** *Heat pump, compressor, condenser, evaporator, dryer, heat, air, drying agent*


## INTRODUCTION

In the technology of materials processing, one of the important tasks is drying and cooling materials to the humidity determined by the regulations for drying, and to a temperature that ensures its long-term storage. As studies conducted by the authors of a number of papers [1,2] have shown, when the temperature drops to 8-10$^0$C, the intensity of physiological and biochemical processes occurring inside the material decreases, and consequently, the duration of storage of the cooled material increases. The widespread use of a heat pump in drying and cooling units as a heat and cold generator can, in our opinion, make a tangible contribution to improving the use of energy for heating the drying agent to a temperature of about 80-100$^0$C and for cooling to 10-12$^0$C of air blown through a layer of material in order to reduce its humidity. The use of a heat pump for drying and cooling of capillary-porous material has a number of advantages compared to existing methods [1]. The maximum heating temperature of the drying agent is determined by the conditions for maintaining the quality of the material during prolonged contact with the drying agent, and the temperature of the cooling air is determined by the conditions for increasing the duration of its storage, as is the case with drying and cooling using a heat pump [2].

At the same time, the heat pump takes heat from the environment with a low temperature and transports it to a higher temperature level, at which it becomes possible to use it. To carry out this process, it is necessary to expend a certain amount of mechanical energy, which is also converted into heat at a higher temperature level. Consequently, the amount of thermal energy given by the heat pump to the heated object is equal to the sum of the thermal energy taken from the environment and the mechanical energy expended. The advantage of a heat pump is the consumption of a relatively small amount of electricity in relation to the heat energy received in it. In addition, the drying agent heated here is not polluted or humidified. Thus, the heat pump will significantly increase the energy efficiency of drying units and recycle secondary energy resources [3].

In accordance with these requirements, we have developed an experimental drying and cooling unit for drying and cooling capillary-porous materials. Dry, environmentally friendly drying and cooling agents are required for drying and cooling.

## EXPERIMENTAL PART

For drying and cooling of capillary-porous materials, it is advisable to use a heat pump. However, single-stage heat pump drying plants (HPDP) are inefficient, uneconomical due to incomplete use of their heat and cold and unsuitable for obtaining a drying agent temperature of more than 40-50$^0$C [4]. Meanwhile, for some materials, it is required to increase the temperature of the drying agent to 90-100$^0$C. For this purpose, two-stage or three-stage heat pumps should be used [5].

Figure 1 shows a diagram of the proposed heat pump drying unit with a three-stage compressor. It consists of a three-stage compressor 1-the first, 2-the second and 3-the third stage; a control valve 9, the first circulation circuit of the drying agent, including a condenser 4, a fan 25, a dryer 13, an atmospheric air inlet pipe 33; a second circulation circuit of the drying agent, including a condenser 5, a fan 24, a dryer 14, atmospheric air inlet pipe 32; the third circulation circuit of the drying agent, including a condenser 6, a fan 23, a dryer 15, an atmospheric air inlet pipe 31; the fourth closed circulation circuit of the drying agent, including a condenser 17, a fan 22, a dryer 16, an atmospheric air inlet pipe 30; the fifth circulation circuit of the drying agent, including a condenser 8, a fan 21, a dryer 17, atmospheric air inlet pipe 29; first closed coolant circulation circuit, including evaporator 10, fan 28, material cooler 20; the second closed circuit of the coolant circulation, including an evaporator 11, a fan 27, a material cooler 19; the third closed circuit of the coolant circulation, including an evaporator 12, a fan 26, a material cooler 18.

The installation works as follows: the working substance – the refrigerating agent is compressed in the first stage of the compressor 1 and pumped into the condenser 4, where it is cooled and sucked by the second stage of the compressor 2, compressed and pumped into the condensers 5 and 6, where it is cooled and sucked by the compressor of the third stage 3, compressed and pumped into the condensers 7 and 8, where it is cooled, after which it enters the control valve 9 and the evaporators 10,11 and 12. The air heated during cooling of condensers 4,5,6,7,8 by fans 21,22,23,24,25 is directed to dryers 13,14,15,16,17, where it is humidified and cooled. The spent drying agent is removed from dryers 13,14,15,16,17, partially mixed with atmospheric air and returned to condensers 4,5,6,7,8. The air cooled by boiling the refrigerating agent in evaporators 10,11 and 12 is directed by fans 26,27 and 28 to coolers 18,19 and 20, where it heats up, cooling the product, and then returns to evaporators 10,11 and 12. Construction of the cycle processes of a three-stage heat pump in the diagram $\lg P - i$ shown in Fig. 2.

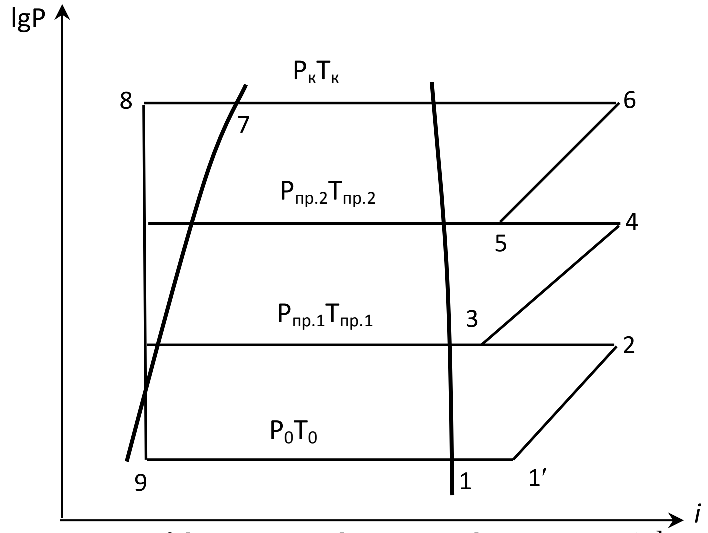


Fig. 1. Image of three-stage cycle processes heat pump (HP) $\lg P - i$ in the diagram

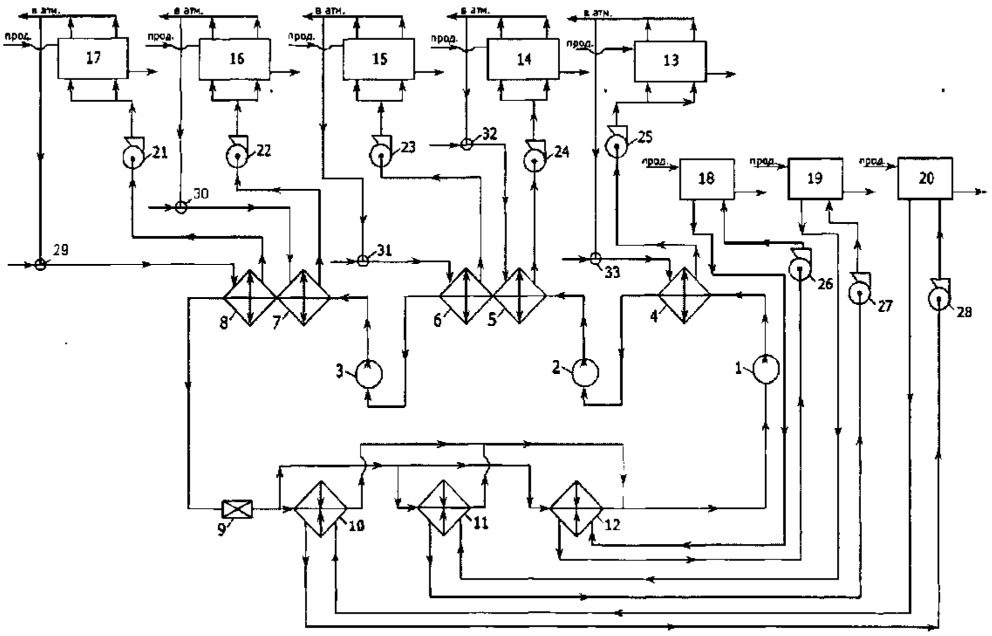


Fig. 2. Diagram of a heat pump drying unit with a three-stage compressor

## RESULTS AND DISCUSSION

The main characteristic of the three-stage cycle of the heat pump and its elements is the coefficient of heat transformation μ:

$$\mu = \frac{Q_0 + Q_т}{N_1 + N_2 + N_3},$$

where $Q_0 = G_0 g_0$ – cooling capacity HP, кВт; $Q_т = G_0 g_k$ – thermal performance HP, кВт; $g_0$ – specific mass cooling capacity, kJ/kg; $g_k$ – specific thermal load on HP capacitors, kJ/kg; $N_1, N_2$ $N_3$ – the drive power of the compressor of the first, second and third stages, respectively, kW.

Here: 1-1′ –selected overheating of the working substance for suction into the compressor of the first stage1′-2 –;compression of the working substance in the compressor of the first stage; 2-3 – condensation of the working substance in a low–temperature condenser at constant pressure; 3-4 - compression of the working substance in the compressor of the second stage; 4-5 condensation of the working substance in a medium temperature condenser at constant pressure 5-6 – compression of the working substance in the compressor of the third stage; 6-7 – condensation of the working substance in a high-temperature condenser at constant pressure; 7-8 – supercooling of the working substance; 8-9 – isentalpy expansion of the working substance in the control valve; 9-1 – isobaric boiling of the working substance in the evaporator HP.

The proposed heat pump unit with a three-stage compressor provides drying and cooling of the material after drying, significantly increases the temperature of the drying agent and the productivity of the drying and cooling process of the material with a slight increase in energy consumption.

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UDC 629.3.02-192

# OPTIMIZATION OF OPERATIONAL PLANNING OF PREPARATION OF MAINTENANCE AND CURRENT REPAIR OF ROLLING STOCK OF ROAD TRANSPORT

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***Abstract***

*The structural scheme of performing disassembly and assembly operations for fault localization is considered. The optimized sequence of automobile fault localization by its external manifestations is outlined. The task of the research is to find the expected time costs for any sequence of fault localization, to compare them with the average labor intensity of fault elimination and to determine such a sequence for which the time spent on fault search was minimal. An enlarged algorithm for minimizing losses in fault finding by determining the optimal sequence of disassembly and assembly operations is presented. The method proposed in the paper allows to reduce the time spent on fault finding, which reduces the time of car stay in maintenance and repair. In addition, the obtained data are the basis for the development of normative and technical documentation used in operational and production planning of maintenance and repair of vehicles.*

***Keywords:*** *vehicle diagnostics, disassembly and assembly operations, labor intensity of disassembly and assembly operations, probability of fault occurrence, fault localization, fault finding sequence, time losses during fault finding*

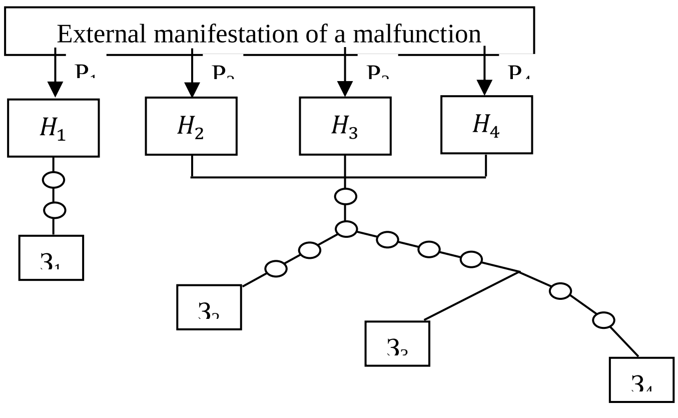
## INTRODUCTION

The initial information for realization of operational and production planning of maintenance and repair preparation for a given external fault manifestation is a set of possible faults $H_i$ (with a priori probabilities of their manifestation $P_i$) with indication of necessary for elimination of disassembly and assembly operations and spare parts. Figure 1 shows the structural scheme of performing disassembly and assembly operations to localize one of the four faults ($H_1$, $H_2$, $H_3$, $H_4$) corresponding to one external manifestation. Each point of branching of post technologies represents a certain level (depth) of elementary disassembly and assembly operations. The post technology is understood as a technologically ordered set of elementary disassembly-assembly operations and non-directly the operation of replacing a defective part (assembly) with a serviceable one.

## EXPERIMENTAL METHODS

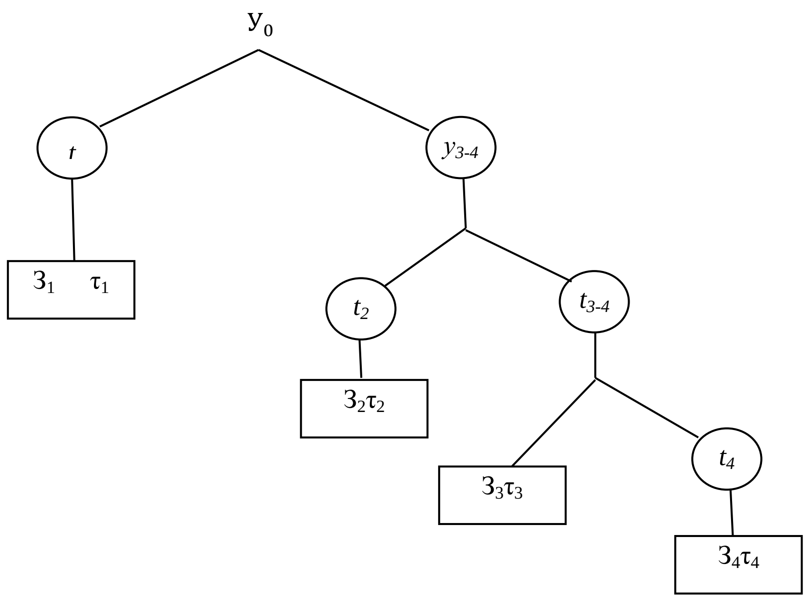
For convenience, Figure 2 shows a modified structural scheme, which is obtained from the scheme (Figure 1) by combining the labor intensity of several elementary disassembly and assembly operations of one level into one, enlarged one. It should be taken into account that if after any branching point there is a replacement operation, it means that at this level the need for the corresponding spare part is already obvious.

In the case when by means of objective or subjective diagnostics it is possible to unambiguously determine the cause of a fault (ideal diagnostics), the average labor input of fault elimination $T_{ид}$ is determined by summing up the labor inputs of individual disassembly and assembly operations taking into account the probabilities of individual disassembly and assembly operations taking into account the probabilities of fault occurrence. In this case, it is obvious that in any variant of fault finding the replacement $З_i$ with labor intensity $\tau_i$ is performed only once for the actual elimination of the fault.




O- elementary disassembly and assembly operation;
$\boxed{3}$ - replacement part;

Fig.1. Structural diagram of disassembly and assembly operations performance during fault localization




*У* -point of branching (level of operations depth);
*t* - total labor intensity of disassembly and assembly operations at a certain level;
$\boxed{З, \tau}$- labor intensity of replacement and name of spare part.

Fig.2. The given structural diagram

Thus, to determine the total labor intensity, it is sufficient to use only the labor intensity of disassembly and assembly operations:

$$Т_{ид} = P_1 t_1 + P_2(t_{2-4} + t_2) + P_3(t_{2-4} + t_{3-4}) + P_4(t_{2-4} + t_{3-4} + t_4) \qquad (1)$$

When the actual fault is unknown (defined unambiguously), it is necessary to find the optimal sequence of fault localization. In this case, the optimization criterion is the execution time of technological disassembly and assembly operations (without taking into account the organization and possible retraining of production).

The optimized sequence can be represented by the technology of localization of various faults, possible at a given external manifestation. In this case, the sequence of fault localization is formed based on the fact that the transition to disassembly and assembly operations of the subsequent fault is carried out at the nearest upper branching point. As soon as the fault is detected, all elements of the unit or system are replaced and then reassembled.

The problem is to find, for any fault localization sequence $H$, the expected time cost of finding the fault $T(\overline{H})$, compare it with $Т_{ид}$, and determine the sequence for which

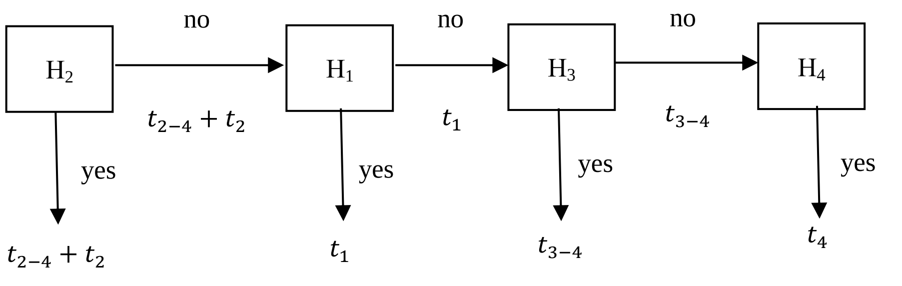
$$\Delta Т = Т\left(\overrightarrow{H^{opt}}\right) - Т_{ид} \rightarrow min \qquad (2)$$

The value of $\Delta Т^{min}$ thus determines the time reserve, which in principle can be realized by performing diagnostics.

Let us consider some sequence of fault finding, for example, for the circuit shown in Figure 1:

$$H_2 \rightarrow H_1 \rightarrow H_3 \rightarrow H_4. \qquad (3)$$

The time loss structure for sequence (3) can be represented as follows:




(4)

Then the expected time loss will be equal:

$$T(H_2, H_1, H_3, H_4) = t_{2-4} + t_2 + (1 - P_2)t_1 + (1 - P_2 - P_1)t_{3-4} + +(1 - P_2 - P_1 - P_3)t_4 \quad (5)$$

or given that $\sum_{i=1}^{4} P_i = 1$,

$$T = (t_{2-4} + t_2) \cdot t_1(P_1 + P_3 + P_4) + t_{3-4}(P_3 + P_4) + t_4 P_4 \quad (6)$$

## RESULTS AND DISCUSSION

In general, the algorithm of loss calculation for an arbitrary fault localization sequence can be represented as follows: an arbitrary fault search sequence $\overrightarrow{H_i}$ is given, where *i=1, ..., n*. Each sequence $H_i$ corresponds to an a priori probability of its occurrence $P_i$. Let $t_{I-J}$ be the time to find one fault, where $I - J$ is a complex symbol characterizing the sequence of disassembly and assembly operations by levels. For $H_1$, the loss is equal to the sum of all $t_{I-J}$ such that $I = 1; J \in N$, where $N = 1, \dots, n$, multiplied by the sum of all fault occurrence probabilities:

$$T(H_1) = \sum_{J=N} t_{1-J} \cdot \sum_{i=1}^{n} P_i = \sum_{J \in N} t_{1-J} \quad (7)$$

for $H_2 T(H_2) = \sum_{J=N} t_{2-J} \cdot (1 - P_2)$ (8)

To localize the i-th fault, the loss is equal to the sum of all t_(1-J) such that contain the index i=j that does not occur in previous disassembly and assembly operations:

$$T(H_i) = \sum_{k=1}^{i} \left( \sum_{(I,J) \in \{n_k\}} t_{I-J} \cdot (1 - \sum_{i=1}^{n} P_i) \right) \quad (9)$$

where *k*-index of the fault location order.

Then the total time loss for an arbitrary fault localization sequence $H_i$ can be determined by the formula:

$$T_{сум} = \sum_{i=1}^{m} T(H_i) \quad (10)$$

Figure 3 shows an enlarged algorithm for minimizing the fault finding loss by determining the optimal sequence of disassembly and assembly operations.

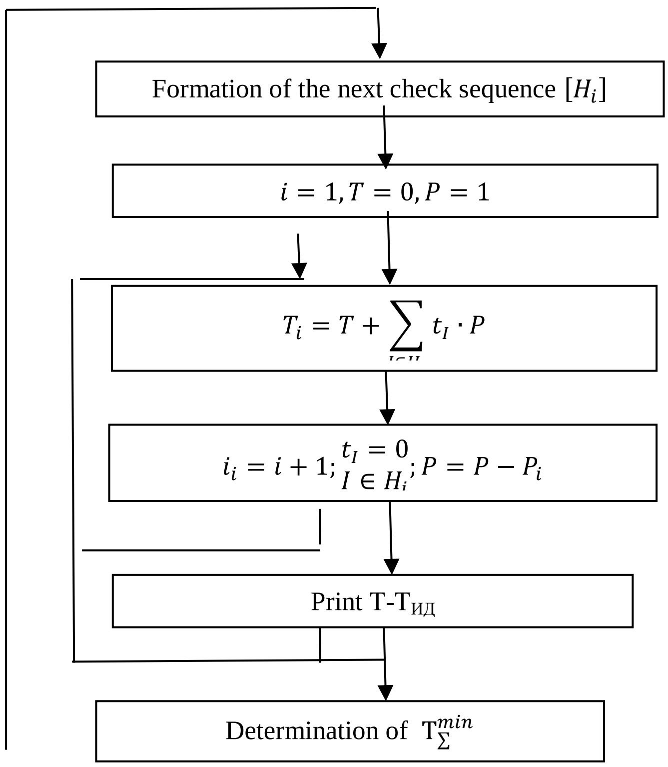



Fig.3. Algorithm for minimizing the loss during fault finding

## CONCLUSION

The proposed approach allows to reduce the time spent on fault finding, which reduces the time a vehicle is in maintenance and current repair. In addition, the data obtained by optimizing the sequence of fault finding are the basis for the development of normative and reference documentation used in the operational and production planning of the preparation of maintenance and repair of rolling stock.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UDC 656.2


# IMPROVING THE EFFICIENCY OF TRANSPORT LOGISTICS THROUGH INTERMODAL TRANSPORT


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***Abstract***

*The organization of intermodal transportation is a complex and multifaceted process that involves the use of various modes of transport at separate stages of transportation, with a combination of advantages and features of each. However, when forming a rational scheme of cargo delivery from the supplier to the consumer based on the principles of logistics, it is necessary to implement a set of measures to optimize cargo flows, the main of which are the choice of modes of transport, the route, the definition of the warehousing system, the stock level and the optimal batch of the order. At the same time, it should be taken into account that at present the main requirements of consumers are the fulfillment of delivery dates - "just in time". Transport serves almost all types of international economic relations. The prices of goods on the world and domestic markets, all possible costs for the transportation of export-import products determine the transport operations that begin and end the process of international commercial transactions. The choice of directions of international transportation and methods of transportation of goods, the search for the most rational ways of transport services, the choice of alternative forms and methods in the technology and organization of the transportation process, the study of optimal and compromise solutions in the conclusion and execution of transportation contracts makes it necessary to ensure the effectiveness of foreign economic activity of all subjects of international economic relations.*



***Keywords:*** *transport logistics, intermodal transportation, organization of transportation, transport market*


## INTRODUCTION

In the transport sector, the term intermodal transportation was first used in the 1960s with the advent of containerization, when standardized containers were created that could be transported both by rail and by road and water transport. Intermodal transportation is understood as the transportation of goods in the same transport unit using two or more vehicles, as a result of which only a change of the mobile means occurs, but the transshipment of the transported goods does not occur.

According to many studies, intermodal transportation is known as a special form of multimodal transportation, and describes a multi-level transport chain that concerns both passenger and cargo transportation.

## EXPERIMENTAL METHODS

The advantages of using different modes of transport is of great importance, since it allows their maximum use in intermodal transport. Since sea vessels have a low cost of cargo transportation. And road transport is very efficient due to its flexibility, since it can easily reach almost any shipper or consignee, however, it is very time-consuming - it significantly pollutes the environment, has a low load capacity, respectively, a large cost of transportation. It has a low cost of transportation, is quite environmentally friendly, but requires large expenditures in the construction and maintenance of infrastructure rail transport, although it can carry a huge amount of cargo [1]. It has a low load capacity and a huge cost of cargo transportation by air, although it allows you to transport cargo over huge distances at maximum speed. Road users who use different modes of transport for a certain period of time are called multimodal, and those who use several modes of transport on the same route are called intermodal.

Intermodality is a special form of multimodality [2]. Often the term "intermodal transportation" is equated with the terms of multimodal and combined transportation.

We present the strengths of intermodal transport and the difficulties associated with its use in Figure 1.

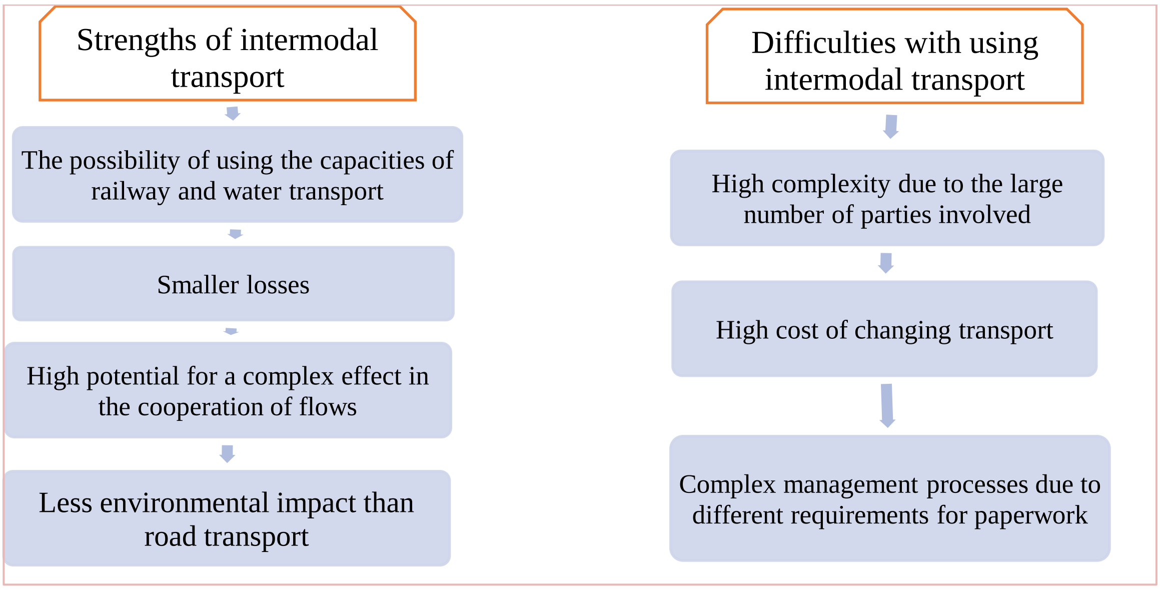


Fig. 1 - Strengths of intermodal transport, and difficulties associated with its use

In many ways, a certain difficulty is the need to coordinate the work of a large number of participants involved in the transportation process, and of course, a large number of operations and actions taking place in the intermodal transport chain.

The organization of transportation must comply with logistics principles, realizing the importance of the entire transport chain from the sender to the consignee. Accordingly, the administrator of the transport network should monitor and process the information coming from above and control what happens down the chain. In addition to the tasks related to providing a safe and reliable service, the logistics company should be able to support the planning and operational decision of the client, for example, to provide accurate information regarding the estimated time of arrival of the cargo [3].

This in turn creates new incentives for interactive planning and communication, short-term planning, reliability, accuracy and sufficiency of input data in the planning process.

Transport operators are inclined to cooperate when using up-to-date tools to provide stakeholders with the required information. The multi-criteria assessment of the effectiveness of a transport solution is associated with the compilation of a route that includes a set of different vehicles and terminal services.

The main task of logistics companies is to develop a systematic and customer-oriented system of work quality criteria that will be able to answer several key questions that are listed below;

1. how well is the intermodal transport system or its individual links organized, functioning and how well is it managed;

2. what types of transport should be chosen based on the specifics of the business of the consumer of carrier services;

3. which type of transport should be chosen at the local level as a priority when integrating the region into the general intermodal transport system.

There are five main categories of criteria for the quality of work, these are:

- security,
- mobility and flexibility.
- long-term investment efficiency,
- environmental impact,
- economic impact.

There are several indicators for each of these categories, covering the features of the system and thereby assessing the quality of intermodal service.

Two main differences from the traditional ones are these criteria for the quality of work:

1. using geographical distance rather than path length;

2. the definition of mobility as the total time of the distance, and not the average speed [4].

These criteria and indicators can be used in systems of various scales, which should undoubtedly stimulate the development of intermodal transport and quantitatively demonstrate their advantages over traditional transport.

Also, assessing the quality of transportation, movement in the intermodal transportation system, it is necessary to take into account many factors related exclusively to the transition points between different modes of transport: the possibility of coupling and accessibility [1].

A good system of criteria for evaluating the quality of work is an important success factor. The development of such a system should be carried out at the initial design stage. Therefore, many researchers have been paying great attention to this problem recently [3].

## RESULTS AND DISCUSSION

As we can see, the peculiarities of the formation and the current state of corporate systems of large transport companies lead to inflexibility, slow reaction to market changes, low customer orientation, respectively, to a decrease in efficiency and profitability.

In this regard, with the ever-growing needs of customers, the urgent tasks for large transport companies are: increasing flexibility and adaptability, increasing customer orientation, improving management efficiency through the implementation of organizational changes.

Improving the interaction between different modes of transport and the organization of intermodal transport on the principles of logistics is the system basis of innovations, as one of the ways to solve the tasks. A distinctive feature of intermodal cargo delivery systems is that the object of management in them is a single cargo unit (container), which goes through all stages of transportation - from supplier to consumer without reformulation in intermediate links of supply chains, thereby minimizing operating costs, improving cargo safety, speeding up container handling at transshipment points., significantly reduce time and labor costs for cargo handling and increase cargo turnover [2].

In turn, logistics management of intermodal transportation should be considered as a systematic, holistic approach, within which the organization of the movement of raw materials, semi-finished products, finished products is carried out throughout from the point of their production to the place of final consumption.

Currently, the development of intermodal transport in transport logistics still faces some significant problems, below we list some of them:

- There is no approved complex of operations of freight forwarding services, which can increase the level of logistics service and improve the transportation process;

- The economic and legal responsibility of freight forwarding companies for the final results of their work is not sufficiently developed;

- A unified management structure for transport services has not been created, a system for planning and managing logistics of freight forwarding operations at transshipment points and along the entire route of cargo flows has not been developed;

- There is no unified legislative framework and agreed legal norms of freight forwarding services, which leads to differences in the design of transport and accompanying documents, does not allow the introduction of end-to-end technologies in the transportation process and the use of automated control systems that require unified indicators and a single information base;

- There are no standard logistics technologies and proper cooperation in the interaction of various modes of transport involved in the delivery of goods.

As can be seen, the problems encountered in the field of physical movement of goods in space involves improving the quality and efficiency of cargo transportation. The relationship and interdependence between the constituent elements of the system of transportation and storage of cargo units and the many functions arising in the process of this movement should take into account the logistics management of intermodal transport. Although in many ways, the functional approach, in which the responsibility for inventory storage and transportation is distributed between the functions of production and distribution, is being replaced by a new logistics paradigm of transportation management. At the present time, the basis of logistics management through the construction of stable internal and external links in the intermodal cargo delivery system is a synergistic effect, the presence of which allows you to increase the total result to values greater than the sum of the individual results of the constituent elements when they work independently of each other. All interactions between shippers and consignees, carriers and forwarders when executing a transportation order in the logistics management system of intermodal transportation cover internal and external relations. The services delivered to cargo owners are the result of the combined efforts of the components of a single intermodal system. Ultimately, the distinctive features of such activities are – direct work taking into account the interests of each element of the system and optimization of the overall integrated effect. At the same time, the growth of the results of some elements can be compensated by the reduction of others.

For example, systems with a large number of warehouses, all other things being equal, are characterized by a higher cost of maintaining stocks and significant storage costs, compared with systems with a smaller number of warehouses. And this allows you to get savings on trunk transportation and reduce the costs associated with downtime, thereby compensating for additional storage costs [4].

## CONCLUSION

Optimization of the combination of individual modes of transport makes it possible to increase the economic efficiency of transportation, contributes to the development of the transport market and logistics, and also has a positive effect on the environment. Moving transport to the railway from public roads reduces the burden on infrastructure and reduces congestion. the client's requests must be fulfilled in order, ultimately, to make the intermodal transportation system competitive and alternative.

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UDC 656.2

# THE CURRENT STATE AND PROBLEMS OF THE LOGISTICS SYSTEM OF CONTAINER CARGO TRANSPORTATION IN THE INTERACTION OF VARIOUS MODES OF TRANSPORT

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**_Abstract_**

*The container transport system is one of the elements that allows the transportation of goods from the "door of the shipper" to the "door of the consignee". The article considers the issues of container transportation organization, and draws attention to the fact that the efficiency of the country's transport complex becomes an indispensable condition for its balanced development and systematic integration into the global transportation system. Various criteria of factors for choosing a rational route in cargo transportation and the problem of technical equipment, which is aggravated by weak coordination between market participants, are given. Container transportation is currently considered one of the most advanced methods of cargo delivery, which have a lot of advantages over other types of transportation and are in high demand in modern economic conditions, thereby saving material and labor resources in transport and related sectors of the national economy of the country.*

***Keywords:*** *transport logistics, logistics systems, container transportation, logistics principles*

## INTRODUCTION

In the conditions of the modern transport market, the issue of interaction of various types of transport is acute. And the most effective way of delivering cargo "from door to door" is container transportation. In order to increase the efficiency of the use of universal containers when transporting goods by rail, special measures are applied to organize their movement. At the moment, most of the containerized cargo is transported in covered wagons. With this method of delivery, the safety of goods is noticeably reduced - due to their losses, when overloading from one type of transport to another. The widespread use of containers in transport logistics makes it possible to minimize losses and reduce the cost of cargo delivery in many parts of the transport and logistics chain [1]. Improving the service of such transportation is one of the most important directions of the container transportation development program. In this regard, it is necessary to bring the volume of cargo delivery on the principle of "door to door" to a high level, providing cargo owners with complete information about the progress of cargo in containers, ensuring the implementation of the principle of cargo delivery on time, and introduce accelerated container trains. As a result, it is possible to achieve a reduction in the turnover of containers on railways by introducing an automated system for calculating the plan for the formation of wagons with containers, reducing the container sorting coefficient, increasing the share of direct wagons with containers, and organizing container trains. However, only when optimizing the container transportation system using a logistics approach to solving this problem, it is possible to fulfill all of the above provisions.

## EXPERIMENTAL METHODS

The most important goal in creating a logistics system for railway transport is to increase the efficiency of the transportation process, thereby obtaining commercial benefits through the implementation of optimal cargo transportation schemes for all participants in the transport conveyor based on a single technological process and information support that combines the activities of all types of transport for the transportation of goods and related services. The quality of the transport process is improving, conditions are being created for the accelerated development of transport infrastructure and the reduction of the mass of goods in circulation due to the containerization of cargo transportation in transport logistics. As is known, containerization of freight transport provides an increase in labor productivity by about 5 times, and reduces downtime of rolling stock by 2 times.

With the correct selection of container types in accordance with the nature of the goods transported in them and the conditions of transportation, the efficiency of containerization increases.

A container, in terms of transport, is a type of removable wagon body that is loaded directly at the sender's warehouse, follows with cargo to the destination station and unloaded at the consignee's warehouse, the facts of cargo loss during transportation are reduced and the need for the construction of covered warehouses at railway stations is reduced [2].

The use of containers allows you to reduce the cost of packing cargo, because most of the packaged goods require one or another packaging, packaging materials depend on the strength, size and characteristics of the goods, duration of transportation, duration of storage, type of transport and value of the cargo, legislative and other rules for the transportation of individual goods.

It allows us to identify a greater number of direct and long-distance streams of container flows, thereby, to consider in detail the issues of organizing container trains for a significant number of destinations - an increase in the share of container traffic in the logistics system.

As you know, a logistics system is a combination of logistics chains interacting on the polygon in question.

The components included in the scheme of the logistics chain of cargo transportation in a container are shown in Figure 1.

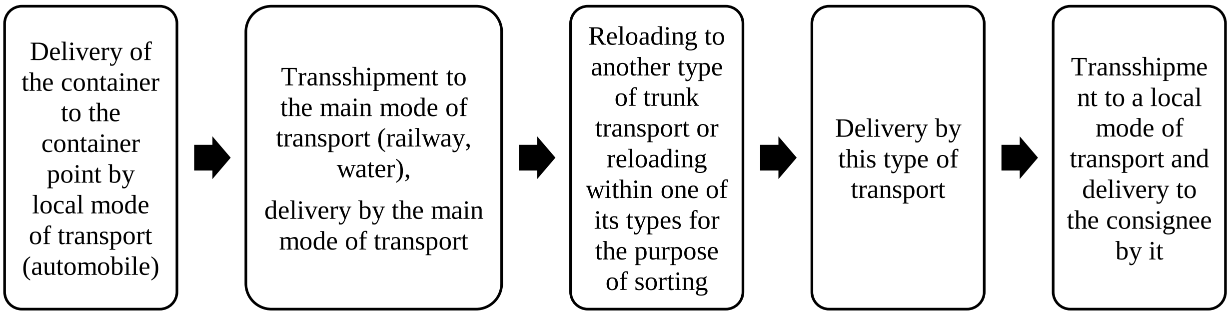


Fig. 1. Diagram of the components of the logistics chain when transporting cargo in a container

As you can see from Figure 1, in the logistics chain of cargo delivery in a container, there is an overload from one type of transport to another at least once. And an important element in such logistics chains is a container point. The issue of determining its processing capacity is an important logistical task, in order to properly plan and interact with various modes of transport [3]. The interaction of local and mainline modes of transport is the second element of the logistics chain, for goods in containers, the interaction between road and rail modes of transport is characteristic.

A detailed statistical survey of the operation of container terminals is needed in order to provide a sufficiently realistic forecast of container flows, which will make it possible to profitably switch to freight forwarding logistics.

To date, railway stations are being developed in our country, approaches to seaports have been strengthened, container terminals are being modernized in accordance with international standards.

## RESULTS AND DISCUSSION

The above shows that many economic entities are involved in the process of organizing container transportation - elements of the regional container transport and logistics system, including freight forwarders, carriers, container terminals, rolling stock operators.

There are a large number of options for following the cargo, each option is characterized by two main parameters, such as:

- the cost of transporting a unit of cargo, expressed in conventional units and the transit time of the cargo, expressed in days;
- the change of the main parameters depending on the route of the cargo occurs very often, and therefore numerous options for the route of transportation of shipments are possible.

In many cases, it is proposed to take the cost of delivery of a unit of goods as a criterion for choosing a transportation route for choosing a rational route for transporting goods in international traffic [4].

This criterion depends on the following factors, which are shown in Figure 2.

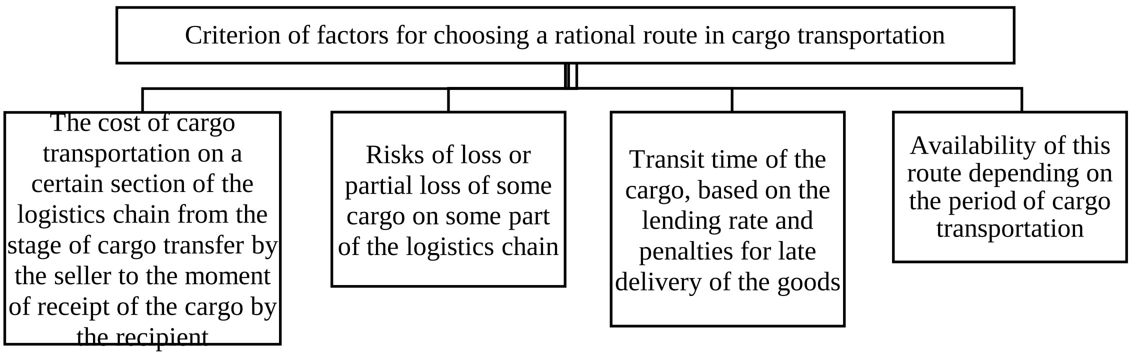


Fig. 2. Criterion of factors for choosing a rational route in the transportation of goods in international traffic

To date, the shortage of terminal capacity, as well as the deterioration of the container fleet and rolling stock is the main problem in the railway container transportation market in the country.

In most cases, the provision of a comprehensive logistics service for the delivery of a container requires the interaction of several economic entities, as a result of which each element of the container transport and logistics system can act both as a supplier and as a consumer of the service.

The problem of technical equipment is aggravated by poor coordination between market participants. The turnover of containers is slowed down due to their disorderly movement, since the owners of containers and rolling stock in pursuit of short-term benefits are not ready to streamline their work. To date, the system of organizing the interaction of railway container operators with ports is poorly developed, which greatly hinders the development of intermodal container transportation [2].

Considering the issue of developing a comprehensive methodology for planning the organization of container traffic on rail transport based on the principles of logistics, this methodology should provide for a joint solution of the stages of planning the transportation of goods in containers.

In this regard, it is necessary to analyze the existing theories and technologies for planning and organizing container flows, to investigate the possibility of containerization of the delivery of small and wagon shipments of bulk cargo in order to increase the volume of container traffic, to develop a methodology for determining the processing capacity of container transshipment points, allowing to read out the specifics of a particular container point, to develop a methodology for organizing container flows at the service site, taking into account the psychological aspect of interaction between cargo owners and railways [3], to develop a methodology for planning the formation of wagons with containers, which will make it possible to analyze all options, taking into account restrictions, to develop a new methodology for scheduling the reception of containers for departure - when using the provisions of which the probability of disruption of the departure of prefabricated wagons with containers decreases, to develop a methodology for determining the delivery time of goods in containers with a given reliability of its implementation, and to develop algorithms and programs for automated execution of the most time-consuming parts of the proposed calculation methodology.

## CONCLUSION

Thus, it can be argued about the development of the container transportation market in our country, which is characterized by such factors as the formed market environment, a new system of relations between market participants, individualization of their goals and interests, expansion of the range of transport services, as well as increased competition and self-organization. However, in the new economic conditions, mechanisms for organizing the interaction of participants in the transport and logistics process - both shippers, terminals, rolling stock operators and carriers – have not yet been formed. In this regard, the problem confirms the need to develop mechanisms for organizing a container transport and logistics system in order to increase the efficiency of container transportation and meet the needs of cargo owners in a qualitative way.

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# ANALYSIS OF MODERN AND PROMISING TYPES OF ADSORBENTS

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***Abstract***

*This article analyzes modern and perspective types of adsorbents used for adsorption type of purification of industrial gases and liquids. The description of the properties of classical and new types of sorbents, their scope of application of adsorbents, as well as the advantages and disadvantages are indicated. It has been established that activated carbon, with its advantages, has many disadvantages. The prospects of using carbonate sludge, waste from the agro-industrial complex and forestry as an adsorbent, as well as the features of the use of bio-coal are shown. It has been established that promising types of adsorbents have many advantages and have properties no worse than the main types of sorbents. Promising adsorbents based on industrial waste are cost-effective options and a good alternative to the classic types of adsorbents.*

***Keywords:*** *adsorption, adsorbent, adsorbent pores, activated carbon, promising sorbents, production waste, bio coal.*

## INTRODACTION

Nowadays, the rapid development of industry has led to an increase in the emission of harmful substances into the environment. Increasing levels of carbon dioxide and titanium dioxide have a detrimental effect on the state of the environment, including the ozone layer of the planet. The main sources of environmental pollution are oil and gas, chemical, machine-building and metallurgical industries.

Adsorption process is used to prevent and reduce harmful emissions in production. At the moment adsorption process of purification of gases and wastewater is a promising type of technology. Adsorption is purposefully applied when other methods of purification are not effective enough.

Due to the high degree of purification from harmful impurities, adsorption has become widespread in industry. With the help of adsorption method of purification, it is possible to almost completely extract harmful substances from wastewater and industrial gases, thus the method allows for deep purification of mixtures. Adsorption is based on the selective absorption of substances by means of a porous material - adsorbent.

There are criteria that adsorbents must meet: high absorption capacity, low cost, low abrasion rate, hardness and strength, resistance to high temperatures and aggressive media, ability to regenerate [1].

## RESULTS AND DISCUSSION

Adsorbent is a sponge [2], which has pores of different volumes, where harmful substances are retained. Pores by their size are divided into three types: macropores (0.1-2 microns), transition pores (0.004-0.1 microns), micropores (less than 0.004 microns). Substances adsorbed from gas and liquid phase are called adsorbent. Fig.1 shows the structure of pores on the example of activated carbon.

Adsorbents differ from each other in their chemical composition and crystal lattice Various types of adsorbents are used in industry: activated carbon, zeolites, polymers, silica gels, etc. The adsorbents used may be of natural origin or artificial. The main advantages and disadvantages of these adsorbents are summarized in Table 1.

Adsorbents are poured on the support grid of adsorber, or poured on special capsules in the form of nozzles. In industry adsorbents are used in the form of granules or tablets with the size from 2 to 8 mm, or in the form of powders with the particle size from 50 to 200 microns.

Activated carbon is one of the most common sorbents used in many industries. It is characterized by low cost and high absorption effect. Activated carbon can absorb most types of harmful substances, but it has the following limitations. Activated carbon has poor efficiency in absorbing compounds, vinyl chloride, methanol and formaldehyde. It is also ineffective for purification of gases with high humidity, as it leads to a decrease in absorption efficiency by 30%, with relative humidity of contaminated gases exceeding 75%. When using adsorbers with activated carbon, fire and explosions may occur in the fixed layer of activated carbon.

Authors [3,4] in their studies do not recommend the use of impurities containing oxygen-containing compounds such as peroxides, ketones, organic acids, aldehydes and organic sulfur compounds because activated carbon can cause exothermic reactions with these compounds. The heat from the exothermic reactions can ignite any flammable compounds present in the contaminated gases.

Some harmful components may undergo chemical reactions to form contaminants that are difficult to remove during desorption. Authors [4] proved that styrene monomers polymerize to form polystyrene, which makes desorption possible only at very high temperatures.

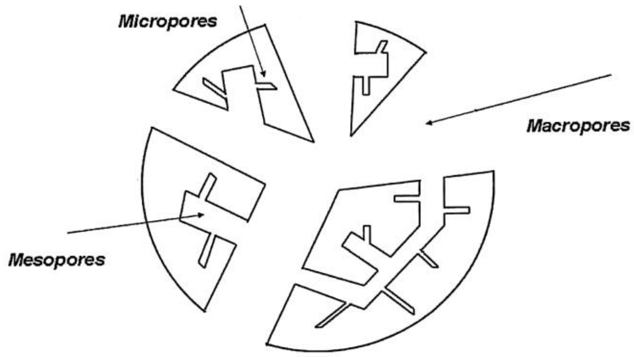


Fig.1. Pore structure of activated carbon

Zeolites are crystalline aluminum silicates with pore channels or molecular pores with high specific surface area. The crystalline structure of zeolites is highly resistant to temperature fluctuations, and their catalytic and adsorptive properties make them useful in various industries and households.

The pores of zeolites trap molecules of certain sizes while allowing other molecules to pass through, due to these zeolites are sometimes called molecular sieves [4,5].

Studies conducted by the author [6] showed that zeolite grade 13X has a maximum degree of adsorption of carbon dioxide equal to 4.5 mol/kg at a pressure of 1 bar and at a temperature of 295K. Generally, zeolites recover fresh adsorption capacity on regeneration, although the author has reported minor irreversible behaviour. Zeolite 13X also provides high selectivity of CO2 over CH4 for N2. Zeolites are used to capture highly polar and volatile substances that are difficult to remove with activated carbon, including such impurities as phenol, acetone, vinyl chloride, methane, formaldehyde, styrene, sulfur compounds and methyl ethyl ketone. Zeolites are not recommended for the removal of large molecules because inefficient absorption occurs [4,5]. Silica gels are common drying agents for gases at low temperatures (able to retain up to 50 % of moisture to the mass of adsorbent) and absorption of vapors of organic compounds (e.g., methyl alcohol). Vapors of nonpolar organic substances are poorly absorbed [7]. Silica gels have well developed porosity. Silica gels are promising adsorbents and have low cost compared to the cost of zeolites [8]. Compared to coals, silica gels are noncombustible, have low regeneration temperature (100-200 °C), relatively high mechanical abrasion resistance and low cost. In many foreign adsorption plants, activated aluminum is widely used. This adsorbent is mainly used for dehydration of gases to dew point and below, and for removal of polar gases from hydrocarbons [8,12]. The applications of aluminum oxide are wide, it is used in the treatment of transformer oils and wastewater from fluorine compounds. Activated aluminum is synthesized from bauxite or aluminum oxide monohydrate by dehydration at controlled temperatures and subsequent recrystallization.

Polymeric adsorbents are spheres or granules made of synthetic polymers that are highly cross-linked to form a matrix with fine pores and large surface area [9]. Polymeric adsorbents are used to capture a wide range of volatile organic compounds such as: toluene, styrene, aldehydes, alcohols, xylenes and chlorinated volatile organic compounds. It is not recommended to use polymers with strong oxidizing agents.

The adsorption capacity of polymers is higher than that of activated carbon, but lower than that of zeolites. Unlike activated carbon adsorbers, they are less susceptible to fire and can achieve removal efficiencies of more than 95% [10].

Table 1. Advantages and disadvantages of the main adsorbents

| Adsorbent | Advantages | Disadvantages |
|---|---|---|
| Activated carbon | Low-cost sorbent, suitable for capturing a wide range of harmful impurities. | Low efficiency against highly volatile compounds (vinyl chloride); low performance at high gas humidity; high energy costs for regeneration; fire hazard when used with oxygen-containing compounds; decomposes during desorption cycles. |
| Zeolite | Used in high mixture humidity; good at trapping VOCs; long service life; resistant to fire. | High cost; limited range of substances captured. |
| Silica gel | Low regeneration temperature, resistant to fire, abrasion resistance, low cost. | Destruction by moisture. |
| Polymers | Desorption faster, less susceptible to fire; longer service life. | High cost, the regeneration temperature should not exceed 125°C. |

Wastes of petrochemical, metallurgical, energy, construction and food industries have great potential for their application as adsorbents. Adsorbents of organic origin, which are wastes of agro-industrial complex, are used for wastewater treatment of enterprises. Agro-industrial enterprise sorbents include seed husks, sawdust of wood, flax, shavings, etc. The results of research conducted by the author [11] show: adsorbent made from agro-industrial wastes has high efficiency in relation to heavy metal ions. The efficiency of flow purification increases with increasing temperature, as well as the method of chemical regeneration of adsorbent proposed by the authors allows to use the sorbent up to 9 adsorption-desorption cycles.

In addition to adsorbents made from wastes of organic origin, wastes of mineral origin are also used. Such types of wastes include ashes, slags of non-ferrous metallurgical industry and sludges [12].

In a study [13,14], the authors proposed the use of carbonate sludge used in thermal power plants, resulting from the coagulation and liming of natural water, as a sorbent. Carbonate sludge is well suited as adsorption material for removal of various harmful impurities from gas-air emissions of industrial enterprises. Sorbents are made in the form of granules, to reduce the hydraulic resistance of the granular layer.

Biochar is a carbon-rich material that is produced by thermochemical conversion in the absence of oxygen (pyrolysis) from wood waste from forestry and is a promising and potential alternative to commercial adsorbents for acid gas cleaning [14].

The results of comparison [14] of biochar with activated carbon, showed that biochar can be used as an acceptable alternative to activated carbon as it is an environmentally friendly and inexpensive adsorbent.

Biochar had better adsorption capacity compared to commercial zeolite. The results in the study showed [15] that biochar can be used as a sustainable and cost-effective option to remove pollutants from acid gases generated from landfill gas treatment, fossil fuel extraction and or combustion.

## CONCLUSION

This paper analyzes the current promising types of sorbents. As a result of the analysis, it is found that activated carbon has low efficiency in the purification of gases with high moisture content, while zeolite has many advantages over other sorbents and is an alternative to activated carbon.

The analysis shows the advantages and prospects of using biochar, carbonate sludge and other industrial wastes. Organic sorbents based on wood, shells and husks have many advantages and are an alternative to classical types of adsorbents.

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# INNOVATION AND TECHNOLOGY IN MODERN ARCHITECTURE

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***Abstract***

*This article reveals the problem of introducing innovative technologies in Kazakhstan. This article briefly analyzes data on innovation activity in Kazakhstan and identifies the problems of introducing innovative technologies in Kazakhstan. The importance of this article is reflected in the possibility of using information to find the optimal approach and distribute any tasks for the implementation and promotion of modern technologies and innovations. In addition, we believe that the issue of innovation is always relevant in any country and at any time, because the desire for innovation is essentially the desire to improve everything and quality in everything. Automation and other technologies can change the way we design. Architecture is a field in which one trend quickly gives way to another, and some new and innovative trends may arise in one direction. It is difficult to predict with certainty specific trends in architecture as the field is constantly evolving and shaped by factors such as cultural, economic and technological changes. However, several general trends have emerged in recent years that may continue to impact the field in the future.*

***Keywords:*** *architecture, innovation, technology, trends, automation, BIM technologies, IoT construction tools.*

## INTRODUCTION

Architecture, like any branch of human activity, is not stands still. With the advent of great progress in this area, freedom of creativity and the possibility of experimentation were revealed to people. New materials, technologies, programs, additional tools - all this and much more has now become part of modern architecture. In this the article will use a number of examples to reveal innovations in current architecture, such as composite facades, Knaufakvapanel facade systems, and the possibilities of kinetic architecture.

One of the striking phenomena of modern technology in construction is kinetic architecture. In our minds, it is understood as a computerized system capable of regulating temperature, light, energy consumption, etc., using high-tech equipment and based on movement, deformation of elements and part building. Technologies today allow humanity to automate architectural objects with minimal electronic load, while ensuring high resource efficiency.

The dynamic development of the innovation sphere is one of the main components of the innovation economy. Such a developing economy requires effective systems and institutions to support the innovation process. According to the UN report, the top ten countries with innovative economies include Finland, the USA, Sweden, Japan, South Korea, the Netherlands, the UK, Canada, Australia and Singapore. They are followed by China and India. If you look in detail, 62% of innovative ideas are used in the USA, and 95% in Japan. What about Kazakhstan? Today Kazakhstan is not even among the top 20 high-tech countries in the world.

Much attention is paid to designing buildings that are environmentally friendly and resource efficient. This includes the use of materials and technologies that reduce energy consumption, such as passive solar design and green roofs. Technology is increasingly being used in design and construction, from modeling and 3D printing to BIM and the Internet of Things (IoT). Concern for the future is understandable given the many challenges and uncertainties we face as a society. Humanity has a long history of adapting to and overcoming challenges. We have made progress in many areas and have the tools and resources to address today's challenges, such as climate change, social inequality and political conflict. The future may be uncertain, but by using our collective knowledge and experience, we can create a better future for ourselves and future generations.[3]

## EXPEREMENTAL METHODS

By 2023, the capabilities of artificial intelligence in architecture, design and art will increase significantly. New tools like the AI-trained modeling bot ChatGPT can even predict architectural trends.

Automation and other technologies can change the way we design. However, it is important to understand that these types of construction have unintended consequences, including potentially displacing workers or changing the nature of work in the industry. However, automation in the construction industry is not a new phenomenon, and many tasks that were once performed manually are now performed using various technologies (such as CAD, 3D printing, robotics, IoT construction tools) and tools. And while automation may replace some jobs, it also creates new jobs and increases efficiency, allowing architects and other professionals to focus on more complex and valuable tasks. Using BIM software can help streamline the design process so architects can spend more time on creative solutions and less time on repetitive tasks.[1]

The principles of sustainable development are now widely accepted, but care must be taken to verify the actual claims made by companies about their use in the construction industry. It may be helpful to look for the following signs: vague or overly general statements, lack of third-party certifications such as LEED or BREEAM, disproportionate emphasis on one aspect, and lack of transparency. Companies that are truly committed to sustainability tend to be transparent about their environmental practices and are willing to provide information and data to support their claims. It is important to remember that no product or building will be perfect from a sustainability perspective and compromises are natural. However, it is important to be aware of greenwashing, conduct research, and do due diligence to ensure that claims about a product or building's environmental performance are accurate and backed by evidence.

Construction supply chains can be complex and involve multiple stakeholders and intermediaries. It is not easy to keep track of and understand all the materials used in a project, especially if they are sourced from different places. It is important that the supply chain is transparent to ensure that companies purchase ethically and sustainably, reducing disruption and increasing cost predictability.[2]

The importance of designing buildings and spaces that are accessible and welcoming to a wide range of people, including people with disabilities. This includes designing for pedestrians and creating spaces that promote social interaction and social participation.

This design approach incorporates elements of nature into the built environment to promote well-being and connection with nature. This includes using natural materials, incorporating greenery and natural light, and designing for natural ventilation. Biophilic design can differ from landscape design in many ways. Landscapes emphasize the design and planning of outdoor spaces such as parks, gardens and green spaces, while biophiles take a more holistic approach and strive to incorporate natural elements into all aspects of the built environment. This includes a wide range of strategies, including the use of natural light, natural materials and natural ventilation in buildings, the use of plants and other natural elements in the design of indoor and outdoor spaces, and visual connections to nature through windows. Overall, biophilic design offers a way to create livable and sustainable communities that adapt to people's needs and preferences and support health, well-being and productivity.

## RESULTS AND DISCUSSION

In Kazakhstan, action plans have already emerged for the introduction of information modeling technologies in the design of construction projects, said Sergei Prapchika, partner and managing director of Boston Consulting Group in Russia and the CIS. - This method involves creating a three-dimensional model of the building using appropriate software, and then based on this model, all decisions regarding the operation of the building during its life cycle are made. The technology can significantly reduce design and construction costs, as well as reduce risks associated with the human factor. In the USA and Great Britain, as well as in a number of countries in Southeast Asia, this technology is now a mandatory standard (mainly when implementing government projects).

Construction companies, as well as clients and society at large, will benefit from innovation. “Gradual change is not the best option. By redefining the final frontier, driving innovation in the construction industry will ultimately help solve society's biggest challenges, from mass urbanization to climate change,” says Michael Bowler, head of infrastructure at the World Economic Forum. and urbanization. : “Widespread implementation of these initiatives will help turn the tide economically and environmentally.”

## CONCLUSION

This article raises issues of introducing modern technologies and innovations in design. The use of automation in architectural design is proposed. Automation and other technologies can change the way we design. However, it is important to understand that these types of construction have unintended consequences, including potentially displacing workers or changing the nature of work in the industry. However, automation in the construction industry is not a new phenomenon, and many tasks that were once performed manually are now performed using various technologies (such as CAD, 3D printing, robotics, IoT construction tools) and tools. And while automation may replace some jobs, it is creating new jobs and allowing architects and other professionals to focus on more complex tasks. Using BIM software can help streamline the design process so architects can spend more time on creative solutions and less time on repetitive tasks.

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# THE EFFECT OF A COMPLEX MODIFIED ADDITIVE ON THE SETTING TIME OF FOAM CONCRETE

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***Abstract***

*Considering the rapid development of the construction industry and the great demand for new types of building materials, in the article the authors proposed a complex modified additive with a plasticizing effect, which favorably affects the structure of concrete. The article presents the results of a laboratory experiment conducted to determine the effect of a complex modified mixture in various percentages on the setting time of foam concrete. The work also describes a method for determining the setting time of cement paste, the preparation of a complex modified mixture in various percentage volumes. In this article, waste from the production of ethyl alcohol (post-alcohol bard), solidification accelerator (gypsum), foaming agent and alkali (caustic soda) were used to obtain the planned composite mixture. As a result of the experiment, it was found that the sodium compound neutralizes the post-alcohol bard, causing a synergistic effect when interacting with gypsum. Due to the plasticizing effect of the mixture, the interval between the beginning and end of the setting period was reduced and the intensity of the manufacturing process of the product increased.*

***Keywords:*** *cement paste, post-alcohol bard, modified additive, setting time, foaming agent*

## INTRODUCTION

Currently, along with the Message of the President Kassym-Jomart Tokayev, a key step in the implementation of the Development Strategy of Kazakhstan until the 2030s is to provide the population with high-quality housing [1-2]. In order to achieve this goal, it is necessary to construct high-quality and affordable buildings based on housing programs, as well as take measures to increase the sustainability of housing under construction to environmental impacts [3]. Since using building materials and products that reduce energy consumption ensure the comfort of the living environment, environmental safety and fire safety was considered as the basis of modern construction. Such positive changes in the construction sector have an impact on the production of construction tools and materials with new properties in reusing industrial waste [4].

The improvement of concrete material, which will become the basis of all construction in accordance with modern requirements, modification of its structure and properties by adding various additives, increasing the possibility of using artificial stone at each stage of construction, have become the basis of modern concrete technology. Peat-insulating foam concrete is of high importance among the types of concrete with such high properties in the construction industry. It is a high-strength and frost-resistant building material with water-repellent and heat-conducting properties with a cellular structure. It is known that it is formed when a mixture of cement and water is mixed with a special stable foam, and the mixture hardens.

For the preparation of foam added to concrete, rosin soap was mixed with casein glue or aluminum sulfur naphthenes and specimen from hydrolyzed animal blood were used [5].

Heat-insulating foam concrete was effective in the construction of low-rise buildings, as well as in construction in regions with a sharply continental climate.

In order to accelerate the pace of work in the construction industry, there are being considered the ways of obtaining a specially planned modifying mixture by adding water-reducing superplasticizers to concrete that accelerate the setting and the solidification of mixtures.

In our research work, samples were prepared from the mixtures included in it to obtain non-autoclave hardening of heat-insulating foam concrete based on industrial waste, the effect of their optimal amount on the setting time of cement dough was determined.

The object of the study is a modified mixture containing various percentage inclusions.

The purpose of the study is to prepare a modified mixture of different percentages and determine its effect on the setting time of the foam concrete.

In the article, the setting accelerator is defined as an additive that reduces the initial setting during the transition of the mixture from a plastic to a rigid state. A hardening accelerator is defined as an additive that increases the rate of early strength gain in concrete, affecting or not affecting the setting time [6-8].

The introduction of plasticizers allows you to influence the setting time and the kinetics of cement hardening, increases the strength, frost resistance and water resistance of concrete by reducing water consumption. Therefore, we took into account the specifics of these mixtures and used gypsum (hardening accelerator), alcohol production waste (post-alcohol bard) and alkali (caustic soda, NaOH) as part of the modifying mixture in our research work. Since post-alcohol bard, which is an inexpensive source of raw materials, contains an acidic medium, it was neutralized with caustic soda (NaOH). It is known that the combined use of gypsum, alkali (sodium hydroxide NaOH) and plasticizer (post-alcohol bard) improves the physico-chemical properties of the manufactured product.

## EXPERIMENTAL METHODS

Construction materials that meet the requirements and standards were used in order to fulfill the goals and objectives of the work, as well as to conduct the study. This:

1. Cement. M400 grade Portland cement as a binder;
2. In the form of the main component of the modified mixture - post-alcohol bard (ethyl alcohol waste) was used 2,5%, 5,0%, 7,5%, 10%; 2,5% in multiples. It was delivered in liquid form from JSC "Idabul distillery".
3. Hardening accelerator – gypsum, which accelerates the hardening process in quantities 1%, 1,5%, 2,0%, 2,5% of the mass of cement, a multiple of 0.5%.
4. Caustic soda (NaOH). Caustic soda, which is 5% of the amount of post-alcohol bard.
5. Foaming agent is a highly concentrated, highly efficient liquid which is used in the production of Foamed Concrete.

In our research work, we developed a modifying mixture with the addition of caustic soda together with modifying components in a cement mixture to obtain foam concrete with new properties. To do this, the components from which the binder and modifying mixture are made were combined in different percentages, and the physico-chemical properties of the resulting concrete product were studied by several methods.

At the first stage of work GOST 310.3-76 "Cements. Methods for determining the typical density, setting time and uniform volume change" investigated how the modifying additive affects the setting time of the dough of standard consistency (beginning and end of setting) in accordance with the requirements. We determined the normal density of the cement dough, the beginning and the end of the setting period with the Vic device shown in Fig.1

Fig. 1. Test samples on the Vica device

Determination of the setting time of the cement dough is one of the most important parameters of the concrete mixture, since further operational properties of concrete depend on them. This method led to the thickening and adhesion of the cement dough as a result of the interaction of cement and water. It is known from the literature that in the process of setting, the cement dough loses its plasticity and the possibility of processing, and the beginning of setting occurs no earlier than 45 minutes, the end - no later than 10 hours from the moment of mixing cement with water [9]. In the study, the setting time was carried out using six mixing coefficients (17 samples) consisting of Portland cement, additives and water. A sample consisting only of cement, foaming agent and water (sample 1) was called a reference sample, that is, a control sample, while in other samples the proportion of the additive varied, as shown in Table 1.

Table 1 - Composition and quantitative characteristics of the tested substances

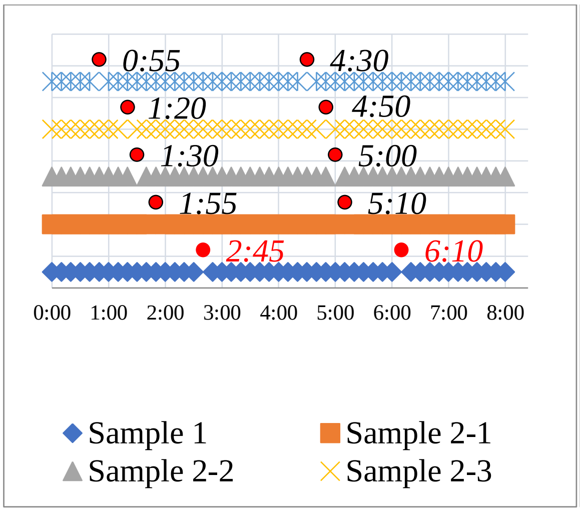
| № | Type of sample | Cement, g | Gypsum, g | Post-alcohol bard, g | Caustic soda, g | Water, g | Foaming agent, ml |
|---|---|---|---|---|---|---|---|
| 1 | Sample 1 Reference sample | 350 | - | - | - | 105 | 5 |
| 2 | Sample 2-1 | 346,5 | 3,5 | 8,75 | 0,4375 | 95,8125 | 5 |
| | Sample 2-2 | 346,5 | 3,5 | 17,5 | 0,875 | 86,625 | 5 |
| | Sample 2-3 | 346,5 | 3,5 | 26,25 | 1,3125 | 77,4375 | 5 |
| | Sample 2-4 | 346,5 | 3,5 | 35 | 1,75 | 68,25 | 5 |
| 3 | Sample 3-1 | 344,75 | 5,25 | 8,75 | 0,4375 | 95,8125 | 5 |
| | Sample 3-2 | 344,75 | 5,25 | 17,5 | 0,875 | 86,625 | 5 |
| | Sample 3-3 | 344,75 | 5,25 | 26,25 | 1,3125 | 77,4375 | 5 |
| | Sample 3-4 | 344,75 | 5,25 | 35 | 1,75 | 68,25 | 5 |
| 4 | Sample 4-1 | 343 | 7 | 8,75 | 0,4375 | 95,8125 | 5 |
| | Sample 4-2 | 343 | 7 | 17,5 | 0,875 | 86,625 | 5 |
| | Sample 4-3 | 343 | 7 | 26,25 | 1,3125 | 77,4375 | 5 |
| | Sample 4-4 | 343 | 7 | 35 | 1,75 | 68,25 | 5 |
| 5 | Sample 5-1 | 341,25 | 8,75 | 8,75 | 0,4375 | 95,8125 | 5 |
| | Sample 5-2 | 341,25 | 8,75 | 17,5 | 0,875 | 86,625 | 5 |
| | Sample 5-3 | 341,25 | 8,75 | 26,25 | 1,3125 | 77,4375 | 5 |
| | Sample 5-4 | 341,25 | 8,75 | 35 | 1,75 | 68,25 | 5 |

During the research work, we weighed the components of each sample on a scale, mixed them in a mixing device, and determined the beginning and end of the setting of the sample using the Vica device. To carry out the test with the help of the Vica device, cement dough was prepared in accordance with a certain order, using the volume of water necessary for normal consistency [9]. The control sample contained (100% Portland cement, i.e. 350 g, foaming agent 5 ml and a water content of about 105 g). The amount of raw materials required for experiments is shown in Table 1.

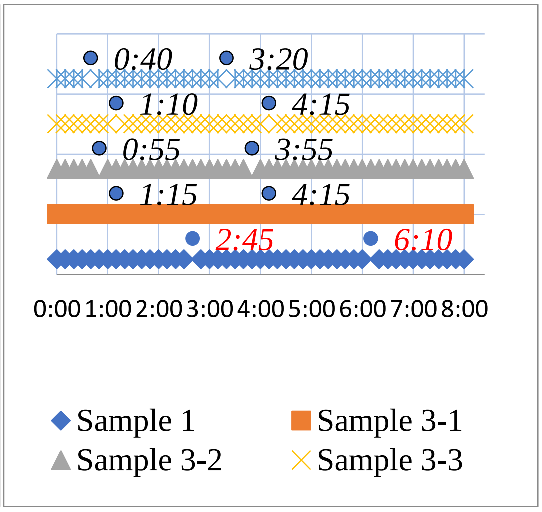
**RESULTS AND DISCUSSION**

In the research work, 17 samples of 5 types were prepared, from all of which the beginning and end of setting were determined, and the results are shown in the diagram. According to the results of the experiment in Fig.1, the modifying additive in optimal quantities led to a change in the setting time compared with the control. After adding the additive, it became clear that not only the time of the beginning of setting, but also its end, is reduced. From this process it was seen that even the addition of small amounts of additives intensifies the process of manufacturing products.

In the diagram shown in Figure 2, the first vertex (peak) represents the beginning of the setting, and the second represents the end. While the samples of the compared compositions were arranged in ascending order from bottom to top, the control variant without impurities in which the comparison was carried out corresponded to the 1st sample.




A




B

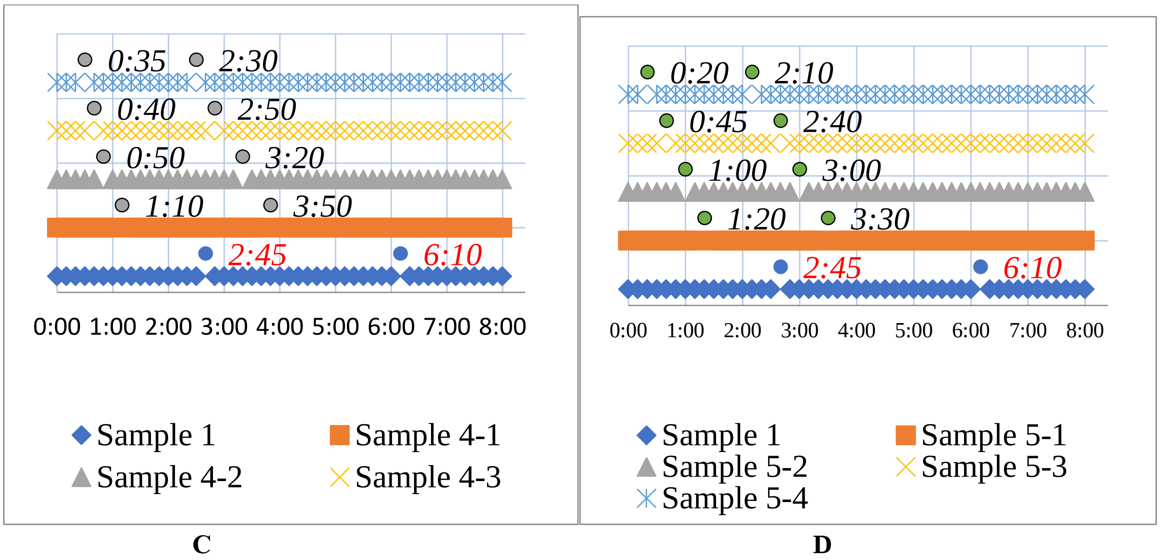



Fig.2. The results of the study of the setting time of foam concrete

The choice of additives used in the experiments was determined by the mechanism of their action. Post-alcohol bard has both hydrophilic and hydrophobic properties.

In addition, due to the plasticizing effect of the post-alcohol bard, the water-cement ratio decreased, the mobility of the concrete mixture was preserved, gave the structures (structures) strength and durability, which led to a favorable distribution of cement dough.

This additive wetted the surface of cement particles, which led to a decrease in the water-cement ratio. The combined use of a modified additive, the mechanisms of action of which are well combined with the processes of hydration, retention and solidification of the cement mass, mutually complemented and enhanced the effect of each ingredient of the additive.

It should be noted that the effect of the modified additive on the setting time of the cement dough largely depends on the number of inclusions. The effect of the studied compositions is due to the presence of gypsum in them, which is traditionally a hardener of cement dough and impurities that form films on cement particles that prevent water penetration during hydration.

In accordance with Table 1, when the quantitative indicator of the post-alcohol bard changes, the content of the sodium compound changes. A small amount of sodium hydroxide was used in the experiment (the optimal concentration was determined from previous studies), which stabilized the hydrogen index (pH) and created a neutral environment. Consequently, the values of sodium compounds will not be cost-effective for the production of cement systems. Since increased acidity slows down the setting time of concrete, therefore the hydrogen index should be neutral [10].

As shown in the results of the study in Figure 2, it was noticed that not only the beginning, but also the end of the setting are reduced. With a strong effect of the modified additive on the system, the tendency of cement setting decreased sharply compared to the control without impurities (sample 1), and also intensifies the hardening of cement in the early hydration periods at the age of 3 and 7 days.

As it can be seen from the results, the maximum plasticizing effect of the additive in the cement mortar was achieved at concentrations of 1.5-2.5% (gypsum) and 5-10% (post-alcohol bard) of the cement mass, equal to the ratio of C / W = 0.3. When the additive is introduced into the mortar mixture, it has a plasticizing effect, which reduced the water-cement ratio by 10% compared to the control composition. The manifestation of plasticization of cement dough was explained by the absorption of hydrophobic molecules on the surface of dispersed cement particles. The setting time of mixtures in solution depends on the concentration of the additive in them. With an increase in the concentration of the additive in the cement dough to 10% (post-alcohol bard) and 2.5% (gypsum) of the cement mass, the setting and hardening time of the cement dough was reduced, which not only affected the process of diluting the cement mortar, but also increased the compressive strength of the artificial stone.

While analyzing the graph in Fig.2, it was found that the beginning of setting in the sample with the additive occurred after 20 minutes-1 hour 55 minutes, and at the control (sample 1), the setting of the cement dough began after 2 hours 45 minutes. This case showed that the samples with the additive have a higher efficiency than the control ones (sample 1). All the mixtures in the picture have the same effect, but their effectiveness is different. With the addition of a modified additive, the setting time was reduced by 30% compared to the sample consisting only of cement, but the duration of setting of the cement dough remained the same, since the setting time was reduced by reducing the time of the end of setting. At the same time, the interval between the beginning and the end of setting was reduced by 40%. This indicator is important for dry building mixes because of the rapid adhesion of cement-containing compositions with water, which leads to the preservation of the plasticizing state and acceleration of the pace of construction work within a time that can be adjusted depending on the presence of an additive during solidification.

From the results obtained during the laboratory experiment, it is known that in 5-4 samples with an additive, the onset of setting was 20 minutes, which is one of the best indicators for obtaining foam concrete. Since it is important to determine the setting time when obtaining foam concrete, it is also necessary to take into account the beginning and end of setting when preparing cement dough and adding foam to it.

According to the results of the experiment considered above, it was found that the effectiveness of the modified additive and the number of components added to it during optimization have a synergistic effect, the interval between the beginning and the end of setting is reduced, the pace of construction work increases.

## CONCLUSION

Summing up the results of the conducted stage of the research experiment, there was a decrease in water consumption in the samples with the additive compared to the control sample and a reduction in the interval between the beginning and end of setting. In the control sample, the onset of setting was 2 h 45 min, and in the type 1-2 sample with an additive (1 h 55 min) and type 5-4 sample (20 min). And the end of setting decreased from 5 h 10 min to 2 h 10 min. A sample with an additive in a laboratory experiment showed that the beginning of setting in type 5-4 is 20 minutes, according to this indication, the amount of additives effective in obtaining foam concrete can be observed. The use of a plasticizing mixture (post-alcohol bard) in practice reduced water consumption by up to 35%. From these results, we see that in a cement dough containing a modifying additive, a plasticizing effect is observed, which shortens the setting time and accelerates the manufacturing process of products. In addition, the use of post-alcohol bard in the work means that industrial waste can be used in the construction industry, and this step is a reflection of the positive result of protecting the environment from pollution.

According to the study, the joint use of a compound of sodium, gypsum and post-alcohol bard created a synergistic effect and increased the physico-chemical properties of cement dough. The strength and durability of the manufactured product is also increased. The data obtained indicate the effectiveness of using a complex modifying additive. The modified additive makes it possible to accelerate the hardening and setting time of the foam concrete mortar.

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UDC 691.31+691.278

# STUDY OF PHYSICAL AND MECHANICAL PROPERTIES AND THERMAL CONDUCTIVITY COEFFICIENT OF PARTICULARLY LIGHT CONCRETE BASED ON LOCAL VERMICULITE

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***Abstract***

*This article examines the issues of creating effective components of vermiculite slab, thermal insulation, sound-absorbing, refractory ultra-lightweight concrete with functional properties obtained on the basis of foamed vermiculite and studying their properties. This article examines the issues of creating effective components of vermiculite slab, thermal insulation, sound-absorbing, refractory ultra-lightweight concrete with functional properties obtained on the basis of foamed vermiculite and studying their properties. Local raw materials are expanded vermiculite, liquid glass, portland cement, microcranes, kmts, lime cookies on the basis of various raw materials. physical and mechanical properties and thermal conductivity of vermiculite plate obtained on the basis of foamed vermiculite based on the composition of the heat-insulating mixture are considered.*

***Keywords:*** *foamed vermiculite, portland cement, liquid glass, thermal conductivity, thermal conductivity, strength, foaming coefficient, pressing, drying.*

## INTRODUCTION

As a result of the reforms carried out in our republic, the production of construction materials and products based on local raw materials is expanding today. Presidential Decision No. PQ-4335 of May 23, 2019 "On additional measures to accelerate the development of the construction Materials industry" was issued. According to this decision, the works that need to be carried out in the construction materials industry in 2019-2025 have been identified. [1,4,6]

The identified reserves of vermiculite raw materials in the world amount to more than 100 million tons, according to estimates, undiscovered reserves of raw materials amount to more than 200 million tons. South Africa, the USA, Russia, Uganda and China have large reserves of vermiculite. Vermiculite reserves are also available in Argentina, Australia, Canada, Brazil, Egypt, India, Japan, Kenya, Zimbabwe, Kazakhstan and Uzbekistan. In Uzbekistan, vermiculite is mined at the Tebinbulok mine, located on the territory of the Karauzak district of the Republic of Karakalpakstan. The identified reserves of vermiculite ore amount to 3,944,000 tons. As of January 1, 2021, 6 licenses for the right to use the Tebinbulok vermiculite deposit and 3 exploration licenses were issued to local entrepreneurs. It is estimated that 592 thousand tons (3 million 944 thousand tons or 15 percent) of vermiculite concentrate can be obtained from the identified active reserves [3,6,9].

## EXPERIMENTAL METHODS

experimental work was carried out using vermiculite ore extracted industrially from the Tebinbulok vermiculite deposit on the territory of the Republic of Karakalpakstan from a mining site allocated under the license of TRIUMPH-MINER LLC. For the production of vermiculite slabs, raw materials and composition selection were carried out in the following sequence:

- sieving of the extracted vermiculite concentrate, separation into small and large fractions;
- determination of specific gravity;
- determination of the chemical composition of vermiculite concentrate;
- swelling of vermiculite concentrate in a conveyor furnace at a temperature of 870-950 $^0$C;
- determination of the specific gravity of expanded vermiculite;
- mixing of raw materials components;
- pressing of a vermiculite plate sample on a hydraulic press;
- drying of vermiculite slab samples in a tunnel dryer;
- determination of flammability;
- determination of the heat transfer coefficient;
- determination of the sound transmission coefficient;
- determination of flexural and compressive strength;
- determination of impact resistance.

## RESULTS AND METHODS

Expanded vermiculite grains are divided into fractions of 0,5-1,0 mm, 1,0-1,6 mm, 1,0-3,0 mm and 5-8 mm in size: small – 0,5 from 3 mm and large - from 3 mm. from 5 mm to 8 mm. Expanded vermiculite by volume weight is divided into the following grades: 100, 150, 200, 250 and 300. The grains of expanded vermiculite have a large deformation: they are slightly compressed, as a result, the vermiculite becomes denser. The chemical composition of the vermiculite sample used as a raw material in the tests is presented in Table 1. [2,5,7].

Table 1- Chemical composition of vermiculite concentrate

| № | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ | $Na_2O$ | $K_2O$ | $TiO_2$ | $Cr_2O_3$ | $Mn_2O_3$ | $P_2O_5$ | Calcination losses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 36,08 | 14,43 | 12,77 | 3,69 | 14,90 | 0,11 | 0,00 | 5,69 | 1,35 | 0,0287 | 0,1404 | 0,00 | 4,75 |

The bulk weight and strength of the vermiculite grains depend on the conditions of its cooking and cooling: when the vermiculite is heated to 800-950 $^{o}$C, the strength of the grains decreases. Expanded vermiculite is a heat–insulating material characterized by high porosity, lightness and a certain heat resistance. Experimental work was carried out according to GOST 7076-99 [3,8,10].

The “heat transfer coefficient of heat-preserving building materials” and mechanical properties were determined using the equipment available in the laboratory (Figures 1-2):

- samples of vermiculite plate for experimental testing;
- machine for determining the heat transfer coefficient (machine type ND-2-30 C);
- hydraulic press;
- caliper SHTS-25 250;
- metal ruler MS;
- electronic scales CZ-3.


Fig.1. Determination of the strength of the vermiculite plate for bending and compression by experimental tests.

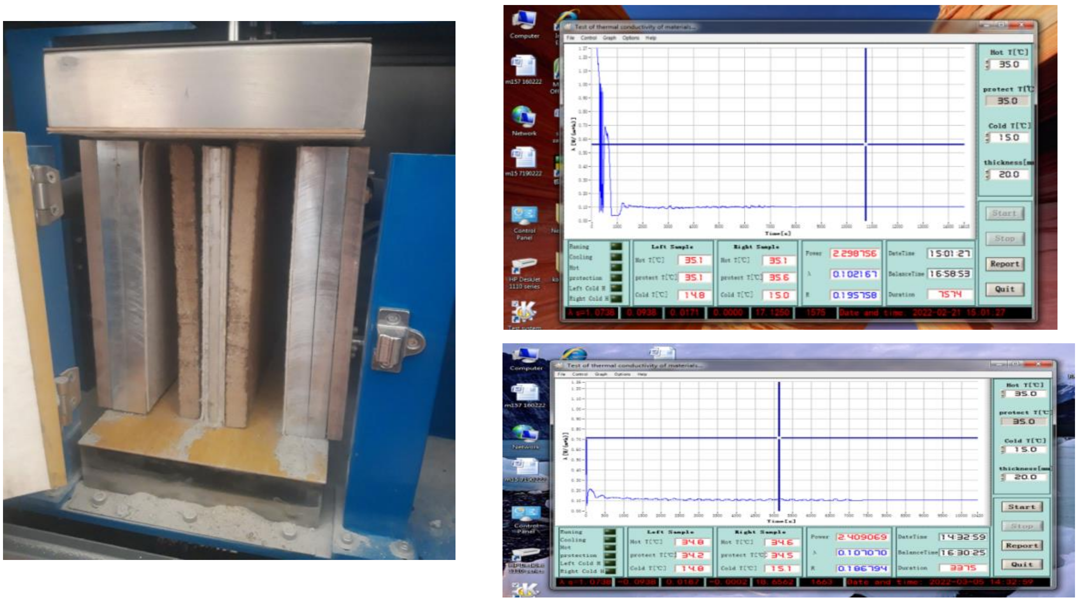


Fig.2. ((XD-2-30C machine) Determination of heat transfer coefficient of vermiculite plate

Table2. Physical and mechanical properties of an experimental plate based on expanded vermiculite

| № | Technological parameters | Research methods | Indicators |
|---|---|---|---|
| 1. | sound transmission coefficient | GOST 23499-2009 | 0,5 (f=500 Gs) |
| 2. | heat transfer coefficient | GOST 7076-99 | 0,102167 Wt/m*$^{o}$C |
| 3. | determination of bending strength | GOST 17177-94 | 1,9 MPa |
| 4. | determination of compressive strength | GOST17177-94 | 2,4 MPa |
| 5. | determination of flammability | GOST 30244-94 | 700 $^{o}$C |
| 6. | determination of impact resistance | GOST 11842-2021 | 2560 |

The vermiculite plate production line provides the movement of the initial components and binder, a mixer, distributors for the serial production of components and binder, a molding unit, a pressing, drying chamber, an edge trimming device and the receipt of finished products.

## CONCLUSION

The conducted scientific studies show that the thermal conductivity coefficient of the vermiculite plate obtained as a result of experiments ranges from. $\lambda$= 0,10 W/m*$^{0}$C to $\lambda$= 0,11 W/m*$^{0}$C, heat transfer resistance R=0,17 m$^{2}$*K/W to R=0,19 m$^{2}$*K/W. The bending strength Re = 1,9 MPa, compressive strength Rs = 2,4 MPa were obtained. The experimental samples were tested in laboratory conditions to determine their physical, mechanical and technical parameters in accordance with the requirements specified in the current regulatory documents.

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# LIGHTWEIGHT CONCRETE CONSTRUCTION WITH THE ADDITION OF OLIVE BIOMASS ASH FOR USE IN RESIDENTIAL BUILDINGS

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***Abstract***

*The ash generated during the combustion of biomass in electricity generation plants is a waste that has increased considerably in recent years, and whose management constitutes an environmental problem. In this regard, the recovery of biomass bottom ash as a partial replacement of natural materials for use in different civil engineering applications, as well as for the manufacture of construction materials, has been the subject of numerous studies that have shown its technical feasibility. However, for its application in the development of new environmentally friendly materials, with the properties of thermal insulation, it is necessary to expand our existing knowledge about it. In this study, the use of bottom ash from original and processed biomass bottom ash in the manufacture of lightweight concrete, as a replacement for sand (15%–25%) and expanded clay (25%–35%), has been evaluated. In addition, after subjecting the ash to a grinding process, it was also incorporated into the concrete by replacing cement. The physical, mechanical, thermal and durability properties were evaluated according to regulations and the results showed that the thermal treatment applied to biomass bottom ash improved the mechanical performance of lightweight concrete. Likewise, thermal conductivity was reduced by up to 43%, which allows these concretes to be used as insulating materials in buildings. Therefore, this study shows the possibility of recovering biomass bottom ash in the manufacture of lightweight concrete for use in construction.*

***Keywords:*** *Thermal conductivity, Durability, Biomass bottom ash lightweight concrete*

## INTRODUCTION

Currently, concern and respect for the environment, together with the progressive depletion of natural resources, has driven initiatives towards sustainable development, such as the recycling of industrial by-products and the implementation of a circular economy. The main reasons for moving towards a circular economy are the increasing demand for raw materials and the scarcity of resources. Several crucial raw materials are finite and, as the world's population grows, demand is also increasing. The use of industrial waste within the concrete industry is an effective alternative towards sustainable development. Concrete, the building material par excellence, is a benchmark with a high degree of economic impact in the building and civil engineering market. The possibilities for improving concrete in terms of the consumption of natural resources are still promising, with wide margins for innovation and development in the components of concrete (cement, additives and placeholders), in accordance with the new paradigms of environmental, economic and social sustainability [1].

In recent years, an increasing number of researchers and academics have shown interest in the sustainable development of concrete, such as the durability of concrete made from industrial byproducts additional cement materials and the recycling of concrete; consequently, concrete made from industrial byproducts (recycled concrete) has begun to attract all more attention as a possible use case in the construction of linear infrastructure. Studies show that the use of concrete made from industrial waste not only meets the operational requirements of conventional concrete, but also solves the problem of a shortage of landfills, which corresponds to the essence of sustainable development, i.e. environmental protection and resource reduction. In this regard, the use of ash generated at coal-fired power plants in the production of lightweight concrete has been studied in several scientific papers.

Improved the strength and reduced the porosity by incorporating furnace bottom ash and fly ash. Replaced sand with furnace bottom ash and the thermal conductivity could be lowered to around 70% to the control lightweight concrete. Developed an empirical equation for mechanical properties of lightweight concrete with bottom ash [2,3].

In the last decade, driven by concerns about $CO_2$ emissions into the atmosphere, the generation of electricity from biomass combustion has been consolidated as a way of obtaining energy in a more efficient way, while reducing pollution. The increase in biomass combustion also produces waste, as is the case of the ash from this process; the most common management of ash from biomass combustion is land filling, which has significant economic and environmental drawbacks. In accordance with the principles established by the European Union in sustainability policies, studies on biomass ash from heat and power generation have increased. There are numerous studies on the characterization of biomass ash, focusing on its physical and chemical properties and environmental behavior through the study of leac hates. Due to the heterogeneity of biomass bottom ash (BBA), there are not many studies using it as a potential building material. Carrasco et al produced compacted building blocks made from Portland cement and BBA, replacing cement with BBA in the range of 10%–90%. Manufactured new cement formulations replacing clinker with BBA. Used different BBA processing methods (crushed, calcined, without light particles, crushed and calcined) to produce mortars and study their mechanical and durability properties. Reported on the stabilization of expansive soils by removing lime and incorporating BBA, showing significant improvements in the mechanical behavior of the mixtures studied [4].

Some authors have studied the manufacture of concrete with BBA due to its potential use as a substitute for materials such as natural sand or cement. Analyzed the mechanical and durability properties of non structural concrete made with BPA, the results showed results of up to 35 MPa with 6% substitution of natural sand by BBA. Studied the physical and mechanical properties of conventional concrete made with 5% and 10% substitutions of sand by BBA, observing that the low pozzolanicity of BBA influenced the loss of strength.

Evaluated the properties of BBA with different treatments and the influence of their use on fresh and hardened properties (mechanical and durability) in the manufacture of self-compacting concrete. The study concluded with the recommendation to use self-compacting concretes with a maximum substitution of 30% of natural sand by BBA and up to 60% of filler by crushed BBA.

The use of BBA in lightweight concretes has been little studied. Reported the possibility of manufacturing lightweight concretes using recycled placeholders mixed with BBA, in which all mixtures presented compressive strength values within the limits established by the Spanish regulations for lightweight structural concretes. In this context, the use of BBA is conditioned by its physical and chemical properties, mainly by its heterogeneity. With all the above and with the widespread global concern for sustainable development, maximum interest has been given to the study of new building materials, including prefabricated ones, with thermal and acoustic insulation technology being an important method of energy saving, cleaner production, lower economic costs, if low-density concretes made with BBA are incorporated. All these new technologies and forms of construction are emerging rapidly [4].

Therefore, the main objective of the present work is to collaborate in the generation of knowledge on the performance related to thermal insulation for buildings without forgetting the mechanical and durability properties of lightweight concretes using BBA with three different treatments (oven-dried at 60°C, heated at 300°C and crushed) and lightweight placeholders.

The results obtained show the viability of the use of concretes made with BBA for use as insulators in building works. The durability of concrete is a fundamental issue, since it allows us to understand the behaviour of concrete throughout the useful life of a structure. The affectation of the concrete's durability behavior can be caused by agents external to the environment or by internal agents of the concrete, triggering one of the degradation phenomena that deserves the most attention, which is reinforcement corrosion.

The two main phenomena that initiate this pathology, by destroying the passive coating of the reinforcing bars, are carbonation and the penetration of chloride ion, and in this work, these durability properties have been analyses, to study their influence on the quality of the lightweight concrete with manufactured BBA [5].

## EXPERIMENTAL METHODS

Ordinary Portland Cement (C) type I with medium-high resistance 42.5 MPa at 28 days with high initial resistance R and sulphate resistant SR was used, CEM I 42.5-R SR. This type of cement is recommended for making normal high performance concrete, very suitable for the industrial manufacture of prefabricated structural elements that require maximum resistance. The composition in table 1.

Table 1- Chemical properties of cement (CEM I 42.5-R SR)

| Content (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | $Al_2O_3$ | $FeO_3$ | CaO | MgO | $SO_3$ | $K_2O$ | $Na_2O$ | Loss of ignition (LOI) |
| 19.31 | 1.40 | 4.45 | 66.01 | 1.26 | 3.32 | 0.35 | 0.08 | 1.42 |

As fine placeholder, a Natural Sand (NS) 0/4 mm size was used. As coarse placeholder, a Natural Coarse Gravel (NCG) 8/16 mm size and a Natural Medium Gravel (NMG) 4/8 mm size were used. These placeholder come from a dolomitic quarry located in Padul, Granada. The main properties and standard used are listed in Table 2, and their granulometries are shown in Fig. 1.

Expanded clay (EC) is a light placeholder of ceramic origin that is obtained from ground clay that expands when fired at 1200°C in rotary kilns. This processing gives it a very porous internal structure, as well as high resistance, which is why it is usually used in the manufacture of lightweight concrete (LWC). EC properties are presented in Table 2, and its granulomere is shown in Fig. 1.

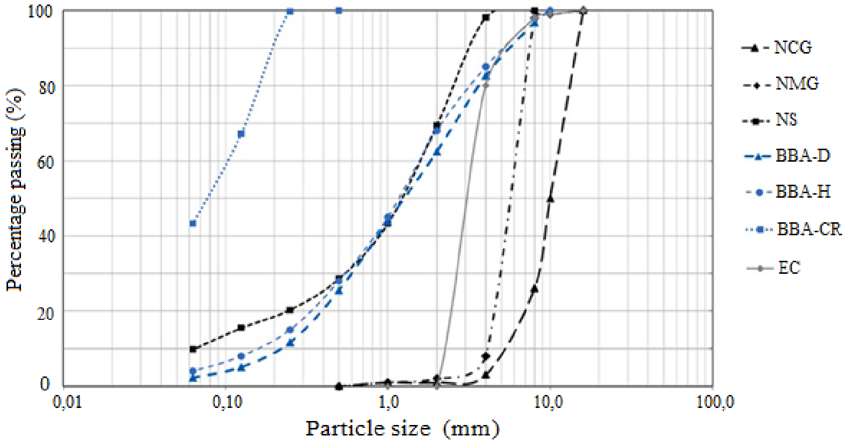

Fig. 1. Particle size distribution curve

Biomass bottom ash. BBA is composed of coarse unburned particles produced in the primary combustion chamber at a temperature of 405°C during the biomass energy production process. The biomass used as fuel supply for the generation of electricity is made up of 60% wood from almond and olive pruning, and 40% olive cake. BBA properties depend on the origin of the biomass as well as the technology of the combustion process. Although the biomass may present some variability, all the material comes from areas close to the combustion plant, so the variability is less. The properties of BBA from the same combustion plant are somewhat homogeneous. Three types of processing were carried out on the BBA to be used in this study. BBA were processed in the laboratory to obtain different materials to manufacture LWC:i) BBA dried (BBA-D): BBA was dried at 60°C in an oven for 24 h; ii) BBA heated (BBA-H): BBA was burned at 300°C in an oven for 5 h; and iii) BBA crushed (BBA-CR): BBA was crushed in an abrasion equipment used for sands, composed of 4 rotating cylinders and an abrasive load of steel balls; to obtain a fine granulomere material 0,5 kg of mater ial with 2,5 kg of abrasive load was subjected to 6000 revolutions. These materials were used in the manufacture of LWC: BBA-D and BBA-H as a replacement for NS and EC, and BBA-CR as a replacement for cement [6].

Table 2 - Physical properties of natural placeholders and BBA

| Properties | NS | NCG | NMG | EC | BBA-D | BBA-H | BBA-CR |
|---|---|---|---|---|---|---|---|
| Granulomere/Size (mm) | 0/4 | 8/16 | 4,8 | 3/8 | 0/10 | 0/10 | - |
| Fines content (%) | 7,51 | - | - | - | 3,02 | - | - |
| Sand equivalent (%) | 51 | - | - | - | 43 | - | - |
| Apparent density of particles (kg/dm³) | 2,83 | 2,76 | 2,76 | 0,63 | 3,12 | 2,38 | - |
| Density of dry particles (kg/dm³) | 2,74 | - | - | - | 1,895 | - | - |
| Density of saturated particles, (kg/dm³) | 2,77 | - | - | 0,96 | 2,085 | 2,14 | - |
| Water absorption (%) | 1,2 | - | - | 15 | 8,7 | 9,8 | - |
| Friability ratio (%) | 21 | - | - | - | 18 | - | - |
| Density of set (kg/dm³) | - | - | - | 0,36 | - | - | - |
| Real density of filler (kg/dm³) | - | - | - | - | - | - | 2,543 |
| Specific surface area ($m^2/g$) | - | - | - | - | - | - | 0,816 |

The physical properties of BBA-D, BBA-H and BBA-CR are listed in table 2. As can be seen, the fines content of BBA-D (3,02%) is lower than NS (7,5%). However, the low bulk density value (3,12 kg/dm$^3$) as well as high water absorption capacity (8,7%) are due to the high porosity of BBA. The friability coefficient determines the degree of fragmentation of the fine placeholder, being 18% for BBA and 21% for NS [4].

As shown in Fig. 1, BBAs present a continuous particle size distribution, allowing an adequate coupling of the LWC component particles. The laser granulometry test carried out by wet method was able to determine the specific surface area and the particle size distribution of BBA-CR.

The chemical composition, as well as the chemical properties of BBA are listed in table 3. The chemical composition determined by XRF establishes that $Al_2O_3$, $Fe_2O_3$, MgO and other components, mainly composes of $SiO_2$, CaO and $K_2O$, and in percentages less than 10% BBA.

Due to the high potassium content of BBA, an alkali silica reaction (ASR) study was carried out. The combination of BBA with cement in the manufacture of concrete can lead to expansive actions caused by hydroxide ions with the alkalis (sodium and potassium). The alkali-silica reaction occurs when some forms of silica and hydroxide ions contained in the placeholders react with the alkalis present in the interstitial solution of the concrete. This reaction forms a gel which, when absorbing water, expands and deteriorates the concrete. To determine the potential reactivity of alkali-silica and alkali-silicate BBA. 3 shows the results obtained.

## RESULTS AND DISCUSSION

In the case of BBA, the alkali-silica reaction is mainly due to the potassium content present. The BBA values were located in the non-reactive placeholders, which demonstrates the non-reactivity of this type of material. Values similar to those obtained in previous studies in which it was found that although BBA have a high potassium content, they are not considered reactive placeholders in the ASR evaluation.

The analysis of BBA leach ates was carried out according to the European standard UNE-EN 12457-4. The leach ate concentration of elements was determined with an L/S ratio of 10 l/kg in order to classify BBA as inert, non-hazardous or hazardous waste according to the European Council Decision 2003/33/EC. As can be seen, Cu is the only element that exceeds the limit for inert waste.

Preliminary analysis shows crystalline phases of calcite ($CaCO_3$) and quartz ($SiO_2$) as main elements; BBA is composed of portlandite ($Ca(OH)_2$, lausonite ($CaAl_2Si_2O_7(OH)_2H_2O$), wadeite ($K_2O_9Si_4$) and kalsilite ($AlKO_4Si$) [5].

Table 3- Chemical composition and chemical properties of BBA.

| Chemical composition (XFR) | Content (%) | Chemical properties | Content (%) |
|---|---|---|---|
| Standard | EN 196-2 | Water-soluble sulphate (% $SO_3$) | EN 1744-1 |
| $SiO_2$ | 26.51 | Acid-soluble sulphate (% $SO_3$) | 0.19 |
| CaO | 23.94 | Water-soluble chlorides | 0.19 |
| $K_2O$ | 14.68 | Organic matter content | 0.25 |
| $Al_2O_3$ | 7,9 | Water-soluble sulphate (% $SO_3$) | 3,31 |

Continuation of table - 3

| | | | |
|---|---|---|---|
| $Fe_2O_3$ | 4,12 | | |
| MgO | 3,27 | | |
| $P_2O_5$ | 2,67 | | |
| $SO_3$ | 1,15 | | |
| $Na_2O$ | 0,78 | | |
| $TiO_2$ | 0,53 | | |
| MnO | 0,07 | | |
| LOI | 13,5 | | |

## CONCLUSION

This research evaluates the use of BBA as a replacement material, replacing sand, expanded clay as a lightning material and/or cement in the manufacture of lightweight concrete for construction elements. The design of dosages with different levels of substitution, incorporating BBA processed in an appropriate way, has allowed the following conclusions to be obtained.

- The density of BBA is greater than that of expanded clay, but with adequate doses, lightweight concrete can be achieved.
- The apparent density of the concrete with the incorporation of BBA were less than 2000 kg/$m^3$, which allowed it to be classified as lightweight concrete in accordance with the Spanish Structural Code.
- The compressive strength values of the concrete made with BBA decreased with respect to the control concrete. However, the use of BBA pre-heated to 300°C as a replacement for sand and expanded clay managed to achieve a compressive strength value at 28 days, similar to that of the control concrete.
- The process applied to the BBA to achieve better properties in this waste, and the higher degree of substitution applied, did not affect the dimensional changes produced in the lightweight concrete.
- The thermal conductivity decreased up to 43% with respect to the control concrete, which allows these types of concrete to be used as insulators materials for construction.
- The ultrasonic propagation speed decreased in lightweight concrete with BBA, being the lowest value in lightweight concrete with replacement of sand and expanded clay due to the higher porosity and lower density of this series.
- Regarding durability, the average depth of carbonation increased in all the concrete, with higher carbonation penetration in the concrete with higher replacement of conventional materials by BBA.
- The permeability of lightweight concrete to the passage of chlorides increased with the incorporation of BBA, and it was similar to that of the control concrete when the cement was also replaced by crushed BBA.

- The maximum depth of water penetration of the evaluated concrete mixtures was reduced up to 17% with the incorporation of BBA.

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# ASSESSMENT OF THE ENVIRONMENTAL IMPACT ON THE PRESERVATION OF THE MONUMENT OF ANCIENT ARCHITECTURE IN SOUTHERN KAZAKHSTAN

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***Abstract***

*The issue of long-term operation of a unique object under the influence of various natural and climatic factors is considered. Practically all the bearing elements of this building are hygroscopic, as a result of which their physical condition is largely subject to changes as a result of fluctuations in air humidity, which in the internal space depends on the movement of air flows, the perceived energy of the sun by the object, structural disturbances in the process of numerous reconstruction and restoration works. According to year-round observations, factors that worsen the temperature and humidity regime of the building are given. The need for additional scientific research to assess the current state of the TVR and the development of measures to restore its stable operational condition is indicated.*

***Keywords:*** *Temperature and humidity regime, natural and climatic impacts, processes of wind-heat-humidity exchange.*

## INTRODUCTION

As a result of the influence of various influences during the long-term operation of buildings and structures, physical wear occurs both of the construction object as a whole and of its individual structural elements. During the entire period of operation, the natural and climatic environment influences the construction objects. These are, first of all: solar energy, wind and temperature factors, precipitation, heat energy of the earth, groundwater, if they are available in the immediate vicinity of the foundations. It should also be noted the production activity of a person, which can also have destructive effects in the case of ill-considered work both inside the building itself during restoration and reconstruction works, and around it. Depending on the intensity of the influence of one or several of the above factors, the building may experience complex negative impacts of varying degrees – from minor to very significant. Over the many years of operation of various architectural monuments, much attention has been paid to these issues. Since specialists from different countries in various natural and climatic conditions of operation of architectural monuments have repeatedly faced the problem of ensuring their long-term operational reliability /1-5/. However, there are no scientific conclusions and recommendations that would give comprehensive, exhaustive answers to all the questions that arise during the operation of many unique objects. This is due to the specifics of functional processes, spatial planning and design solutions of the construction objects themselves, as well as to the variety of natural and climatic influences inherent in different regions where buildings and structures are erected and operated.

### Temperature and humidity regime

Maintaining the required temperature and humidity regime (TVR) inside the building is a determining factor that creates favorable conditions for its long-term operation. Acceleration of the aging process of building structures occurs due to an increase in excess of permissible values of humidity, as well as with its sharp fluctuations. Most building elements of a building easily absorb moisture, which is why their physical condition is largely determined by the presence of water vapor in the air. Exceeding the regulatory limits of relative humidity and temperature in the internal volume of the building contributes to the spread of mold, fungi, efflorescence, erosion, peeling of finishing coatings that destroy the exterior surfaces of building structures. Humidity inside the premises, during operation, becomes greater than outside the building. At the same time, it should be noted that the humidity of the internal surfaces of the building can be significantly adjusted downward due to proper ventilation, especially if the outside air temperature is higher than inside the building. In conditions of increasing humidity, the intensity of destruction of building elements is rapidly increasing. So, for example, in the walls there are detachments in the plane of the wall. The reason is the dew point shifting inside the moistened wall. In the actual practice of operation, the distribution of humidity over the depth of structures is not taken into account, which does not allow for sufficiently accurate compliance with the regulatory TVR in its internal space. [1].

Due to the high location of groundwater, humidification is noted from below, due to the capillary rise of water into the lower part of the building – floors and adjacent sections of walls. In some cases, groundwater contains aggressive salt compounds that destroy the materials of walls and floors.

Taking into account the wind regime of the construction region should be taken into account when forecasting the humidity state of the interior surfaces of premises, since the processes of wind-heat-humidity exchange are closely interrelated. If the required air exchange regime is not observed in the entire volume of the operated building, air stagnation zones are formed, which, as the analysis of field observations shows, are located in the corners and along the outer walls of the premises. The issue of the influence of the movement of outdoor air (wind) on the temperature and humidity condition of the interior, namely, multilayer coatings of floors, walls and ceilings requires further study and development. Detailed studies of the influence of the wind regime in the general model of moisture exchange should contribute to ensuring the durability of building elements. [2].

One of the most important physical parameters that determine the microclimate in the interior of buildings is the air temperature. The vertical temperature change characterizes the TVB and depends, in turn, on a number of factors: the influence of solar radiation, the temperature difference from the outside and in the interior of the building, the thermal parameters of walls and coatings, air permeability, the propagation of air flows at various levels in the height of the building, etc. The issue of heating the building in cold weather becomes of great importance the time of the year.  In the warmer months, there is a more uniform distribution of temperature over the height of the building.

Once again, we emphasize the need to comply with the required temperature and humidity conditions during the operation of architectural monuments. The fact is that the unique construction objects created are cultural heritage and, often, cannot be recreated anew, since they use techniques and materials that have no modern analogues. Therefore, if these monuments or their fragments are damaged due to moisture or the occurrence of, for example, mold, etc., then it is not possible to restore their physical condition in its original form, in fact, it is not possible. [3].

The mausoleum of H.A. Yasawi in the south of Kazakhstan, which has a world cultural heritage, belongs to unheated buildings. In view of its historical, cultural and religious significance, it is taken under the patronage of UNESCO.  During the period of these scientific studies, an increase in humidity of internal structural elements – walls, floors, domes, stalactites, etc. - was noted in the mausoleum. This manifests itself in the form of dark spots that are well defined visually. Moreover, at first glance, the spread of moisture spots does not have any regularity, they are located randomly in different rooms of the mausoleum. In order to identify the regularity of humidification of this object, which is significant for the whole Republic of Kazakhstan and the world community, a methodology was developed and experimental studies were carried out.

The obtained results of instrumental measurements show that the humidity of the lower part of the walls is inextricably dependent on the appearance of dampness in the floors. In the rooms: Kazanlak, Mosque, Kitaphana, Ashana and Bolshoy Aksaray, the humidity of the floors was the strongest and manifested itself in the form of spots of different shapes. [2-3].

For the convenience of comparing the development of humidity of walls and floors by mausoleum premises and by seasons, the data obtained are averaged and shown in Table 1.

Table 1-Average humidity data of walls and floors

| | Spring | Summer | Autumn |
|---|---|---|---|
| Humidity of the walls | | | |
| Kudukhana | 2,49 | 1,76 | 1,75 |
| Big Aksaray | 1,94 | 1,29 | 1,75 |
| Askhana | 2,68 | 0,78 | 1,15 |
| **The average value of humidity in the walls** | **2,37** | **1,27** | **1,55** |
| Humidity of floors | | | |
| Kazanlak | 8,7 | 2,58 | - |
| Mosque | 37,2 | 3,8 | 7,72 |
| Kitaphana | 12,41 | 2,88 | 6,52 |
| **The average value of humidity in the floors** | **19,34** | **3,08** | **7,12** |

From the data given in the table, it follows that both in the walls and in the floors, the maximum humidity was observed in spring and autumn, and in summer it decreases. Thus, in the walls of the studied premises in spring (March), the average humidity was 2.37%, in summer (July) - 1.27%, in autumn (October) – 1.55%. In the constructions of floors: in spring (March) – 19.34%, in summer (July) – 3.08%, in autumn (October) – 7.12%. Therefore, it can be argued that cycles of "wetting – drying" are traced in the constructions of the walls and floors of the mausoleum, in accordance with the cycles of the seasons. It is also confirmed that the moisture content in the floors is almost always greater than the moisture of the walls: in spring (March) – 19.34% - in the floors; 2.37% - in the walls; in summer (July) – 3.08% - in the floors; 1.27% - in the walls; in autumn (October) – 7.12% - in the floors; 1.55% - in the walls. Moreover, the amplitude of the increase in humidity of the floors is much greater than in the walls. The humidity of the floors rose in the spring to 19.34% , and the walls to 2.37% . In summer, these figures were respectively equal - 3.08% - in the floors and 1.27% - in the walls. This indicates the spread of humidity in the "bottom – up" direction and it is the greater in the walls, the lower the reference point under study is located. [3].

This is confirmed by experiments conducted in the Kudukhana corridor, where humidity measurements were carried out using reference points fixed vertically and horizontally of the moistened section of the wall. The data is given in table 2.

Table 2-Humidity in the structures of the corridor wall Kuduhany vertically and horizontally.

| Kudukhana Corridor | Number of points | Date of measurements | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 19.03. | 26.03. | 01.04. | 13.07. | 09.09. | 23.09. | 06.10. |
| Vertical | 1 | 1,6 | 1,8 | 1,6 | 1,8 | 1,7 | 1,8 | 1,8 |
| | 2 | 2,0 | 2,0 | 1,9 | 2,0 | 2,0 | 2,1 | 2,1 |
| | 3 | 4,2 | 5,0 | 5,4 | 6,7 | 6,5 | 6,0 | 6,7 |
| | 4 | 9,4 | 10,3 | 11,0 | 10,5 | 10,5 | 9,3 | 9,8 |
| | 5 | 2,1 | 2,1 | 2,1 | 2,2 | 2,1 | 2,2 | 2,2 |
| Horizontal | 1 | 7,1 | 9,9 | 9,6 | 7,6 | 8,5 | 7,2 | 9,2 |
| | 2 | 6,7 | 9,3 | 10,4 | 8,0 | 8,2 | 7,4 | 8,5 |
| | 3 | 9,0 | 11,5 | 11,3 | 10,5 | 7,1 | 8,2 | 6,6 |
| | 4 | 11,4 | 11,7 | 12,8 | 13,0 | 10,5 | 9,3 | 9,8 |
| | 5 | 7,4 | 10,0 | 10,8 | 9,9 | 10,0 | 9,3 | 8,4 |

## CONCLUSIONS

The building of the mausoleum of H.A. Yassawi was successfully operated for a long time. But at the moment, additional scientific research is required to assess the current state of the TVB and develop measures to restore its stable operational condition.

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# ASSESSMENT OF POZZOLANIC ACTIVITY OF MINERAL ADDITIVES TO CONCRETE AND MORTAR


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***Abstract***

*Mineral additives play an important role in cement and concrete production, as their use leads not only to saving the most expensive component of concrete - Portland cement but also to increasing the mechanical strength and durability of concrete structures. It is also necessary to consider that the use of local materials in construction allows to solve economic and environmental issues. When choosing mineral additives for concrete and mortars, one of the main criteria is their pozzolanic activity. This article is devoted to the study of different methods of pozzolanic activity of mineral additives such as fly ash, fly ash, slag ash mixture, metakaolin, and silica fume. The results of studies of the pozzolanic activity of the investigated mineral additives are given.*



***Keywords:*** *method, mineral additives, pozzolanic activity, pozzolans, lime, silica fume, fly ash, metakaolin, ash slag mixture*

## INTRODUCTION

The increasing volume and pace of construction around the world is increasing the demand for cement and concrete, which consequently leads to increased greenhouse gas emission problems due to cement production. One way to address these issues and save cement in the production of concrete and mortar is by using mineral admixtures. Mineral admixtures are powder and are introduced in concrete 30 to 200 kg/m3 or more [1]. P. Mehta divides mineral admixtures by origin into natural and artificial [2]. Natural - processed for the sole purpose of producing pozzolana. Processing usually involves crushing, grinding, and size separation; in some cases, this may also include thermal activation. By-products that are not the primary product of the industry that produces them. Industrial by-products may or may not require any processing (e.g. drying and grinding) prior to use as mineral additives [1-3].

Mineral additives depending on the nature of interaction with cement hydration products are subdivided into types [4] - type I - active mineral; - type II - inert mineral; Active mineral additives are subdivided into the following groups: - possessing binding properties; - possessing pozzolanic activity; - possessing both binding properties and pozzolanic activity. According to the classification, ASTM C618 mineral additives are categorized into the following types [5]: N - raw or calcined natural pozzolan, such as some diatomites; opal flints and shales; tuff and volcanic ash or pumice; some clays or shales requiring firing; F - loose ash with pozzolanic properties, usually derived from anthracite or bituminous coal; C - fly ash with pozzolanic and cementitious properties, usually derived from lignite or semi-bituminous coal. May have a lime content of more than 10 %.

In concrete mixtures, mineral admixtures are often used to reduce cement consumption, improve the technological properties of the mixture, and increase the strength and durability of hardened concrete. The main properties of mineral additives are dispersibility, pozzolanic activity, and water content [1], which are interrelated with each other.

When active mineral additives are added to concrete, the pozzolanic reaction starts with the hydrolysis of silica and aluminosilicates of the active mineral admixture, which then interacts with calcium hydroxide formed by the hydration of cement [3]. This process leads to the formation of solid products such as calcium hydrosilicate (CSH) and calcium hydroaluminate (CAH), which provide strength and durability to concrete [6]. The pozzolanic reaction is slow, consumes calcium hydroxide (CH), and reduces the pore and grain size of the cementitious system. The pore refinement effect is due to the ¬ formation of additional CSH, which fills large capillary pores, increasing the strength and impermeability of the system; and grain refinement is due to the reduction of CH crystal content and size, matrix enhancement, and -sealing of the transition zone [2].

When selecting an active mineral additive, its pozzolanic activity should be investigated. There are many methods to evaluate the pozzolanic activity of mineral additives. S. Donatello et al. [7] divide them into direct and indirect methods. Direct methods involve the determination of $Ca(OH)_2$ content during the time of the pozzolanic reaction, using analytical techniques such as classical chemical titration, X-ray diffraction (XRD), and thermogravimetric analysis (TGA). In this field, the most widely used method is the Frattini test, which measures the amount of calcium hydroxide consumed by the mineral additive [8]. In the indirect test method, properties such as compressive strength, electrical conductivity, or heat generation using conductive calorimetry, etc. [7].

Authors [9] emphasize that there is no universal method for the determination of pozzolanic activity, and the choice of method depends on specific conditions and requirements. Researchers [10] emphasize the advantages of the rapid method, such as its high speed and accuracy in determining the activity of silica raw materials.

The purpose of this study was to evaluate, different methods of testing pozzolanic activity. Three methods of pozzolanic activity testing were used to evaluate the pozzolanic activity of four different pozzolans tested and the results were compared.

## MATERIALS AND RESEARCH METHODS

The following mineral additives were selected for the research - fly ash and slag ash mixture of dry disposal of Angren TPP, silica fume of JSC "Uzmetkombinat", and metakaolin fired at a temperature of 600 °C. Metakaolin used in the research was obtained by calcination of 20 mm pellets from kaolin clay of Angren deposit at a temperature of 600 °C for 1 hour. After that, the samples were cooled to room temperature. All the samples of mineral additives were dried to constant weight for the studies. Metakaolin and slag ash were ground in a laboratory planetary mill.

The mineralogical composition of the mineral additives was investigated by X-ray phase analysis, using a RigakuMiniFlex 600 X-ray diffractometer.

The following three methods were applied to compare the pozzolanic activity of mineral additives:

- the first method is based on the determination of lime uptake from the saturated solution of silicon oxide of mineral additive, a full description of which is given in the literature [11]. Determinations were carried out every 2 days, for 30 days;

- the second method involves the determination of pozzolanic activity by heating 1 g of mineral additive in a 30% NaOH solution at a temperature of 90 °C for 2 h. A full description of this is given in the literature [10].

The mineral additive activity coefficient ($C_a$, %) determined by this express method was calculated by the formula:

$$C_a = \frac{m_1 - m_2}{m_1} \cdot 100\%$$

where $m_1$ - mass of initial mineral additive, g; $m_2$ - mass of dried mineral residue, g.

The application of the developed express method for determining the activity of a mineral additive allows ranking the latter by the value of the activity coefficient into highly active ($C_a$ from 51 to 100% and above), active ($C_a$ from 21 to 50%), low-active ($C_a$ from 5 to 20%) [11].

- the third method also involves the determination of lime absorption from saturated solution by silicon oxide of the additive, a full description of which is given in the literature [11]. The amount of CaO absorbed by 1 g of active mineral additive (AMA) from saturated calcium hydroxide solution was calculated taking into account the differential correction for the change in the solubility of calcium hydroxide with temperature change by the formula:

$$CaO = 1{,}4 \cdot 2 \left[ \frac{V_0(V_2 - V_1)}{V_2} \right]$$

where 1.4 - titer of 0.05 mol/l hydrochloric acid solution for CaO (differential correction), mg/mL g; $V_0$ - volume of hydrochloric acid used for titration of 50 ml of saturated calcium hydroxide solution without AMA at temperature (20 ± 2) °C, ml; $V_1$ - volume of hydrochloric acid consumed for titration of 50 ml of analyzed solution with AMA at temperature 85 °C-90 °C, ml; $V_2$ - volume of hydrochloric acid consumed for titration of 50 ml of saturated calcium hydroxide solution without AMA at temperature 85 °C-90 °C, ml.

The arithmetic mean of two results of determination of the amount of CaO absorbed from saturated calcium hydroxide solution by one gram of AMA was taken as the test result if the difference between the results of two parallel determinations does not exceed 1% of the arithmetic mean.

## RESULTS AND DISCUSSIONS

X-ray diffraction analysis

In order to study the phase compositions, an X-ray diffraction analysis of the investigated mineral additives was carried out. Fig. 1 shows the results of the X-ray diffraction analysis of metakaolin and fly ash. As a result of the analysis, it was found that metakaolin has an amorphous structure. Broad and less pronounced peaks, as well as "noise" between the main peaks, may indicate the presence of amorphous (disordered) silica. Amorphous silica does not have a characteristic crystalline structure, so it appears as "blurred" peaks or a background intensity distribution on the diffraction. The main and most pronounced peak, which probably indicates a significant quartz ($SiO_2$) content. This sample also contains small amounts of impurity phase (residual kaolinite and montmorillonite). The fly ash, along with a large amount of quartz phases, also contains hematite and albite as impurities.

The results of the X-ray phase analysis of silica fume and ash and slag mixture of dry removal are shown in Fig. 2. Diffractogram of silica fume shows that along with the amorphous phase, there are small amounts of impurities of crystalline quartz and hematite. In contrast to silica fume in the composition of ash and slag mixture of dry removal along with a large amount of quartz, there are also dolomite, anorthite, and calcite.

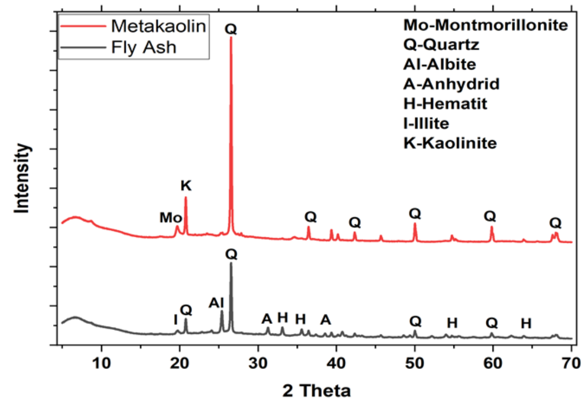


Fig. 1.X-ray patterns of metakaolin and fly ash

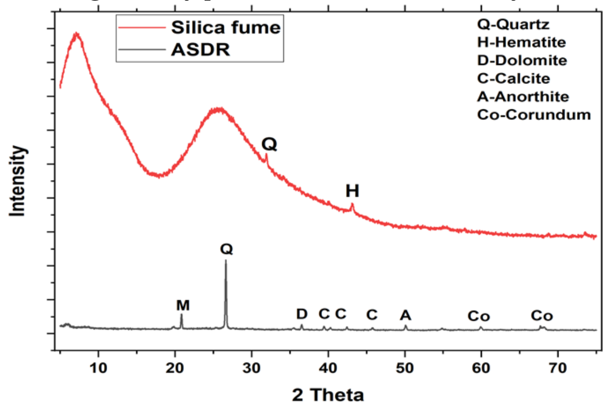


Fig.2. X-ray patterns of silica fume and slag ash mixture of dry disposal

Determination of pozzolanic activity

The obtained data of research (Fig.3) on pozzolanic activity of mineral additives by the method of calcium hydroxide absorption from a saturated solution of lime, showed that two days from the beginning of the experiment, stored in room conditions, the difference in pozzolanic activity of the studied mineral additives is noticeable. During this period the highest index of lime absorption from the lime solution was for silica fume, which was equal to 58.8 mg/g. This index for metakaolin was equal to 42 mg/g and respectively 32.2 and 26.32 mg/g for dry and fly ash mixture. As we indicated the experiments were conducted for 30 days. In the conducted studies it was found that the intensity of lime uptake by silicon oxide of mineral additives was also found to be unequal. By 30 days the highest index was recorded for silica fume, which was equal to 475.86 mg/g. These values for other mineral additives were equal to 293.16; 195.56 and 190.26 for metakaolin, dry fly ash, and fly ash mixture respectively.

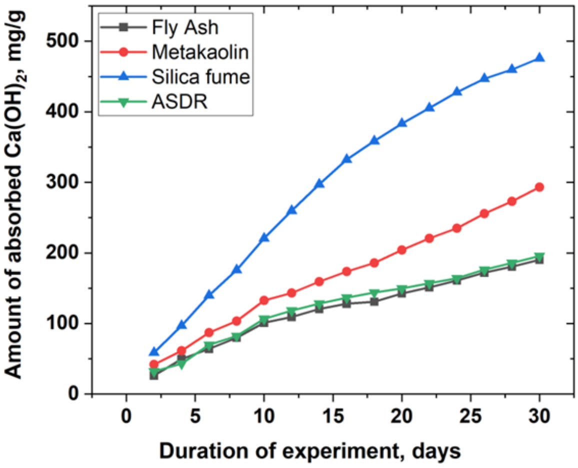


Fig.3. Absorption by mineral additives of $Ca(OH)_2$ in time, from saturated lime solution

The obtained results emphasize the differences in the chemical activity of the studied active mineral additives. Such a high index of lime absorption by silica fume can be explained by the fact that, firstly, the high specific surface area (23328 cm2/g) of silica fume and a higher content of amorphous silica in its composition.

The obtained results of studies of determination of the amount of CaO absorbed by 1 g of AMA from saturated calcium hydroxide solution (the second method) showed (Fig. 4) that the highest value of this index was for silica fume, which was equal to 103.62 mgCaO/g. The other mineral additives showed the following values of 76.32; 72.96 and 65.91 mgCaO/g for metakaolin, fly ash, and dry fly ash respectively. This high difference of one-day values from the results obtained by the first method can be explained by the effect of temperature on the course of the absorption reaction, since in the second method saturated solutions with samples of mineral additives were subjected to heat treatment at 90 oC for 8 hours. After the end of the experiments, these samples were hermetically sealed in hermetically sealed vessels and stored in laboratory conditions.

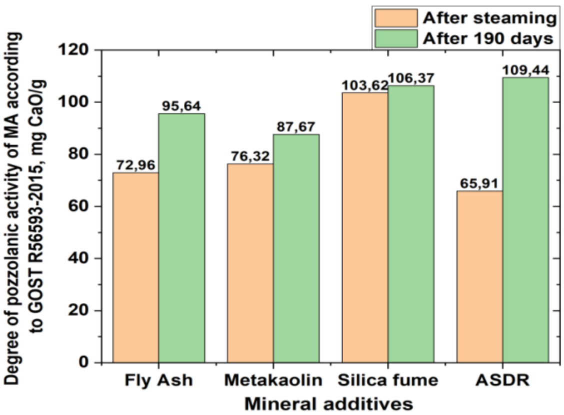


Fig.4. Degrees of pozzolanic activity of mineral additives

By investigating the re-determination of lime uptake after 190 days, data on the continuation of the pozzolanic reaction were obtained and are summarized in Figure 4.

It was found that the change in the absorption index of silica fume was insignificant. The highest increase of absorption index was found in dry bottom ash, which was equal to 109,44mgCaO/g (166% increase in relation to the initial one). A noticeable change was also shown by fly ash 95.64 mgCaO/g.

The studies carried out by the conditionally called express method showed (Fig.5) that the highest activity coefficient is silica fume (44,54%) and the lowest is fly ash (34,21%). It can be stated that all mineral additives were found to be active according to activity coefficient ($C_a$), as their activity coefficient ($C_a$) ranges from 21 to 50%.

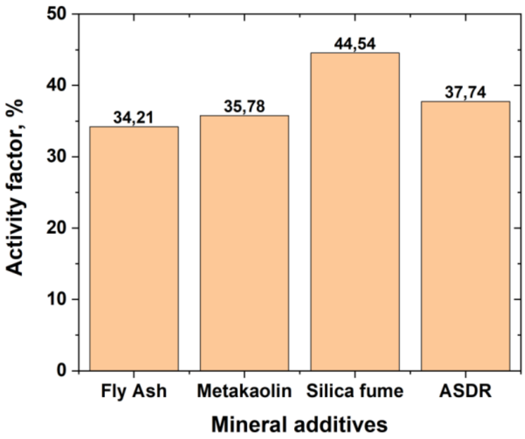


Fig.5. Activity coefficient of mineral additives

## CONCLUSIONS

The results obtained lead to the following conclusions:

The mineral additives silica fume, metakaolin, fly ash and slag ash mixture of dry disposal of Angre power plant showed the presence of pozzolanic activity. The obtained data revealed that the value of pozzolanic activity was found to be different depending on the method of determination of the latter. In all three methods of research high pozzolanic properties were shown by microsilica in comparison with other mineral additives.

Analyzing the obtained results of the study we can say that each used method of determination of pozzolanic activity has its advantages and disadvantages. The methods of determination of pozzolanic activity by heat treatment allow obtaining results within 1 day, but they can be used only when selecting a pozzolanic additive for use. The method of calcium hydroxide absorption in natural temperature conditions gives more accurate information about pozzolanic activity of mineral additives, but this method is long-term. In our opinion, the choice of the method of pozzolanic activity determination depends on the purpose of pozzolanic activity determination.

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# DEVELOPMENT VECTOR OF CULTURAL TOURIST OBJECTS IN KAZAKHSTAN

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***Abstract***

*The national yurtochny towns restored and the revived traditions can become a basis for development of this tourism. As one of the priority areas of the Republic's economy development, agriculture has a huge potential and largestreserve. The diverse climatic conditions made it possible to introduce diversification in the economy of this structure, which allowed the agro-industrial complex (AIC) to become one of the largest inter-industry complexes, combining several sectors of the economy aimed at the production and processing of agricultural raw materials and obtaining products from it that are brought to the end consumer. Considering the rating of interest of foreign tourists in types of tours, it is possible to draw a conclusion that for the most popular steppe safari tourism Kazakhstan is provided with resources, but at the same time the low level of development of infrastructure is observed. This article provides the basic concepts and terms of architectural tourism; cultural and historical architectural buildings, traditions and symbols of color in different cultures; psychology and levels of color perception, features of the tourism industry in Kazakhstan; Considering the rating of interest of foreign tourists in types of tours, it is possible to draw a conclusion that for the most popular steppe safari tourism Kazakhstan is provided with resources, but at the same time the low level of development of infrastructure is observed. Apparently from the submitted data, the steppe safari, namely trips on jeeps around steppes and national hunting uses the greatest interest at foreign consumers.*

***Keywords****: Tourism, marketing, infrastructure, foreign tourists, culture, excursion, Kazakhstan.*

## INTRODUCTION

Introduction in the world is observed in recent years the intensive growth of the market of tourist services. Tourism has the huge potential of growth, more considerable, than any other branch of economy.

According to forecasts of World Tourism Organization the flow of tourists will increase worldwide in 2012 and the persons will make more than 1 billion. Market researches of the market of tourist services create a basis for effective use of territorial capacities of the country as initially market researches in tourism are directed not only to studying of demand and definition of the potential clients, but also to formation of the demand taking into account development and use of the available tourist capacity of certain territories.

The domestic tourist market is actively connected to the international sphere of tourist and hotel services that represents the difficult organizational and technical and economic process demanding not only various knowledge in the field of tourism, professionalism in tourist and excursion activity, but also researches of appeal of the tourist market to foreign tourists.

## EXPERIMENT METHODS

Apparently from the submitted data, the steppe safari, namely trips on jeeps around steppes and national hunting uses the greatest interest at foreign consumers. For this type of tourism in Kazakhstan there are 20 landscape zones presented by steppes with salty and fresh lakes. On the basis of the carried-out analysis of secondary data the following conclusions are drawn: for involvement of foreign tourists to Kazakhstan there are all necessary resources and a certain infrastructure. Considering the rating of interest of foreign tourists in types of tours, it is possible to draw a conclusion that for the most popular steppe safari tourism Kazakhstan is provided with resources, but at the same time the low level of development of infrastructure is observed. Even in the absence of infrastructure the organization of a travel and involvement of foreign tourists are possible since big financial investments aren't required.

The second place on the importance is allocated cultural informative to tourism which is presented by the Kazakh national culture, customs and mentality. It is especially relevant in the context of interest from the European and American tourists in recent years. For this tourism 7 zones as a part of which are available a piece of the Great silk way, the culture of nomads, more than 9 thousand monuments among which there are mausoleums of "Hodge-Ahmed Yassaui", Aisha-Bibi, Babadzhi-Hatun, Karahan and Davutbek, mysterious the ancient settlement "Akyrtas", the underground mosque Beket-Ata are allocated. The most part of historical monuments of Kazakhstan was restored and continues to be restored [3].

The special appeal in foreign tourists is caused by a part of the Great silk way in Kazakhstan: the tourist can plunge into the atmosphere of wars of antiquity, pass in the ways of medieval batyrs, see the ruins of the ancient cities, mausoleums well-known once on all steppe of a bath of the ancient settlement Otrar, great variety of monuments of the Stone Age, parking, petroglyphs, to participate in excavation. The national yurtochny towns restored and the revived traditions can become a basis for development of this tourism.

On the third place at foreign tourists according to rating ecological tours as in Kazakhstan there are attractive natural resources and reserved places. Ecological tourism is referred to one of the most low-cost and attractive. For ecological tourism Kazakhstan has the untouched beautiful and attractive nature, flora and fauna. Ecological tourism in Kazakhstan gives the chance to tourists to learn the natural environment, to see natural monuments and sights, to watch for animals and birds, assumes a unification with the nature.

In Kazakhstan 900 attractive routes on national reserves and parks are provided. For foreign tourists there is an opportunity to watch for rare and the disappearing animal species, such as snow leopard, tyan-shansky bear, caracal, lynx, джейран and many - many others. In Kazakhstan 900 routes are developed, "bird's paradise" in reserves, special interest is shown by tourists to the Korgalzhinsky reserve [5].

Mountaineering gained the development in Kazakhstan: formation and building of alpine skiing bases is begun. In the republic there are 20 mountain zones provided by such massif as Medeo, Chimbulak, Tabagang, Joint stock company-Bulak and Kazakhstan Mount Ala Tau, Tien Shan.

Except mountaineering, attracts foreign tourists extremal, sporting and adventure types of tourism. The perspective direction in Kazakhstan beach tourism on the Caspian Sea, Lake Alakol, Balkhash, the Bukhtarminsky water reservoir is represented. Also tours in the form of rafting began to function (for example, on the Katun River or on river. Or), and the same mountain routes, but only laid out on more interesting (and respectively, more difficult for achievement) to places, and travelings by mountain bicycles. Besides, in the Kazakhstan market walks helicopter, with a paraplane, parachute jumps (Bayserke's airfield), non-standard tours are cultivated.

Foreign tourists show interest in the Aral Sea which visit will allow to see unusual landscapes: the died port, the huge cemetery of the ships, salt valleys. Are interesting the trip to Baikonur, hotel accommodation intended for astronauts, survey of the place of start of legendary spaceships, their models and presence in case of start of new carrier rockets at least.

The considered resources and tourist possibilities of Kazakhstan bring to the fact that it is expedient to create the modern tourist product. The most important component of optimization of the market of tourist services is development of a new tourist product of Kazakhstan which would be competitive in the world market of tourist services and won a foreign tourist segment for its attraction to Kazakhstan. As necessary components of a new tourist product it is possible to select the following:

- use of natural resources of Kazakhstan with a favor for the country and as least wasteful segment of a tourist product;
- use of historical, cultural, architectural sights which can attract the tourist and induce to make a trip, with further application of tourist profit on their maintenance and development;
- use of the equipment of the international level (means of accommodation of tourists, restaurant equipment for rest, sports activities, etc.);
- possibilities of an eredvizheniye which in a certain measure depend on a mode on the different types of transport used by tourists.

For assessment of appeal of tourism in Kazakhstan data of the market researches conducted by the international company "IPK" have been used.

Treat specific features of a tourist product:

- the difficult system of relations between different material and non-material components of service;
- extremely elastic demand in relation to income level and the prices depending on political and social conditions;
- consuming is in most cases carried out directly on the place of production of tourist service;
- existence of the distance separating a customer from a product and the place of consuming;
- dependence on such variables as space and time;
- inflexible production;
- influence of the external factors having force majeur character (weather, an environment, a policy in the field of tourism, the international events, etc.).

At the same time it is necessary to consider that process of purchase of a concrete tourist product begins long before commission of the act of purchase and sale. Decision-making by the consumer is subject to influence of a number of factors. It solves problems of various scale and complexity, however has the steady structure including the following stages: awareness of need for a travel and formation of a purpose of visit, information search, preshopping assessment of alternatives, purchase and consumption.

For introduction of a competitive national tourist's product it is necessary to consider its specifics and to form it taking into account unique opportunities of tourist space of the republic, namely:

cultural and historical space saturated various historical and cultural objects: monuments history, cultures, architecture, including the museums, theaters, the exhibition centers, parks, reserved zones and so forth;

the natural tourist space is kept practically in original state and attracts tourists with the rich natural tourist resources giving the chance to do active sports, to contact to the untouched nature and maloizmenny natural landscapes. Such type of space is made by reserves, wildlife areas, national parks and other nature protection territories;

the ethnic space — here is meant all set of the values of the people connected with the concrete historical phenomenon.

Creation of attractive image is impossible only by means of resources of the country, the whole complex, namely the developed infrastructure, consistent state policy, various programs and excursions is for this purpose necessary [1; 145].

At the same time, developing the strategy of development of tourism, it is necessary to estimate objectively constraining negative factors and to make recommendations for elimination of the existing problems to which it is possible to carry:

the high risk level for tourists — Kazakhstan is referred to unsafe the region. In this regard for formation of positive image it is necessary to advance new associative images of this territory through media, to cover positive interesting events, to actively propagandize and advertize the country beyond her limits;

lack of qualified personnel — presence of the qualified labor in this area is very limited. For overcoming personnel problems it is necessary to develop professional tourist education in the republic, including on the basis of studying of the best practices and the international cooperation;

inefficient tax policy — tax authorities raise illegal payments at businessmen, the due returns, the VAT detain, unevenly tax the enterprises. In this case improvement of tax policy of the state, in particular, in the field of improvement of the special tax modes and optimization of all tax policy in general is necessary;

limited transport opportunities — the limited choice of airlines, inconvenient schedules of flights, the high prices of air tickets, a difficult order of receipt of a visa. In this regard adoption of the serious political and economic decisions aimed at the development of railway transport, construction of qualitative highways and all road infrastructure is required.

The greatest gain of tourist flows is noted in Almaty, Astana and the Western regions of Kazakhstan where the high business activity is observed.

Development of entrance tourism and indicators of its competitiveness in the state are in direct dependence on such factors as:

- level of development of national economy;
- availability of tourist resources;
- visa system for foreign tourists;
- development of the sphere of a tour operator product and services;
- improvement of a product in tourist destinations;
- condition of transport and infrastructure;
- policy of the state in the field of tourism;
- effective marketing.

Forming of the sector of outbound tourism depends on the following factors:

- indicators of income of the population;
- indicators of an expense and consumption by the population of material benefits and services;
- indicators of differentiation of income of the population, level and poverty lines;
- cultural factors and relation of consumers to tourism;
- indicators of the generalizing assessment of level and quality of life of the population;
- social and demographic characteristics of the population of the country.

**Results and discussion**

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Formation of the hotel industry exerts strong impact on development of entrance tourism. Researches have shown that the main tendencies in development of hotel business of Kazakhstan are:

- the specialization of a number of hotels allowing to be guided more accurately by certain segments of consumers taking into account various signs;
- globalization and concentration of hotel business, occurrence of representatives of new international hotel chains;
- the widespread introduction of new means of communication and information technologies allowing to carry out deep and system economic diagnostics;
- introduction of new technologies in the business strategy of the hotel enterprises, in particular, wide use of the Internet for the purpose of advance of hotel products and services.

One of infrastructure elements of tourism is transport. The main transport problems in tourism it is possible to call the following:

- neediness of the air transport during the seasonal period;
- discrepancy of quality of transport services to price level;
- use of transport according to the charter program having certain restrictions, for example time as according to the charter program a tour is offered only within the concrete duration of stay.

Are of particular importance in the industry of tourism of the enterprise of food. As the main problems in the sphere of food in Kazakhstan foreign tourists note not various kitchen and low level of service.

The analysis of activity of the Kazakhstan travel agencies has allowed to reveal also the following problems and shortcomings of their activity:

1) in the sector of entrance tourism of a problem, connected with execution of visas and high price level in hotels and on the air transport;

2) backwardness of animation activity. It is expedient to develop the separate animation program for children and adult family members as in different age categories various interests for the tourists coming families. The importance acquires knowledge of supply and demand that for them is interesting and attractive what types of rest they prefer;

3) in spite of the fact that the Ministry of tourism of RK allocates funds for participation in the international exhibitions, the most part of firms, being small business enterprises, aren't able to afford to participate in them therefore most often they are limited only to their visit;

4) the shortage of regular and charter flights of the local air transport in the period of a season. In the Kazakhstan market one large airline "Eyre Astana" which takes exclusive positions on aviation market functions. Several foreign airlines function, however the available park during the seasonal period doesn't provide the existing demand for flights. Many foreign airlines tried to enter the Kazakhstan market, however so far their attempts are unsuccessful;

5) level of service and quality of service is insufficiently high. Even the available high quality hotels completely don't conform to the international standards on the level of service and service that is caused by inefficient personnel policy;

6) limitation of resources for use of instruments of marketing, absence of marketing specialists.

The carried-out analysis has allowed to draw a conclusion that at the present stage for creation of an attractive tourist product in Kazakhstan it is expedient to solve the following problems:

- formation and development of external communications in the locations of tourist resources;
- creation of conditions and preferences for development of activity of the travel agencies which are engaged in reception of foreign tourists;
- formation to the effective, corresponding needs of foreign tourists of the industry of public catering and support of the state in providing with the air transport;
- professional development of tourist personnel, training abroad, use of foreign experience of conducting tourist business.

In general it is possible to draw a conclusion that the Kazakhstan tourism has powerful potential and attracts foreigners not only the resources, but also original and original cultural heritage.

## CONCLUSIONS

Considering the rating of interest of foreign tourists in types of tours, it is possible to draw a conclusion that for the most popular steppe safari tourism Kazakhstan is provided with resources, but at the same time the low level of development of infrastructure is observed. Even in the absence of infrastructure the organization of a travel and involvement of foreign tourists are possible since big financial investments aren't required.On the basis of the carried-out analysis of secondary data the following conclusions are drawn: for involvement of foreign tourists to Kazakhstan there are all necessary resources and a certain infrastructure.

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## LANDSCAPE DESIGN OF HISTORICAL AND CULTURAL CITIES ON THE SILK ROAD

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***Abstract***

*New resources of increasing the tourist attractions can be popular objects of nomads, shopping streets of farmers, historical and gydro technical facilities located in the recreation zone. Taking into the modern trends in the development of landscape architecture, the usage of Lucks symbols` (symbols of luck) and prosperity of the ethnos in the landscape architecture can also be an important link for improving the quality of landscape compositions and small informative forms. These objects of the worldview of nomads reflect the universal human warm relations, as respect for the neighbor, education of the younger generation can serve as the objects of education, history, culture, attractive for a wide range of people and tourists. With the account of these trends, the authors of this article suggest an alternative development option for the development of the city recreation on the Silk Road.In recent days, cultural traditions of the historical cities on the Silk Road that cover all spheres of the life-activity of the ethnos become the popular objects of our contemporaries and they become an important factor in its development. In this case, the main component is the historical and cultural landscapes as the environment formative oases for designing recreational zones.*

***Keywords:*** *cultural traditions, historical and cultural landscapes, ethno-aul, symbols of luck.*

### INTRODUCTION

The role of historical and cultural landscapes and symbols of luck in the city improvement has not been fully explored although these aspects have more or less been examined in the following publications [4,5,6,7,8,9,10,11,12].

Nowadays, many countries commuity plans to revive the "Economic belt of the Silk Road" of Eurasia [1]. It should be noted that UNESCO also emphasizes the timeless significance and powerful influence of trade routes for the cultural development and also it actively encourages the programs aimed at saving and developing the rich heritage of the Silk Road [2]. In terms of tourism, the historical areas of the ancient cities of the Silk Road restored from the ruins attract more and more tourists [3]. Taking into account these tendencies, the questions of revival of the historical and cultural landscapes of the Silk Road are considered in this article on the example of Shymkent city.

The regional center of the South Kazakhstan, Shymkent city is located in a picturesque valley at the foot of the Tien-Shan mountain system. Scientists interpret the origin of the city's name in different ways: “garden city”, “green city”, etc. According to the interpretation of the Turkic and Iranian sources, “Shym” means a meadow, a flowering valley, and with the addition of the word “kent” it means a green (blooming) city. In the countryside, there are areas of medicinal herbs and relict tulips [13].

### MATERIALS AND METHODS

Cultural heritage is our heritage from the past: today we protect it and must convey this example to future generations. World cultural heritage plays a key role and is the starting point for the evolution of society. The idea of a UNESCO World Heritage Site is unique because of its universal application. The protection of World Heritage sites is the common duty of all peoples of the world, regardless of the territory in which they live.

UNESCO's purpose is therefore to recognize, protect and preserve universal heritage throughout the world, especially in places where it may be at risk in conflict-ridden societies or exposed to natural disasters.

Over the centuries, hundreds of cultural historical sites and monuments were created on the territory of various regions of the Silk Road. Each of these sites and monuments represents not only the different customs and traditions of the local communities, but also testifies to their cultural interaction and shows the influence on them of different cultures from around the world that came into contact through the historical trade routes of the Silk Road.

Among the most promising projects of the 21st century, the international program for the revival of the Great Silk Road (GSR) rightfully occupies a special place in its historical and universal scale. The Great Silk Road has long attracted the attention of researchers: historians, ethnographers, archaeologists and scientists of other scientific fields. Modern opportunities and trends in the formation of the tourism industry in Southern Kazakhstan have their own characteristics in contrast to other regions of the country, namely: the presence of a historically established main route of the Higher Silk Road and, accordingly, significant potential for tourist sites of historical and cultural heritage, a high degree of urbanization and population growth dynamics as a carrier of culture. They are also determined by geographical location, natural and climatic conditions, transport and hydrographic network, proximity to the borders of neighboring states.

The Great Silk Road is rightfully considered one of the remarkable achievements of ancient civilizations. For the first time in the history of mankind, across the gigantic expanses from the Mediterranean to the Pacific Ocean, it connected different countries and peoples, connecting their material, artistic and spiritual cultures. For many centuries, ideas, technologies, crafts, and beliefs were exchanged along this path. The chronicles record the feat of brave pioneers who overcame deserts and mountains in search of unknown countries, treasures and adventures. The travelers were not afraid of anything - neither the arduous journey that took many years, nor the formidable, warlike nomads who attacked the caravans, nor the waterless Asian deserts, in which sandstorms often blocked the roads so much that their direction could only be found “by the bones of people and animals.”

Silk and products made from it have accompanied humans for many thousands of years. For various reasons, the silk industry experienced ups and downs, a decrease in interest in silk was replaced by “silk fevers”, prices for silk goods rose and fell, but even today silk is the main raw material for a wide variety of sectors of the national economy, and we have yet to discover new possibilities for it applications.

The history of sericulture goes back centuries. The secret of making silk was discovered by the Chinese more than four thousand years ago. However, many researchers push this period back another thousand years, and Fava and Witt, famous Western European silkworm breeders of the last century, claim that silk obtained from silkworm cocoons has been known in China for 7,000 years.

There is no consensus on who was the first after the Chinese to master the art of making silk fabrics. It is likely that they were Indians, but there are other opinions. According to ancient historical chronicles, the silk industry (though not in the form in which we know it) first penetrated from the Chinese Empire to Japan around the 4th century BC and only then to India.

## RESULTS AND DISCUSSION

During the heyday of Greco-Roman Egypt (IV - 1st centuries AD), trade relations between states located on the Mediterranean coast were increasingly expanding, although the first maritime trade campaigns of the Egyptians, apparently, began much earlier - in the middle of the 3rd millennium BC ad. But only from the middle of the 2nd century BC, Indian trading ships began to regularly arrive in Egypt and, among a variety of goods, bring silk fabrics there. If you believe ancient sources, these were not Indian silks, but Chinese ones. India acted only as a trade intermediary.

In Rome, silk began to be worn in 46 BC. e., but excessive consumption of very expensive fabric was considered immoral. In 16 BC. e. The Senate, by special decree, prohibited people from “dishonoring themselves by dressing in silk.” However, the source of silk - the silkworm - became known in Greece only in the 4th century, although it is mentioned in the works of Aristotle (384-322 BC), in particular in the treatise “History of Animals” and somewhat later in works of Pliny the Elder (23/24 - 79). Aristotle probably used information about the silkworm obtained from the stories of people who visited other countries.

In the IV-VI centuries. silk production ceases to be a monopoly of China; Central Asia, Korea, Japan, and India become familiar with it. Almost nothing is known about whether sericulture originated in these countries independently, or penetrated from China, and if it was borrowed, then in what way. There are only numerous legends and assumptions on this matter.

Sericulture, in all likelihood, came to Europe (initially to Spain) through Byzantium and the Arab countries. Until the 8th century. silk was known in many countries, but only as a product brought from distant countries. Sericulture, in the proper sense of the word, became widespread in Europe only in the 13th century.

In Russia, the first attempts to breed silkworms were made under Tsar Mikhail Fedorovich (1596 - 1645). Later, by royal decree, mulberry plantations (the food plant of the silkworm) were established near Moscow, in the village of Izmailovo. Peter I banned the destruction of existing plantations and ordered the creation of new ones in Astrakhan and Akhtuba. Attempts were made to engage in sericulture at the courts of Catherine II and Paul I.

The entire prehistory and true history of sericulture, based on documents, is accompanied by legends, speculation and romantic descriptions of difficulties and adventures on the complex Great Silk Road - this was the name of the trade caravan road connecting China with Western Asia through Central Asia and further with Europe.

The beginning of the Great Silk Road dates back to the second half of the 2nd century BC. e., when the diplomat Zhang Jiang first opened the Western Region - the countries of Central Asia - to the Chinese. Thus, two great roads were united into one - one that went from the West from the Mediterranean countries to Central Asia, explored and traversed by the Hellenes and Macedonians during the campaigns of Alexander the Great and the Seleucid commander Demodamus, right up to Yaxartes (Syr Darya), and the other leading from the East, from the Han Empire to Central Asia.

The concept of the “Great Silk Road” is associated with a precious commodity at that time - silk, which introduced two different worlds: the West and the East. This term was first used in 1877 by the German scientist Ferdinand Richthofen in his classic scientific work “China”. This is what he called the system of roads connecting various parts of the vast Eurasian continent.

The Silk Road had a huge influence on the formation of the political, economic, and cultural structure of the countries through which it passed. Large and small trading cities and settlements arose along all its routes, and Central Asia was especially dotted with caravan routes. Dozens of trade routes crossed this region. The most important ethnic processes took place here, active interaction of cultures took place, large-scale trade operations were carried out, diplomatic treaties and military alliances were concluded. The peoples of this region played an outstanding role in the spread of alphabetic writing and world religions, many cultural and technological achievements to the countries of Inner Asia and the Far East.

The Great Silk Road began in Rome and through the Mediterranean Sea went to the Syrian city of Hyropolis, and from there through Mesopotamia, Northern Iran, Central Asia led to the oases of Eastern Turkestan and further to China. The Central Asian section began in Areya (Herat). From here the road deviated to the north and went to Antioch of Margiana (Merv), from here to the southwest to Bactria, and then went in two directions - to the north and east.

The northern road crossed the Oxus (Amu Darya) in the area of Termez (ancient Tarmita) and then diverged in two directions: from Termez and the Shurab, Chushka-Guzar and Kara-Kamar crossings along the river valley. Sherabad led to the Iron Gate, located in Western Hissar, 8 kilometers northwest of the settlement of Derbent (Darbant). Along the mountain passes through the passes and along the valleys of the Kushtanga and Baysuntau rivers passed the main and, in essence, the only route of trade caravans and military formations traveling from the central regions of Asia to Bactria, Tokharistan and India and, conversely, from India to Bactria, Sogd, Bukhara and Chach.

This path from Derbent ran past the Kafirkala settlement, which arose already in early Kushan times on the northern outskirts of the modern city of Sherabad, then through the already mentioned Iron Gate it went to Akrabat, where in the Middle Ages the Sogdian settlement of Kendek was located. Further, the path turned north and crossed the Uryadarya valley, the village of Karakhaval, emerging along the Kamdarvaza gorge into the Kesh region (modern Shakhrisabz and Kitab) and then to Marakanda. This was the shortest route from Tokharistan to Samarkand, much shorter than the route through Guzar. From Marakanda, through the Hungry Steppe, the road went to the Chach region (the modern Tashkent oasis), Fergana and through the Terek-Davan pass to East Turkestan.

Another direction of this road from Tarmita along the Surkhandarya valley went to the country inhabited by the Komeds (the region located in Karategin), then reached the Stone Tower (Alai Valley), after which the road went beyond the borders of Central Asia to East Turkestan. Another Central Asian branch of this route had a different direction: from Antioch of Margiana (ancient Merv) it went through the sands of the Karakum, crossed the Oxus, then went to Bukhara, from there to Marakanda, Chach, Fergana and further to the oases of Eastern Turkestan.

The third route of the Great Silk Road - the Steppe Road, passed north of Central Asia. It began in the cities of the Northern Black Sea region, then through the large ancient city of Tanais, located in the lower reaches of the Don, crossed the southern Russian steppes, the Lower Volga region, the Aral Sea region, and then through southern Kazakhstan it reached Altai and Eastern Turkestan, where it connected with the main route of the Great Silk Road. One of the branches of this road from the Northern Aral Sea region through Khorezm went to Sogdiana and further to the south.

The Bukhara-Samarkand route of the Great Silk Road and its regional branches were of great importance for the development of the economy and culture of Western Sogd. All of them finally took shape at the end of the 5th - beginning of the 6th centuries. The new section of the Great Silk Road, which ran along the left bank of the Zeravshan, was much more convenient and efficient than the old route (through the upper reaches of the Amu Darya). Later it became the main one and the corresponding name was assigned to it - “Shakhrokh” (“Main Path”). With the transfer of the main route of the Great Silk Road to the Zeravshan Valley, the epicenter of economic and cultural progress throughout Central Asia also shifted here.

The concept of “Central Asia” is quite arbitrary. Many researchers define the boundaries of its territory in different ways. However, this region was the center of ancient civilizations, dating back to long before 1500 BC. e. Great trading cities such as Kashgar, Kokand, Samarkand, Bukhara, Khiva, Kunya-Urgench, Merv and Nishapur arose at the intersection of the Silk Roads. Linking Turkey, the Caucasus, Western China, Iran, Afghanistan and India, caravan routes turned them into one huge cultural and economic zone. The free movement of people and ideas across this territory contributed to the emergence of a number of outstanding encyclopedists, scientists, poets and philosophers and their schools - Ibn Sino, Beruni, al-Farghoni, al-Khorezmi, Rudaki, Navoi. The majestic medieval mausoleums, mosques and madrassas of Central Asia testify to the exquisite craftsmanship of artisans.

To this day, Bukhara, the urban core of Khiva - Ichan-Kala, and the Timurid masterpieces of Samarkand and Shakhrisabz have retained their charm and are a very precious and fragile heritage. For centuries, ancient buildings were influenced by harsh climates and were subject to earthquakes. Therefore, restoration work is constantly being carried out here, which, however, sometimes leads to the loss of the authenticity of the monuments. A consequence of the desire in the recent past to display major monuments of Islamic heritage as "Open Air Museums" has been that huge areas around selected buildings have been destroyed. Settlements breathing in antiquity with houses in traditional style gradually turned into modern buildings.

Considering that the protection of this heritage at the national level is often insufficient due to the amount of funds it requires and the lack of local economic, scientific and technical resources, UNESCO, the United Nations educational, scientific and cultural organization, included in the list A number of unique sites in Central Asia are World Heritage Sites, including the Khiva complex of Ichan-Kala, the historical centers of Bukhara, Samarkand and Shakhrisabz. They are now under the protection of the international community, which is helping to restore and preserve them for future generations. For example, UNESCO allocated 90 thousand US dollars for the conservation of the historical monuments Chor-Minor in Bukhara and Tillya-Kari in Samarkand.

The peoples of many countries today strive to study the roots of their history, understand the origins of spirituality, and their national involvement in world culture. And therefore, it is not at all accidental that in recent years there has been an increase in scientific and public interest in the Great Silk Road, the idea of its revival as the most important channel for the interaction of cultural, economic, and tourist ties.

The Great Silk Road represents a unique cultural value for humanity. Therefore, UNESCO pays special attention not only to the study, but also to the preservation of the enormous heritage of the vast heritage left by ancient peoples to current generations.

UNESCO has great opportunities for this. Created in 1945, it currently unites about 190 states and performs several main functions. Among them are conducting advanced research, promoting, transferring and sharing knowledge and accumulated information, providing the services of the best experts, preparing and adopting international acts and recommendations that are binding on its members.

In 1972, UNESCO adopted the Convention for the Protection of the World Cultural and Natural Heritage. 146 countries are supporters of this agreement, which involves the world community in the process of recognizing, protecting and reviving the unique values that human civilization possesses. The Convention provides a permanent legal, administrative and financial basis for international cooperation in this area. Its implementation made it possible to formulate a “world heritage concept” that transcends all political and geographical boundaries. The international community, in accordance with the adopted agreement, helps countries in protecting the so-called cultural and natural sites classified as world values. To identify them, a World Heritage List was compiled. Today, it includes 721 similar objects from more than 100 countries. At the same time, areas that are in danger are separately identified - under the threat of destruction, deformation or abandonment. Work related to their protection and restoration is financed by the World Heritage Fund.

This extensive activity is directly related to the development of cultural tourism. According to the WTO, tourism is today the most profitable sector of human activity. This industry developed more dynamically than any other after World War II. International experts believe that in the current century it will not only maintain, but also increase the pace of its development. So, if in 1998 its worldwide income amounted to about 445 billion dollars, and the number of tourists reached almost 650 million people, then by 2010 experts predict a doubling - compared to 1998 - the number of travelers leaving outside their countries. Accordingly, the profitability of both the industry itself and others directly related to it will increase. By providing constant and high profits, this industry can contribute to the conservation of World Heritage sites, but - equally - it can also put them at risk of degradation and extinction.

An analysis by the European Commission found that for 60 percent of tourists, culture is the main subject of interest when traveling. It is quite natural that the 12th session of the WTO General Assembly adopted a decision on “Preserving World Heritage for the New Millennium”. Its participants expressed the belief that international tourism, which represents a unique opportunity for mutually beneficial enrichment and dissemination of cultural values, is a powerful factor in promoting the dialogue of civilizations.

Today, hundreds of routes have been developed and operate on all continents. However, one of the most attractive and longest in the world, with a length of 12,800 km, is the Great Silk Road. This road, which for thousands of years connected East and West as a two-way river of civilization. Tourists have now joined the expeditions of traders, missionaries and geographers of past centuries. Largely thanks to the organization of routes along the Great Silk Road, most of humanity now has direct access to global heritage, not limited by geographical boundaries.

In 1998, UNESCO announced the start of a ten-year project called “Integral Study of the Silk Road - the Road of Dialogue.” It provides for a broad and comprehensive study of the history of civilizations, the establishment of close cultural contacts between East and West, and improvement of relations between the numerous peoples inhabiting the Eurasian continent. The revival of the Great Silk Road is the resumption of the thousand-year dialogue of civilizations.

The unique project, which is part of the UNESCO Decade of World Cultural Development, has stimulated interest in the Silk Road throughout the world. It was designed for several years and included different types of activities. In addition, it was distinguished by an interdisciplinary approach, making it possible to fully study the scientific, technological and cultural connections that existed between the West and the East, with the aim of encouraging further research at the international and national levels within the framework of the concept of world heritage. At the presentation ceremony of one of the project expeditions, it was emphasized that although the Silk Road had been studied for years by archaeologists, historians, geographers, ethnologists, sociologists and linguists, until now there had never been a comprehensive, systematic and interdisciplinary examination of this vast treasury of human history.

## CONCLUSIONS

Designing the architectural environment of historical cities requires an individual approach, taking into account the role of the environment forming role of historical and cultural landscapes. The article highlights the main modern socio-economic factors of their development. Particularly, it is necessary to emphasize the role of historical and cultural landscapes in the formation of the architectural and artistic appearance of recreational zones and the adjacent territory. New resources for the development of historic cities are the design of the ethno-aul, the shopping street of medieval handicraftsmen with the corresponding attributes. We should especially take into account the symbolic ornamental patterns in landscape architecture, which reflect human values as love for one's neighbor, spiritual support for young people. In general, the historical-cultural tradition is taken into account in the design process, enhancing the architectural and artistic expressiveness, the ecologization of the urban environment and the tourist attraction of the city on the Silk Road.

Transcontinental contacts developed closed systems of rural communities, broadened people's horizons, and contributed to more intensive development of the intellectual sphere. Of course, the ancient traders, driven primarily by a concern for profit, hardly had such a result in mind for their activities, but this is precisely the phenomenon of the Great Silk Road, which made a unique contribution to world civilization.

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## RECONSTRUCTION AND RESTORATION OF LANDSCAPE ARCHITECTURE

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***Abstract***

*In the modern world, the ancient traditions of the people of Kazakhstan are clearly reflected in the conditions of globalization. However, some researchers especially note the negative impact of environmental and current sociocultural factors on the preservation of the cultural heritage of some landscape objects. In this regard, this article examines methods for restoring the landscape architecture of historic sites, which require a lot of effort, cooperation and careful attention to detail, but can significantly improve the quality of the environment and preserve historical heritage. Respecting cultural traditions and taking into account environmental sustainability will help maintain harmony with the world around us.*

***Key words:*** *ecology, reconstruction, cultural heritage, historical monuments, landscape architecture*.

### INTRODUCTION

Cultural and historical monuments are witnesses of their eras; they can tell younger generations about their history, thereby awakening national identity, love for their homeland, respect for its history and culture. Respect for cultural traditions in the restoration and reconstruction of landscape objects is crucial for the preservation historical and cultural value of these places. In addition, monuments are a connecting thread between generations through the preservation and enhancement of traditions and values of the original culture. [4,5,6,7,8,9,10,11,12].

Reconstruction and restoration of landscape architecture objects are long-term and multi-tasking processes that require professional knowledge and approach.

### MATERIALS AND METHODS

According to some studies, some key aspects should be taken into account when carrying out the reconstruction and restoration of landscape objects of a historical area:

• Research and analysis: a thorough study of the object and its history. This includes analysis of structures, materials, original plans and photographs, as well as examination of historical and contextual information.

• Design: This process should take into account the historical details and style of the property, as well as modern requirements for safety and sustainability.

• Public involvement: a social survey of local residents and stakeholders is carried out to take into account their interests and ensure the legitimacy of the project.

• Documentation and Archiving: It is important to document each stage of the project and preserve the information for future generations.

• Project execution: carrying out reconstruction or restoration work in accordance with the project. This may include the restoration of lost elements, the use of authentic materials and consideration of environmental aspects.

• Sustainability Assessment: Once a project is completed, an assessment of its sustainability and long-term impact on the environment and society is carried out. This will help determine whether your goals have been achieved.

## RESEARCH RESULT

**.** Environmental aspects play an important role in the restoration of landscape objects. Here it is important to take into account the natural ecosystems and species composition of vegetation and animals in the restored area. During restoration, measures should be taken to preserve and restore biodiversity.

In the modern world, territories and objects of tourist interest and monuments of religious architecture have become priorities for conservation. Whenever possible, local materials and plants should be used for restoration to minimize the environmental burden of transportation. Respect for cultural traditions in the restoration and reconstruction of landscape sites is critical to preserving the historical and cultural value of these sites.

Using scientific research methods, the authors of this study put forward some key aspects in the restoration of landscape objects:

1. Research and understanding of cultural traditions: analysis of the cultural traditions and historical context associated with the object. This will give you a better idea of which items should be saved and restored.

2. Authenticity and materials: Authentic materials and techniques should be used that were characteristic of the period in which the object was created. This helps preserve the original style and character of the area.

3. Preservation of design and composition: When restoring objects, special importance is attached to preserving the original composition and design of the object. This includes the restoration of lost decorative elements and structures.

4. Preservation of functionality: When reconstructing, the original functionality of the object should be taken into account. For example, if it is a historical park, the original purpose and use of the area must be taken into account.

5. Consideration of local customs and rituals: When restoring or reconstructing landscape sites of religious or cultural significance, local customs and rituals should be studied. This helps create a respectful and inclusive space.

6. Collaboration with the local community: It is important to involve the local population and public organizations in the decision-making process for restoration or reconstruction. Their opinions and knowledge about cultural practices can be valuable.

## RESEARCH RESULTS

Compliance with cultural traditions during the restoration and reconstruction of landscape objects helps preserve the unique history and cultural heritage of the area, which is important for enriching the cultural landscape and maintaining connections with the past.

Reconstruction and restoration of landscape architecture are important steps for preserving cultural and natural heritage and creating attractive and sustainable public spaces. Collaboration with experienced professionals and active community involvement are key to the success of these projects.

In general, an environmentally balanced approach to the restoration of landscape objects contributes to the conservation of nature and improvement of environmental quality.

The urban environment is an integral part of the life of every city dweller. In it, both buildings and structures and the spaces of streets, intersections, squares, embankments, and courtyard areas interact equally.

In the modern urban environment, it is necessary to use elements of nature, and this need increases with the growth of cities due to the associated undesirable consequences (increased building density, atmospheric pollution and smoke, noise and vibration, fumes from asphalt pavements, etc.).

The creation of an environment that is complete in utilitarian, architectural and artistic terms depends not only on the volumetric-spatial solution, but also on the elements of the organization of urban spaces that fill it. This includes landscaping, small architectural forms, landscape design, works of monumental and decorative art.

As the city of Astrakhan develops and associated with its growth

With noticeable environmental degradation, awareness of environmental priorities is becoming increasingly necessary. The city has an urgent need to maintain and maximize the natural component of the environment; this is facilitated by landscape design, which shapes spatial conditions and fills environmental situations with the help of natural components.

The main tasks of landscape design in the urban environment: the formation of the microclimate of the environment (due to the noise-protective, environment-protective and phytoncidal properties of green spaces, natural aeration, watering, etc.), the formation of its appearance, giving the environment a variety of colors, textures (including seasonal changes in the type of greenery); improvement of the utilitarian and practical properties of the environment (noise protection by dense plantings, separation of zones by water devices while maintaining the visual integrity of the space, etc.) [5]

The main element of landscape design is green spaces. They help purify the air, regulate the temperature and humidity conditions of the urban environment and the insolation conditions of the territory, and actively influence its comfort, especially in the summer. When the weather is hot, unfavorable microclimatic conditions are created in the city under the influence of the following factors:

• in open spaces a person is exposed to direct sunlight, which can contribute to overheating;

• the surfaces of the walls of buildings, pavements, sidewalks and soil give a significant amount of reflections of radiant energy, which worsens the radiation regime of open spaces in the city; the radiation of such heated surfaces can account for 30–40% of direct solar radiation;

• near heated surfaces, the air temperature rises significantly.

Consequently, a city resident located in an open, ungreened area, on a sidewalk or near buildings may be exposed not only to direct solar radiation, but also to additional radiation from highly heated surfaces and the influence of higher air temperatures.

Another problem is that the large open pedestrian alleys of the embankment without sufficient shade make it uncomfortable and even unsafe for health during the summer daytime hours.

During the construction of new and reconstruction of historical public and residential facilities, much attention from the standpoint of functionality and convenience for users is paid to the architecture of the structure and interiors, when the external, “extra-architectural” space is left without special attention. Pedestrian spaces adjacent to public buildings, in particular shopping centers, are often unattractive due to the monotony of the environment and the lack of landscape design components.

The development of such areas consists of an excessive amount of hard surfaces, which does not allow using the potential of nature.

## CONCLUSIONS

The initial originality of fragments of urban space, due to the uniqueness of its natural components - characteristic forms of relief, water areas, vegetation massifs - is transformed in the process of urbanization depending on the nature of subsequent urban development. The urban landscape is constantly being supplemented with new “cultural layers”, preserving in its composition fragments of heterogeneous types of the natural environment of various periods of transformation [4].

Vegetation, as the least stable component of the urban landscape, simultaneously acts as one of the main means of landscape design to regulate most of the characteristics of the city's climate. The inevitability of constant renewal of plant material, which takes on a significant share of anthropogenic loads, determines considerable reserves in updating the aesthetics of urban spaces for various purposes.

The consequences of technogenic impact extend to the entire territory of the city, despite the heterogeneity of the ecological situation in its individual parts, and cannot be compensated without the use of natural resources at the level of the city and its surroundings. In this sense, all existing provisions on the need to create a continuous system of green areas, a kind of “natural frame”, within urban boundaries remain relevant.

Landscape architecture is the architecture of open spaces, in the organization of which the leading role belongs to natural elements and elements of external improvement. Landscape architecture materials - relief, green spaces, flowers, water, small architectural forms.

Landscape design is one of the methods of architectural creativity, a type of architectural design. Basic concepts of landscape architecture.

Floral and ornamental herbaceous plants occupy an important place in the decoration of the park and, together with woody plants, water features, stones, and sculptures, form its aesthetic appearance. With the help of flower beds, the planning nodes of the park are designed - ground areas, entrances, rest areas, accents are created that concentrate attention, guide movement and complete the artistic design of park compositions - places near reservoirs, in clearings, at the edges, sculptures, etc.

Creating a harmonious and highly artistic object of landscape art is possible only by using the experience of past generations, compositional and technical techniques. When working on a project, a landscape architect must have a good understanding of the task assigned to him. He must choose the most acceptable solution in a stylistic sense, organically fit the new or reconstructed object into the surrounding landscape, taking into account the characteristics of the area.

Study of the theoretical and practical foundations of restoring the integrity of the spatial and architectural environment, humanized for further human life. Studying practical ways to solve problems in the reconstruction of territories based on modern world experience in urban planning.

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**CONSIDERATION OF WIND REGIME WHEN DESIGNING HOUSINGS IN HOT CLIMATES**

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***Abstract***

*When designing and constructing dwellings in areas with a hot and dry climate, the goal is to ensure that in order to ensure comfortable microclimatic conditions in them, the capabilities of construction means can be used to the maximum, and the role of mechanical ones should be minimized. The functional dependence of the intensity of ventilation of premises on the space-planning structure has been determined apartments, buildings and wind conditions of the area.Methods for calculating the aeration of an apartment have been developed, taking into account the space-planning features of residential buildings. Problems with summer overheating have been considered and solved. An analysis of volumetric techniques for regulating natural air exchange in traditional and modern types of housing in a hot, dry climate, as well as the results of previous work, has been carried out. The basic patterns of air flow in ventilated rooms were also studied.*

***Keywords****: Design, climate, microclimate, wind conditions, premises, moderation, modern methods, wind speed, ventilation efficiency.*

**INTRODUCTION**

The issue of increasing the comfort of apartments and improving living conditions in them is especially acute in areas with a hot, dry climate. The main problem: preventing and combating summer overheating.

Therefore, the main task in the design and construction of housing in areas with a hot, dry climate is to make maximum use of the capabilities of construction means to ensure comfortable microclimatic conditions in them, and reduce the role of mechanical ones to a minimum.

One of the most effective means of influencing the internal climate of apartments is ventilation (in other words, controlled natural air exchange). Essentially, during the unheated period, natural air exchange determines the rate of heat exchange between the internal and external environments, and therefore the level of microclimatic comfort of apartments. Research shows that rationally organized natural air exchange in summer allows: the difference between the maximum temperatures of indoor and outdoor air to be brought to 6-110C; maintain favorable living conditions even during hot hours.

The importance and necessity of providing apartments with ventilation is indicated in every work on the design of housing in hot climates. Ventilation is also considered in recent works on the thermology of southern housing as one of the main means of regulating the microclimate of apartments in the summer.

Despite the abundance of research, answers to the basic questions of architectural and construction practice in the southern regions about where, when and what systems and schemes for ventilation of apartments are appropriate have not been received. And the space-planning solutions for dwellings in a particular area largely depend on the answer to them. Until now, architects and designers still do not have scientifically based recommendations and methods in their arsenal, the implementation of which would ensure controlled air exchange in an apartment in the summer.

As studies in recent years show, in many cases the ventilation conditions for apartments, even in new series of buildings, cannot be considered satisfactory, although they were built taking into account all the requirements of modern standards and recommendations.

## EXPERIMENT METHODS

An analysis of research materials and existing projects allows us to explain this by the fact that residential buildings are actually designed without sufficient consideration of the wind conditions of the specific area and are largely the same in terms of the method of organizing ventilation of apartments throughout the IV climatic zone.

As a result, not only the effectiveness of ventilation decreases, but at the same time the architectural, structural and planning means of regulating the microclimate of the apartment.

To develop methods for assessing and regulating the aeration conditions of apartments at the design stage, which will make it possible to make maximum use of the space-planning structure of the southern dwelling to improve its sanitary, hygienic and operational qualities during the unheated period.

## RESULTS AND DISCUSSION

An analysis of volumetric-breading techniques for regulating natural air exchange in traditional and modern types of housing in a hot, dry climate, as well as the results of previous work, was carried out;

The nature of the influence of the planning structure of the apartment on the formation of the microclimate in the premises, in conditions of the external environment typical for a hot dry climate and conditions of natural air exchange, has been clarified;

The basic patterns of air flow in ventilated rooms have been studied;

Determination of the functional dependence of the intensity of ventilation of premises on the space-planning structure of the apartment, building and wind conditions of the area;

Methods have been developed for calculating the aeration of an apartment, taking into account the space-planning features of residential buildings.

The work was carried out on the basis of:

Studying domestic and foreign experience from literary sources;

Analysis of design materials of central, zonal and republican research and design institutes;

Field observations of changes in the thermal regime of apartments under different conditions of natural air exchange and the movement of air flows in ventilated apartments in the summer;

Physical modeling of the ventilation process;

Use of modern methods for assessing errors in measurement results and mathematical statistics.

A functional dependence of the conditions for ventilation of premises on the planning structure of the apartment, building and wind conditions has been established;

The nature of the influence of individual factors and space-planning solutions of housing on the conditions of aeration of premises has been clarified;

A typological feature of modern southern housing, of course, is the provision of apartments with cross-ventilation (corner) ventilation to regulate the microclimate of the premises in the summer months. Therefore, naturally, the most accurate knowledge is necessary about the factors that determine the effectiveness of this product: ventilation mode and wind conditions of the area.

In works concerning the issues of zoning the territory of southern Kazakhstan and typifying housing, as a rule, the features of the wind regime are not taken into account. But the efficiency of ventilation and the appropriateness of the space-planning decisions taken for the home largely depend on this.

It is quite clear that in summer the wind speed and its direction matter only when the apartment is in open mode.

It is advisable to use round-the-clock ventilation of premises in areas with an estimated outside air temperature of no more than 32-33ºC. But such areas in the sharply continental, hot, dry climate in the south of Kazakhstan make up a small part of it. In addition, this ventilation mode cannot be adopted on a mass scale because during the day, as a rule, the wind speed is higher and, therefore, there is a high probability of dust transfer, and also because during the daytime the vast majority of the population is outside the house (adults - in workplaces, children in child care institutions). Therefore, during overheating periods, the duration of which reaches up to 90 days, night ventilation prevails almost everywhere. In non-overheating, depending on the health status of the resident, the density of the apartment, the nature of household processes, it is carried out in the morning, afternoon, evenings or around the clock without a clearly defined circadian rhythm, i.e. is chaotic and non-massive in nature. Consequently, in summer, the thermal conditions of the external environment and the household rhythm of the population in the south of Kazakhstan determine only two ventilation modes: night and chaotic.

As a rule, the population begins to ventilate premises immediately after sunset, more precisely from 19-20 hours, i.e. when the outside temperature drops rapidly. The need for ventilation during these hours also arises because it is at this time that the peak of functional and household processes falls, and, consequently, the maximum of additional heat and moisture in the apartment. After a certain time, the activity and rhythm of life in apartments slows down, after which the need for ventilation may disappear or its intensity should be significantly reduced. Obviously, this period of the day will be the most pleasant and at the same time the minimum necessary for airing the rooms.

The limits of the minimum required time for ventilation of premises can be determined from an analysis of the results of previous microclimatic studies. As can be seen in the studies, the difference between establishing a comfortable air temperature in the apartment and outside ranges from 4 to 6.5 hours. If we count 19 hours as the start of airing the apartment, then the most favorable period for ventilation is in the range from 19 hours to 1 hour. Consequently, the maximum interest should be represented by the wind regime precisely for these hours, for this segment of the day. Based on this, it is proposed that the wind speed of the area for the entire aeration of apartments is taken according to long-term data, averaged over a period from 19 hours to 1 hour, the hottest month with a large population. In this case, the wind direction having the greatest frequency during the same hours of the day should be taken as the prevailing one.

Under the influence of external conditions (socio-economic, political, natural and climatic) in each region over the centuries, its own specific type of people's housing was formed. Let us consider the types of folk dwellings that developed in climatic conditions similar to the climatic conditions of the south of Kazakhstan.

In the pre-revolutionary period, 3 types of housing were used: portable, temporary and permanent.

A portable, collapsible, felt-covered dwelling with a lattice frame, known as a yurt (in Kazakh - kiiz uy), was widespread at that time. This is a round, one-room dwelling with a portable fireplace. As a rule, the height of the lower cylindrical part of the yurt was 1.5 times higher than the upper, conical part. Together, the fusion of the shape and structure of the yurt, along with a high degree of mobility, in strong winds provided it with good streamlining, reduced airflow and eliminated the possibility of capsizing (the dead weight of the yurt is no more than 300 kg). The air exchange of the yurt in a closed mode was carried out through the cracks, seams, pores of the fences and the upper opening "tundik", with an adjustable opening area, which actually played the role of a light-aeration lantern. If necessary, flexible felt fencing made it possible to immediately create through ventilation in the horizontal and vertical directions. By winter, the yurt was replaced by temporary dwellings, which, however, had a strictly permanent location for each clan - wintering quarters (kystau). It was a half-dugout. It required little labor and materials for the device, but retained heat better. The reduction in heat loss was also facilitated by the small contact area between the ground part and the cold piercing wind. Naturally, at this time, the flow of air from the outside was limited in every possible way and therefore it could only enter through cracks and pores in the fences, as well as at the entrance and exit from the home. The exhaust air mainly escaped through the chimney.

The permanent dwellings of the settled part of the population, who lived mainly in places with fertile soils (floodplains, foothills), depending on the wealth of the owner, had one, two, three or more rooms located in one row. They could be with or without ivan. The most common room layout was based on the "korzhun" principle (a saddle bag with two compartments). The Korzhun-type residential building consisted of rooms to the right and left of the front room. The house is of the "half-korzhun" type, consisting of a room and a hallway; in the hallway there is a fireplace and a storage room. Often, to allow air to flow into the living room, a hole with a brick cross-section was left in the lower part of a blank wall, which was plugged during the hottest hours. In winter it was sealed tightly.

In all cases, the windows faced one side of the horizon, usually the south. Deviation from this rule occurred only under the influence of seasonal, unfavorable winds. At the same time, the houses were oriented in such a way that, by reducing the area of the walls facing the wind, their airflow was reduced. In the summer, the one-sided arrangement of the openings helped to slow down the air exchange of the premises with the external environment (windows, as a rule, did not open), which reduced not only the intensity of heat input from the outside, but and the rate of cooling of rooms during cool hours. In this regard, after the heat subsided, all household processes were transferred to the yard.

## CONCLUSIONS

1. The main part of the territory of southern Kazakhstan is occupied by steppes, semi-deserts and deserts, which are open, low-water, slightly hilly plains with sparse vegetation cover, and therefore necessitate a more careful consideration of temperature and wind conditions.

2. The territory of southern Kazakhstan belongs to areas with a sharply continental, hot, dry climate, with sharp temperature contrasts between day and night, summer and winter. The duration of the unheated period ranges from 50 to 60% of the annual time. At the same time, at the beginning and end of the unheated period throughout the entire territory, according to temperature characteristics, only daytime hours are comfortable, in the middle - evening, night and morning hours.

3. Most of the territory of southern Kazakhstan belongs to areas with a stable wind regime and moderate wind speeds. A characteristic feature of the wind regime is: an increased probability of transition to a dust storm (frequency 3-5 days in July; duration on average 1.5-5.4 hours); wind speed increases to maximums in the afternoon and decreases to minimums by sunrise.

4. The peculiarities of the climate, as well as the labor and economic rhythm of the population dictate the need to distinguish only two daily ventilation modes: during the overheated period - at night; in the non-overheated period, it is chaotic (i.e., does not have a clearly defined daily rhythm and is not of a mass nature).

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# PRODUCTION OF ENERGY-SAVING BUILDING MATERIALS BASED ON HEAT-ACCUMULATIVE ADDITIVES


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***Abstract***

*The paper considers heat-insulating materials with phase transitions based on organic compounds consisting of paraffin. In addition to the heat of the phase transition, in addition to the heat capacity in solid and liquid states, the possibility of using energy for accumulation is provided. At the same time, in order to reduce the use of energy resources in housing construction, materials with a low density and low thermal conductivity were used, using modern building materials. Now inorganic and organic building materials are used in housing construction. A material based on the use of a physical or chemical process associated with the absorption and release of heat, which has the ability to heat energy in building structures. Based on this, the accumulation-release of internal energy during heating-cooling of phase-shifting solid or liquid bodies, a material that absorbs latent heat, is considered. Heat accumulating material takes heat from the sun under high temperature conditions and transfers it back to the environment at night.*



***Keywords:*** *phase transition, liquid paraffin, mineral wool, heat accumulation, heat saving, enclosing structures, enthalpy.*


## INTRODUCTION

Thermal energy storage is a general strategy for improving energy efficiency in industries by reducing energy consumption at peak loads. But thermal energy storage can also be useful in the residential sector, where heat and electricity are generated simultaneously (for example, from a solar installation on the roof), but it can be used for different periods of time. The problem of heat conservation, rational use of energy and thermal resources occupies a special place in construction technologies. From the point of view of building materials science, researchers are trying to create a material with a low average density and low thermal conductivity. On this basis, a large number of heat-insulating and structural-heat-insulating materials have been developed that reduce heat loss through the enclosing structures of buildings and structures, as well as insulate industrial equipment and heating networks. In the modern construction market, there are various heat-insulating materials: according to the type of basic raw materials (inorganic and organic), structure (fibrous, granular, cellular), shape (loose, piece, shaped, wire) and other features. In practice, the following types of thermal insulation materials are most often used: mineral wool, glass wool, foam glass, cellular concretes (foam concrete, gas silicate), concretes based on light fillers, parts and fibreboard, polyurethane foam, polystyrene foam and others. In addition, despite the wide variety of thermal insulation materials, each of them has its own advantages and disadvantages.

In this article we want to consider a material capable of storing thermal energy (heat accumulating) and then transferring it to the environment. The possibility of heat accumulation of thermal energy is based on the use of a physical or chemical process associated with the absorption and release of heat. The main ones include the accumulation-release of internal energy during heating-cooling of solid or liquid bodies, latent heat absorption-release phase transitions, the sorption-disorption process or a reversible chemical reaction that occurs through heat dissipation-absorption [2]. The specified processes are carried out in special devices – heat accumulators (JAS) [3]. Substances used to store thermal energy are called heat storage materials.

Salt hydrates and organic materials, including paraffins, are most often used as a material with a phase transition. The main property that determines the efficiency of use in it is the magnitude of the change in enthalpy between the use temperature. Currently, paraffins are considered the most suitable for heat preservation, they are a mixture of aliphatic hydrocarbons in the series, they are also called marginal hydrocarbons. Paraffins have a high phase transition heat and a low viscosity coefficient, they do not have a hypothermic effect. Paraffin in liquid form is a nonpolar liquid and therefore does not mix with polar liquids such as water and alcohol. This is important when using them as a coolant in direct contact there. Paraffins have low electrical conductivity, which is why they are classified as good electrical insulators. The density of thermal paraffins in liquid form ranges from 750 to 850 kg.

The main physical properties of various types of paraffins are presented in тable 1.

Table 1. Physical properties of paraffins

| Types of paraffin | Phase transition temperature (freezing) $T_F$, $^oC$ | Specific heat in phase transition $Q_{F\cdot udel,}$ KJ/kg |
|---|---|---|
| 6107 | 40-43 | 189 |
| 6116 | 44-47 | 210 |
| 5838 | 47-51 | 189 |
| 6035 | 57-61 | 189 |
| 6403 | 62-65 | 189 |
| 6499 | 66-69 | 189 |

They have no hypothermia effect. Thus, a heat accumulator material (jam) is considered, consisting of a polymer binder and a heat accumulator substance, the nuclear material of which is paraffin, the shell is a Silicon organic compound, which is synthesized microcapsules [1].

Microcapsules in it are designed to accumulate and accumulate thermal energy due to phase transitions in the temperature zone of 10-50ºC. At the same time, the energy effect of reversible phase transformation is used, which carries out heat accumulation at temperatures above plus 25-30ºC, and at temperatures below plus 20ºC – allows you to produce heat return, which contributes to the creation of effective heat-saving premises.

Microcapsules in it are well combined with mineral, silicate and polymer viscous substances as phase transition materials and are intended for the manufacture of various building materials.

Microcapsules can be used there:

- for existing construction objects in the form of internal or external application to the elements of walls, ceilings, floors;
- for addition to concrete mixes, mortars, dry building mixes, paintwork materials, construction products (wall bricks or stones, panels, foam concrete blocks, floor slabs, etc.);
- in the form of heat-accumulative filling of cavities for hollow and multilayer products (hollow bricks and stones, multilayer slabs, etc.) [1].

There are the following advantages of using microcapsules that have a heat-capping effect on various building materials or objects. Heataccumulating material receives heat under high temperature conditions, such as in the sun, and transfers it to the environment at night. In this case, temperature fluctuations will be balanced, which will lead to an improvement in the housing climate.

There are no constructive requirements. Its technical parameters are important, the main ones are: melting point in the temperature zone plus 20-50ºC; high melting heat per unit mass and consistent melting characteristics of adsorbtive and adsorbent; chemical resistance; high corrosion resistance; low toxicity; low hypothermia and overheating resistance; slight volume change during Phase Transition; high thermal conductivity and heat capacity.

Such microcapsules are not inferior in properties to advanced heat-insulating material. In it, let's make a comparative analysis of several indicators of microcapsules and some effective thermal insulation materials (table 2).

Table 2. Comparative indicators of the quality of used thermal insulation materials and microcapsules

| Indicator name | Styrofoam | Mineral wool | Thermoaccumulating microcapsules |
|---|---|---|---|
| Thermal conductivity W/(m·$^o$C) | 0,037-0,042 | 0,048-0,07 | not more than 0,3 |
| Fire resistance | burns very well, releases a harmful substance | fire safety | difficult to burn, low smoke emission capacity |
| Vapor permeability mg/Pa·m·hours | 0,05 | 0,49-0,6 | 0,1-0,6 |
| Environmental friendliness (toxicity) | - | + | ++ |
| Length | Long-term | Long-term | Long-term |

## CONCLUSION

From the above indicators, it can be seen that microcapsules are practically not inferior to heat-insulating materials. In addition, traditional thermal insulation materials have their drawbacks. Mineral wool cannot hold the shape, even tile material is only installed in the crate; prone to shrinkage and shedding. It is not recommended to use mineral wool for insulation of vertical structures; high labor intensity during installation.

Polystyrene foam boards are a very fragile material, they often break, crumble. Styrofoam is subject to biocorrosion and exposure to mice and other rodents. When insulating with foam, you need to take care of improving ventilation, otherwise condensation may form on the walls, since this material has low vapor permeability.

As a result, I would like to say that the heat-insulating material considered in the article can compete with existing heat-insulating materials, but requires additional research. First of all, this is an assessment of thermal-physical properties when working on specific structures, an accurate determination of the amount of accumulated and transferred thermal energy, as well as heating and cooling cycles.

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# BEARING CAPACITY OF THE FOUNDATIONS OF CATENARY SUPPORTS WHEN INSTALLED IN A SANDY SOIL SUBGRADE


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***Abstract***

*This article presents the results of calculations of bearing capacity of foundations of railway contact network supports using the developed NSFORS program in the C# programming language. The bearing capacity of the foundations of the contact network supports in the ground is determined in accordance with the requirements and methods stated in the normative documents. When choosing the methods of fixing the contact network supports in the ground of the earth bed, the varieties of soils, characteristics of the foundations and methods of their driving were taken into account. The NSFORS program was developed in the C# programming language to calculate the bearing capacity of the foundations of the railway contact network supports. The program is developed taking into account the variety of soils, characteristics of foundations and methods of their driving. There is a graph of change of bearing capacity of the foundation on the action of the moment in different soils. There are recommendations on the use of pile foundations with the length from 6 to 10 m. Fixing of the contact network supports due to the resistance of the lateral surface of the 8 m long pile foundation is considered.*



***Keywords:*** *bearing capacity, foundation, pile foundations, support, sandy soil, calculation, analysis, design moment, design vertical force.*


## INTRODUCTION

A comprehensive study on the selection and application of the design of supports and foundations of the contact network was carried out to justify the structural and technological solutions for the construction of contact network supports on the earth bed of sandy soils on the object "Electrification of the railway line Bukhara-Urgench-Khiva" [1, 2]. The results obtained in the study are reliable in accordance with the initial data put in the design decisions (design, policy documents, materials of engineering and geological surveys, soil compaction factor and slope steepness of the earth bed, etc.) for the implementation of the project "Electrification of the railway line Bukhara-Urgench-Khiva" in the construction of contact network supports on the earth bed of sandy soils [3].

Three-beam cup foundations, as well as foundations of increased reliability and wedge-shaped anchors [4, 5] are predominantly used to support the contact network of railways. The installation of pile and pile-and-rocker foundations is envisaged on the railway subgrade in difficult engineering and geological conditions [6-9].

## MATERIAL METHODS

The bearing capacity of the foundation, under the action of the load in one vertical plane, is calculated using the initial data of Boshtransloyiha JSC. It is taken into account that:

a) the height of application of the equal horizontal load at the level of the contact wire is H'= 6.75 m.
b) the coefficient of proportion of the calculated constant load to the total load is $\xi$=0.35.
c) proportionality coefficient of ultimate (normative) soil resistance Ru= 80 kN/m3 [10].

Calculations on fixing of contact network supports and justification of design and technological solutions for construction of contact network supports on the earthen bed of sandy soils are performed under the condition of design moment and design vertical force [10-13]:

$$M^d \le M_f;$$
$$N^d \le N_f,$$

where $M_f$–design bearing capacity of the foundation on the ground for the action of moment or horizontal force applied at height $H$;

$N_f$– design bearing capacity of the foundation on the ground for the action of vertical force.

The carried out researches give the basis to accept the following design and technological decisions on a choice and use of various designs of supports and foundations of a contact network taking into account their bearing capacity on an earth bed from sandy soils.

Analysis and comparison of the results of the performed calculations of the values of vertical forces $N^d$ acting on the foundation with different designs of the contact network and values $N_f$ of the design bearing capacity of the foundation on the ground on the action of vertical force on the types of supports taking into account the reliability factor $\gamma_k$=1,4 [14] is as follows:

- for the foundations of intermediate support and middle anchorage supports, the condition $N^d \le N_f$ is fulfilled;
- for the foundations of the outermost anchorage, the condition $N^d \le N_f$ is not fulfilled. Due to the fact that the required condition is not fulfilled for the foundations of the outermost anchorage support, it is recommended to use metal supports or pile foundations with a length of 10 m or double pile foundations with a length of 8 m with a stanchion.

The soil bearing capacity of the foundations of the contact network supports is determined in accordance with the methodology described in [15-17], which is based on experimental and theoretical studies conducted by E.P. Kryukov, K.S. Zavriev and G.S. Shpiro [18]. The foundations of the contact network supports are calculated according to the method of limit states (Fig. 1).

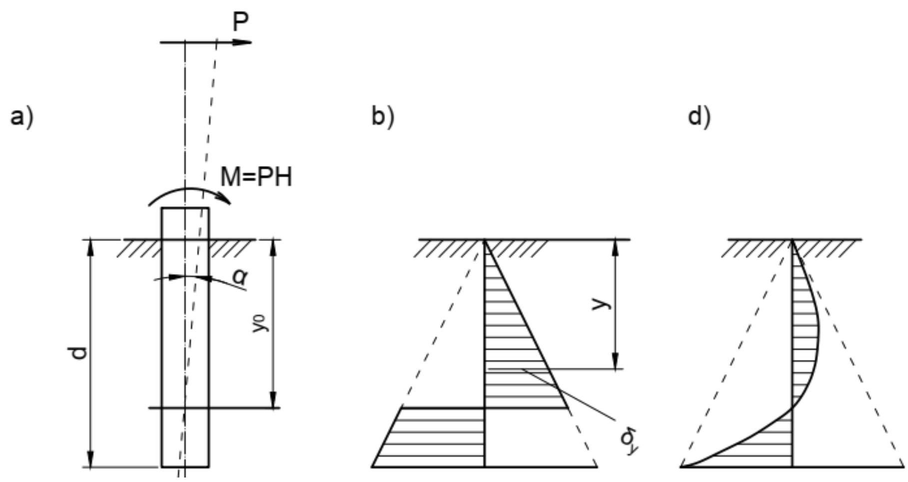


Fig.1. Soil pressure diagrams on the lateral surface of the foundation of the contact network supports under the action of horizontal load: a) scheme of load action on the foundation, b) soil pressure diagram in the limit state, c) the same in the elastic stage.

**Calculation of the moment bearing capacity of the foundation on the soil**

To calculate the moment bearing capacity of the foundation on the ground, the NSFORS program has been developed in the C# programming language.The program for calculating the moment bearing capacity of the foundation on the ground has been developed with the following data and notations:

- design load-bearing capacity of foundations on the soil for the action of the moment – "to the field" – $M_{fL}$; "to the track" – $M_{fR}$;
- soil varieties – i (0 – coarse and medium coarse sands, clays, loams and sandy loam; 1 – fine sands, clays,

loams and sandy loams that are stiff-plastic; 2 – dusty sands, clays, loams and sandy loams that are soft-plastic; 3 – sandy and clayey soils with admixture of plant residues; marshy soils that have accumulated at the base of the subgrade);

- shape of foundation cross-section – j (0–rectangular; 1–three-beam);
- varieties of foundations and methods of their driving – k (0–pile foundations of solid sections and hollow foundations driven with closed end; 1–pile foundations of hollow foundations driven with open end, I–beam and three-beam);
- height of the embankment– $d_1$;
- foundation depth (length) – d (4,5 and 7,5 m);
- width of the earth bed– $B_{zp}$.

## RESULTS AND DISCUSSION

The results of calculating the moment load carrying capacity of the foundation using the NSFORS program are shown in Table 1. The graphs of change in the moment bearing capacity of the foundation for different soils are shown in Figure 2.

Table 1 Design load-bearing capacity of foundations on soil for moment action

| Height of embank-ment, m | Values of design load-bearing capacity of soil foundations for moment action in case of soil types | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | i=0 | | i=1 | | i=2 | | i=3 | |
| $d_1$ | $M_{fL}$ | $M_{fR}$ | $M_{fL}$ | $M_{fR}$ | $M_{fL}$ | $M_{fR}$ | $M_{fL}$ | $M_{fR}$ |
| 0 | 301.92 | 301.92 | 215.34 | 215.34 | 155.61 | 155.61 | 91.97 | 91.97 |
| 1 | 241.53 | 271.72 | 172.27 | 193.80 | 124.49 | 140.05 | 73.58 | 82.77 |
| 2 | 181.15 | 241.53 | 129.20 | 172.27 | 93.37 | 124.49 | 55.18 | 73.58 |
| 3 | 150.96 | 211.34 | 107.67 | 150.74 | 77.80 | 108.93 | 45.99 | 64.38 |
| 4 | 135.86 | 181.15 | 96.90 | 129.20 | 70.02 | 93.37 | 41.39 | 55.18 |
| 5 | 135.86 | 181.15 | 96.90 | 129.20 | 70.02 | 93.37 | 41.39 | 55.18 |
| 6 | 135.86 | 181.15 | 96.90 | 129.20 | 70.02 | 93.37 | 41.39 | 55.18 |

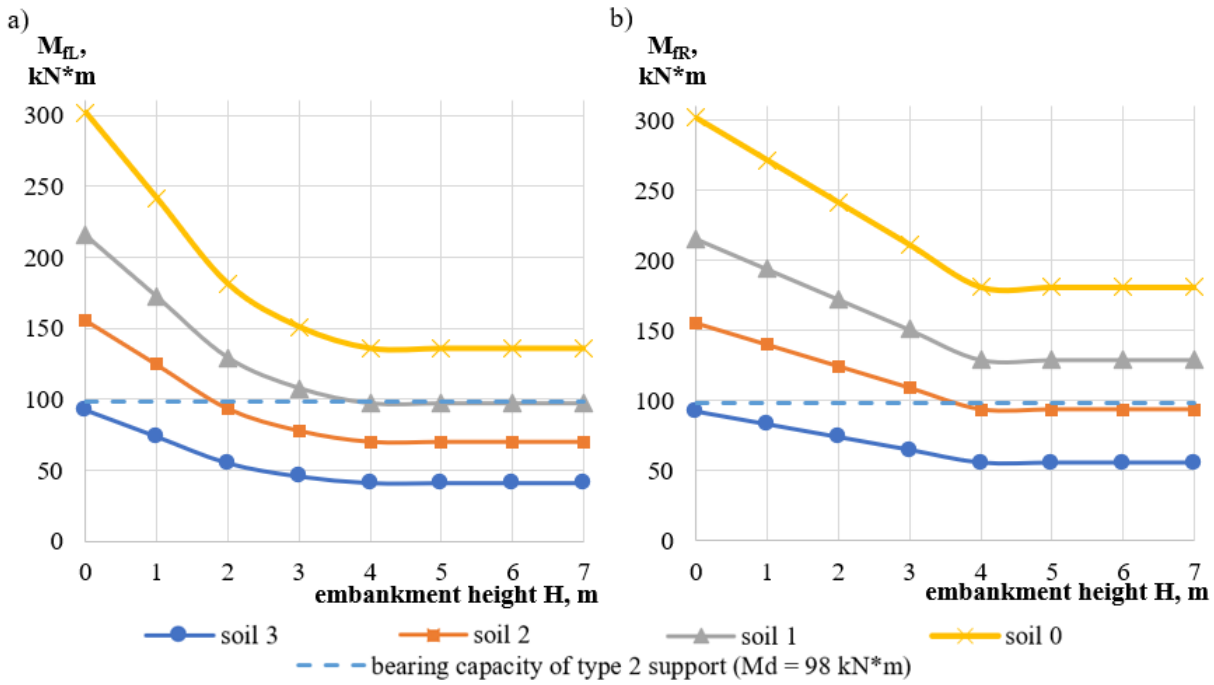


Fig.2. Graph of the change in the load-bearing capacity of the foundation on the action of the moment for different soils

The calculations were performed with the load acting in one vertical plane to satisfy the conditions $M^d \leq M_f$, for type 2 piers ($M^d$ = 98 kN*m). Analyses of the results of calculations of application of a 5 m long three-beam foundation on the earth bed in different soils are as follows:

- in case of soil type – i=0, satisfies the required condition and ensures stable anchorage of the foundation in the ground;

- in case of soil type – i=1, satisfies the required condition and ensures stable anchorage of the foundation in the ground at the height of the embankment $H_н \leq 3.90$ m;
- in case of soil type – i=2, satisfies the required condition and ensures stable anchoring of the foundation in the ground at the height of the embankment $H_н \leq 1.85$ m;
- in case of soil type – i=3, the required condition is not fulfilled and stable anchorage of the foundation in the ground is not ensured.

Consequently, when constructing catenary towers on sandy soil subgrades, it is recommended to use pile foundations with a length of 6 to 10 m, resting on dense soil, which are located below the weak soil. In this case, foundations in the form of single piles or a group of piles can be used depending on the bearing capacity of the supports [19, 20]. Taking into account these recommendations, we have considered the anchoring of the supports of the contact network due to the resistance of the lateral surface of the pile foundation.

The graph of change in the bearing capacity of an 8 m long pile foundation on an earth bed made of sandy soils is shown in Figure 3.

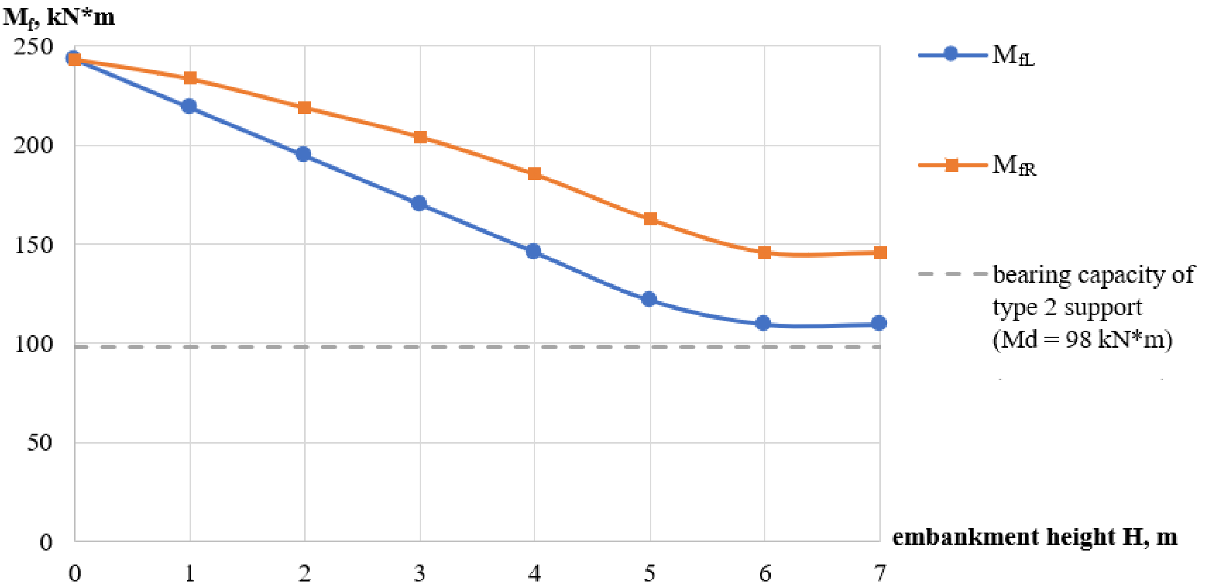


Fig. 3. Graph of change in bearing capacity of 8 m long pile foundation on sandy soil subgrade

In freshly excavated embankments, the stability of the supports and anchors of the overhead catenary network is ensured by the use of:

- non-separable supports with the underground part of the support increased by 0.5m, as well as separate supports with pile foundations, using vibro-loaders;
- non-separated supports with reverse conicality in the lower part, installed in stamped out excavations;
- pile anchors with a length of more than 4.5 m, using vibratory loaders.

The main site and the slopes of the sandy earth bed must be reinforced with a strip at least 3 metres wide along the excavation berms and embankment footings. In order for the overhead catenary support to stand reliably and for a long time, it is necessary to take measures to secure the sand from blowing out from under its base. The following alternatives should be considered when constructing overhead catenary supports in order to reinforce their base with a feasibility study:

- mixing the backfill sand with water-soluble polyacrylamide glue and laying a layer of at least 15 cm with compaction and backfilling with a layer of crushed stone-wooden soils;
- prefabricated reinforced concrete purlins in combination with crushed stone backfilling of cells;
- pneumatic spraying with binders on the anchored grid.

Sand consolidation should be carried out in the form of a semicircle with a diameter of 10-12 m around the installed supports. When selecting the method of sand fixing, it is necessary to take into account the growth of desert vegetation and the possibility of development of the root system of plants.

## CONCLUSION

The complex research on determination of bearing capacity of the foundations of the contact network supports is carried out to substantiate the structural and technological solutions for construction of the contact network supports on the earth bed made of sandy soils.

The NSFORS programme has been developed in the C# programming language to calculate the load-bearing capacity of the foundation on the soil for the action of the moment, taking into account the types of soils, characteristics of foundations and methods of their driving.

The results of calculation results of application of 5 m long three-beam foundation on the earth bed in different soils on satisfaction of $M^d \leq M_f$, for supports of type 2 ($M^d$ = 98 kN*m) have been analysed.

It is recommended to use pile foundations for the supports of the contact network when installing in the earth bed of sandy soils. In this case due to the resistance of the lateral surface of the pile foundation their bearing capacity is ensured.

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UDC 625.143

# A STAND FOR DETERMINING THE LINEAR RESISTANCE TO THE LONGITUDINAL MOVEMENT OF RAILS

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***Abstract***

*The article deals with the problem of linear resistance to longitudinal movement of rails on sleepers. The resistance to longitudinal movements of the track is a determining factor in its temperature operation. The total resistance to transverse movements (sideways and upward), the rotation of the rails and the rigidity of the rails determine the stability of the joint-less track against curvature (ejection). Resistance to downward movement of the path (drawdown) – counteraction of the base of the path to vertical forces. To solve it, the design of a special test bench has been developed for conducting a complex of studies to determine the actual values of linear resistances for track structures with various types of intermediate rail fasteners.*

***Keywords:*** *joint-less path, linear resistance, ejection path, fasteners, stability, longitudinal forces, tensioning machine.*

## INTRODUCTION

The current regulatory documents in the field of laying, maintenance and repair of rail lashes of a jointless track set the values of linear resistance to longitudinal movement of rails on sleepers, should be 2.5 – 3.5 t / m (25 - 30 kN / m). Failure to comply with the norms of linear resistance leads to the hijacking of the path and can provoke the ejection of the path. In this regard, it is necessary to evaluate the real values of linear resistances as a factor in ensuring the safety of train traffic on a jointless track [1].

In the track economy of JSC "Uzbekiston Temir yillari", a jointless track with different sleepers and types of intermediate rail fasteners is operated; in some cases, there is theft of rail lashes, which is extremely dangerous and at the same time guaranteed stability of the lashes of the jointless track cannot be ensured; rail theft is not the same and depends on the duration of operation of the track structure – depends on the size the tonnage missed along the way and the degree of wear of the elements and parts of the intermediate rail fastening [2-4].

For the construction of the upper structure of the track with BF70 type sleepers and Pandrol Fastclip fastening, which is most common at Yzbekiston Temir Yillari JSC, there is insufficient information about the actual linear resistance to the longitudinal movement of rails along the track under the influence of hijacking forces and temperature forces. In such a situation, it is very difficult to guarantee reliable and safe operation of a jointless track. There is still a risk of unpredictable path ejection. Such a risk increases with the aging and wear of the parts of the intermediate rail fastening, in which the main technical characteristics of the fastening deteriorate. The degree and timing of the loss of the main properties of the Pandrol Fastclip type fasteners for the conditions of the track economy of JSC "Uzbekiston Temir Yillari" have not been studied at a sufficient level. The absence of indicators of aging of the intermediate rail fastening is especially dangerous for sections of high-speed and high-speed train traffic, taking into account the transition to the construction of a jointless track with rail lashes of increased length [5-8].

In this regard, in order to determine the actual actual linear resistance to the movement of the rail along the track, it is necessary to conduct a complex of special studies and tests using non-standard testing equipment.

To carry out a complex of studies to determine the actual values of linear resistances for track structures with various types of intermediate rail fasteners, a project was developed in 2015 for the construction of a special test stand on the territory of the Tashkent Track Distance (PCH-2) of JSC "Uzbekiston Temir Yillari". The stand is designed to determine the actual linear resistance to the longitudinal movement of rails along sleepers for track structures with various types of sleepers and intermediate rail fasteners [9, 10].

## METHODOLOGY OF THE EXPERIMENT

The test bench is a massive reinforced concrete foundation, the top of which is located above the relief (Fig. 1). Two rails of type P65 are horizontally embedded in the foundation body, protruding towards the test link with a length of 12.5 m. Between the test link and the rails embedded in the foundation body, tensioning machines of type TN 70 VL of Geismar are located (Fig. 2), which perform the role of force-loading mechanisms to create a longitudinal force in the rails of the tested link in the testing process [11, 12, 13].

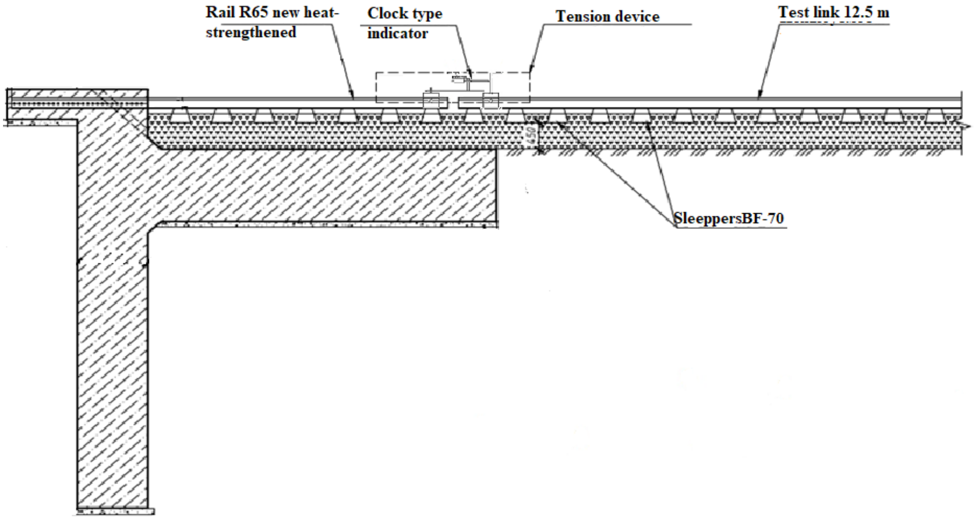


Fig. 1. Test bench for determining linear resistance to longitudinal movement of rails on sleepers.

The magnitude of the longitudinal force generated by the tensioning machines of the TN 70 VL type of Geismar company is controlled by an instrument (pressure gauge) mounted in the pumping station of the tensioning machine with an accuracy of 0.1 kN. If necessary, it is possible to carry out metrological certification of each of the TN 70 VL Geismar machines used during testing at the stand, with the involvement of the Uzstandart Agency.

The moment of the beginning of the displacement of the rail under the action of the longitudinal force created by machines of the TN 70 VL type of Geismar company is set visually; at the same time, the force created by the tensioning machine at the moment of the beginning of the rail movement is recorded by the pressure gauge.

Machines of the TN 70 VL type of Geismar company are available in the distances of the way of JSC "Uzbekiston Temir yillari" and their additional purchase is not required. With the help of tension machines, a static force is created that simulates longitudinal temperature forces in the rails of the operated track. Using the control and measuring tools of the TN 70 VL type machine, the value of the longitudinal force at which the movement of rails along the track begins is set [14-16].

Prior to the start of the test, each test link is inspected and checked for the completeness of all parts of the intermediate rail fastening. The distance between the sleepers is measured and the correspondence of the sleeper plot to the link number is checked. Shortcomings in the completeness of the intermediate fastening parts are eliminated. If a mismatch of the plot is detected, the link is reassembled with the corresponding plot.

The key is being reactivated. The absence of damage to the key and its connecting square, including its crumpling, is checked. The coincidence of the arrow with the zero mark of the scale is checked. The mismatch of the arrow should not exceed 0.1 of the price of the key scale. The end head is selected according to the size and shape of the bolt and is put on the connecting square.

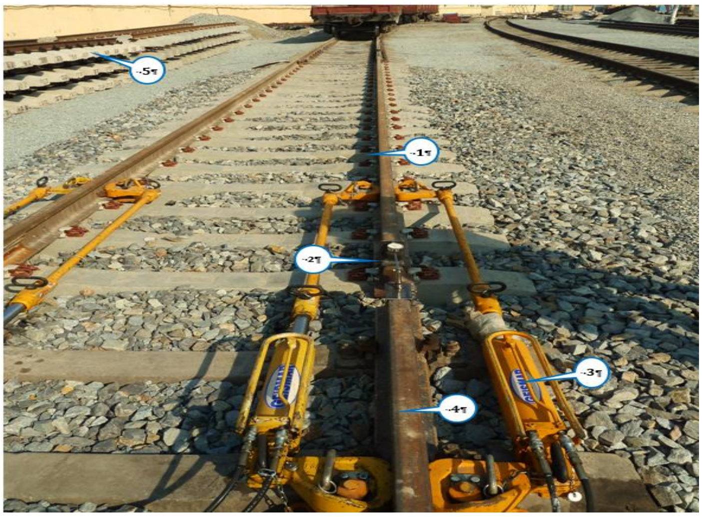

Fig 2. A fragment of a test bench with TY 70 M type tensioning machines from Geismar:
1 – a test link with a length of 12.5 m; 2 – an indicator of the ICH – 10 clock type; 3 – a tensioning machine; 4 – a rail embedded in the foundation body; 5 – links for testing with various defects and a plot.

The setting of the indicator to zero is checked. With the help of tension machines, a static force is created (Fig. 3), simulating longitudinal temperature forces in the rails of the operated track.

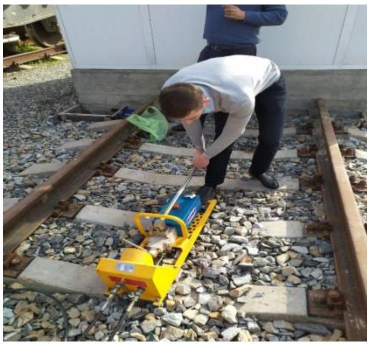

Fig. 3 Creating a static force

The displacement of the rail under the action of the longitudinal force created by the tension walls is measured using a clock-type indicator, and the pressure gauge of the tension device sets the value of the force created by it (Fig. 4). During testing, the static longitudinal force applied to the tested rail changes gradually with an interval of 10 kN; each load stage is held in for 1 min.

Fig. 4 Force fixation.

Before the next increase in the static longitudinal force, the movement of the rails is recorded using the ICH-10 clock type indicator and recorded in the Test Sheet (Table 1).

The test is considered completed when the rail movement occurs without increasing the value of the longitudinal force created by the tensioning machine type TN 70 VL of Geismar.

Table 1. A list of longitudinal movements with Pandrol Fastclip type fasteners.

| Longitudinal force, kN | Rail movement in the "traction" mode, mm | | |
|---|---|---|---|
| | Test № 1 | Test № 2 | Test № 3 |
| 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0,12 |
| 40 | 0,1 | 0,11 | 0,25 |
| 50 | 0,43 | 0,45 | 0,61 |
| 60 | 0,59 | 0,64 | 1,13 |
| 70 | 0,88 | 1,59 | 2,0 |
| 80 | 1,43 | 2,10 | 2,36 |
| 90 | 2,15 | 2,74 | 2,97 |
| 100 | 2,99 | 3,64 | 3,89 |
| 110 | 3,62 | 4,32 | 4,56 |
| 120 | 4,48 | 5,21 | 5,42 |
| 130 | 5,43 | 6,0 | 6,31 |
| 140 | 6,07 | 6,65 | 7,03 |
| 150 | 7,25 | 7,66 | 8,11 |
| 160 | 7,96 | 8,84 | 9,22 |
| 170 | 8,83 | 9,59 | 10,36 |
| 180 | 9,62 | 10,79 | 10,95 |
| 190 | 10,8 | 11,4 | 12,46 |
| 200 | 12,2 | 12,6 | 13,98 |

## RESULTS AND DISCUSSION

The value of the linear path resistances is determined based on the results of three tests. The measurement results should not differ by more than 10%. If the measurement results differ by more than 10%, then three more test cycles are carried out. To calculate the linear resistance to the longitudinal movement of the rails, the smallest of all the values of the longitudinal forces measured in the test cycle is taken.

The results were processed for each power load determined by the test bench, the rail movements were measured with an accuracy of 0.01 mm (Fig. 5).

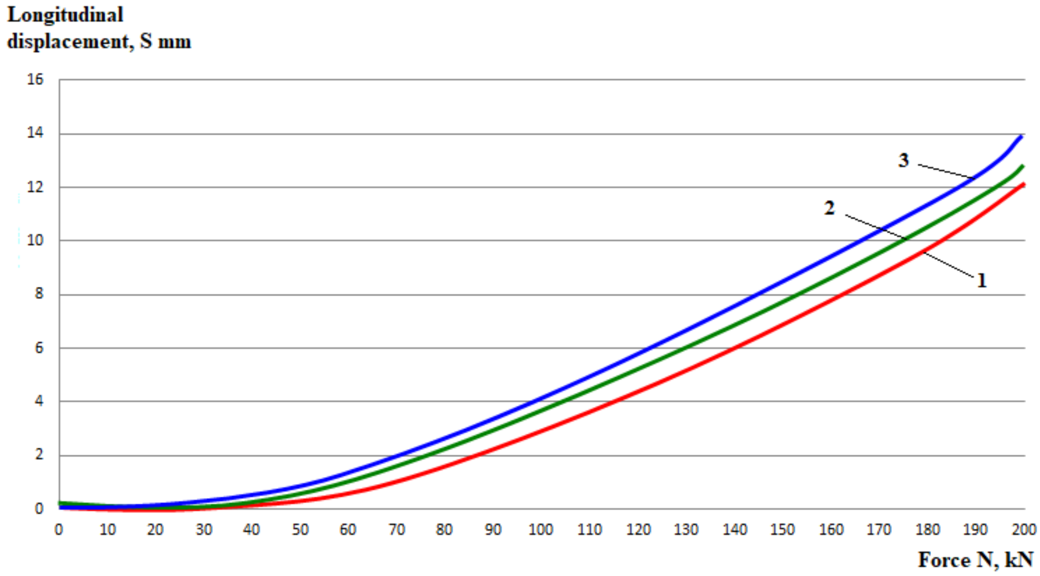


Fig. 5 Dependence of longitudinal displacement and force:
1 – test No. 1; 2 – test No. 2; 3 – test No. 3.

As a result of the performed studies, the dependencies of the longitudinal displacement and the force on the path with the "Pandrol Fastclip" fasteners were obtained. The initial shear force is in the range of 30 – 40 kN (the average displacement value is 0.2 mm). At a maximum load of 200 kN, the displacements averaged 12.93 mm.

## CONCLUSIONS

The resistance to the longitudinal movement of the rails is in the range of 25-30 kN / m, which also meets regulatory requirements. Using the control and measuring tools of the TN 70 VL type machine, the value of the longitudinal force at which the movement of rails along the track begins is set. The displacement of the rail under the action of the longitudinal force created by the tensioning machines is measured using a clock-type indicator, and the pressure gauge of the tensioning device sets the force value created by it.

In general, the experiments performed and subsequent operational studies have confirmed good resistance to longitudinal movement of the rails and high stability of the clamping force of the terminals during operation. At the same time, the minimum resistance to the movement of the rail (25 kN/ m) is provided.

It is necessary to continue research using a test bench to evaluate linear resistances with other track structures with different missed tonnage, weather and climatic conditions, as well as conducting tests not only in the static state of the rails, but also under the influence of special vibrators simulating oscillatory processes during train movement.

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## THE POSSIBILITIES OF USING MINING WASTE IN THE PRODUCTION OF BUILDING MATERIALS


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***Abstract***

*Reducing energy and material costs in the production of building materials and products is an urgent task that can be solved by using various industrial wastes. At the same time, such fundamental issues as environmental protection, economical, integrated and rational use of natural raw materials are being solved. A huge amount of industrial waste has been accumulated at the enterprises of the mining complex of Kazakhstan, besides their number is increasing by about 1.5 billion. t per year. The world has accumulated vast experience in research on the use of technogenic mineral raw materials. Mining waste is used to produce bricks, concrete, glass ceramics, as raw materials for the production of building materials, taking into account the environmental factors of their impact on the environment. The article discusses the possible use of various wastes of the mining industry in the south of Kazakhstan in the construction industry, the data of physico-chemical research are given.*


***Keywords:*** *concrete, mining waste, mineralogical composition, additives.*

### INTRODUCTION

One of the promising directions in solving the problem of waste disposal of mining production and the creation of highly efficient building materials is the creation of modified concrete.

World experience shows that increasing the production and use of modified concrete using industrial waste leads to a significant reduction in heat consumption, both in the production of building materials, and in construction work and in the operation of civil and industrial construction facilities.

The rapid development of the construction industry in Kazakhstan requires a significant amount of mineral raw materials for the construction materials industry. Intensification in this direction involves the use of industrial waste instead of primary natural resources in order to reduce the cost of building materials. The use of solid mining waste in the construction materials industry is more economical compared to the production of building materials based on special extraction of mineral raw materials. In addition, the problem of reducing the yield and maximum utilization of solid technogenic mineral formations of mining production is one of the most important tasks within which such fundamental issues as environmental protection, economical, integrated and rational use of natural raw materials are solved, and construction and technological waste disposal is promising in this direction, since it is the construction of and the construction materials industry is able to ensure the scale of waste consumption, comparable to the scale of their education [1].

### EXPERIMENTAL METHODS

A review of existing scientific papers in this field shows that there is a significant global practice of conducting research on the use of technogenic mineral raw materials. So, in the far abroad, mining waste is used to produce bricks [2], concrete [3], glass ceramics [4]. Studies have been conducted on the use of technogenic waste as raw materials for the production of building materials, taking into account the environmental factors of their impact on the environment [5]. Similar studies on the use of mining waste for the production of construction materials and products are carried out in neighboring countries [6]. According to modern estimates, over 40 billion tons of industrial waste have been accumulated at the enterprises of the mining complex of Kazakhstan. Every year, the amount of industrial waste increases by about 1.5 billion tons [7]. Moreover, the largest reserves of TMO are concentrated in tailings dumps.

There is experience in the use of crystalline limestones and waste during its mechanical processing in the production of cements with the identification of patterns of hydration of cements with carbonate additives, the development of optimal compositions of cements, mortars and concretes with specified performance properties and reducing the cost of production by using their own waste lime and cement production [8].

Studies show that the content of carbonates in polymetallic or dressing waste is 50-70%, which makes it possible to use them as a carbonate-containing additive to cement and it has been established that the presence of barium sulfate introduced with polymetallic ore dressing waste can increase the protective properties of composite cement from gamma and X-ray radiation [9]. The work [10] presents studies on the use of tailings waste from polymetallic ore enrichment of JSC "Achpolymetal" in the production of facing plates.

A lot of work has been done on the use of waste from electrothermophosphoric production, blast furnace and ash slag, which have shown that the materials studied are suitable for the production of cement clinkers for various purposes [11]. Non-ferrous metallurgy slags allow replacing scarce pyrite stubs.

The authors [12] suggest using barite waste as a filler and filler for heavy concrete, with partial or complete replacement of quartz sand in the composition of the concrete mixture. At the same time, an increase in the linear absorption coefficient of gamma rays to 19% is observed, however, the partial replacement of quartz sand in the volume of 40% with barite makes it possible to achieve protection from both gamma rays and neutron radiation. It has been established that with proper optimization of the composition of concrete on barite sand, it is possible to obtain superior mechanical performance than on quartz sand [13].

Compositions of dry building mixes based on barite-containing waste are proposed [14].

Quantitative and qualitative characteristics of technogenic wastes of some large mining enterprises of Kazakhstan have been established, technological solutions for the production of dry building mixes and cellular concrete and on the basis of ore dressing waste have been proposed [15].

But an analysis of the practice of processing and application of mining waste shows that technogenic waste cannot be used because of the unprofitability of their processing and because of the imperfection of the technology of their secondary use, although by their resource value, waste from mining, mining and processing, metallurgical, fuel and energy industries are promising, stacked and constantly replenished mineral raw materials of technogenic origin, and the largest volumes of their utilization fall on overburden and host rocks of ferrous and non-ferrous metallurgy enterprises, which are used to obtain crushed stone, gravel, sand for road surfaces, for filling dams, tailings dumps, reclamation of disturbed lands, etc. [16].

We have studied the waste of mining production in the south of Kazakhstan to develop technologies for the production of modified concrete using industrial waste while reducing the negative impact on the environment and protecting the population from the harmful effects of technogenic waste.

Table 1 shows the selected objects for research that are suitable as raw materials for concrete with specified performance properties.

Table 1 – Waste reserves of various mining enterprises in the South of Kazakhstan

| № | Objects of research | reserves, t |
|---|---|---|
| 1 | Slags of the Shymkent phosphorus plant | 1,09 million |
| 2 | Dropouts of the Achisai polymetallic plant in Kentau | 182 million |
| 3 | Tailings of the enrichment of the Ansai deposit in Kentau | 5,4 million |
| 4 | Lead slags of Yuzhpolymetal JSC | 2,3 million |
| 5 | Carbonate screenings of SAS-Tobe technologies LLP | 5,4 million |

## RESULTS AND DISCUSSION

Physico-chemical studies of mining waste from the south of Kazakhstan, waste from the Shymkent phosphorus plant, the Shymkent lead plant, tailings of the Achisai tailings dump, screenings of the Ansai deposit, carbonate screenings of the Sastyubinsk lime plant were carried out. X-ray diffractometric analyses were carried out on the Bruker D&ENDEAVOR device (Germany) with Si radiation, filter, differential thermal analysis on the Q 1500 D (Demo) derivatograph of the L system. Erdey in the air, in the temperature range from 20 to 1000 °C, scanning electron microscopy performed on a scanning electron microscope (SEM) JEOL-6490 LV.

All analyses were carried out at Testing regional laboratory of engineering profile "Structural and biochemical materials" South Kazakhstan University named after M.Auezov, Shymkent. The results of the analyses are shown in Table 2.

Table 2 – Chemical composition of waste

| Elements | Achisai dropout | Aksai dropout | Carbonate screening | Lead slag | Phosphoric slag |
|---|---|---|---|---|---|
| C | 9,12 | 14,16 | 13,97 | 7,2 | 11,82 |
| O | 37,11 | 49,56 | 46,76 | 36,98 | 46,06 |
| Mg | 2,32 | 0,31 | 0,33 | 1,87 | 1,41 |
| Al | 2,55 | 1,12 | 0,40 | 2,81 | 3,34 |
| Si | 8,81 | 6,36 | 1,21 | 10,00 | 13,86 |
| S | 0,74 | - | 0,44 | 1,25 | - |
| K | 0,56 | 0,39 | 0,18 | 0,65 | 1,41 |
| Ca | 7,66 | 23,86 | 35,77 | 7,56 | 13,41 |
| Ti | 0,38 | - | - | - | 0,20 |
| Fe | 23,87 | 1,2 | 0,45 | 22,83 | 3,10 |
| Ba | - | 2.22 | - | - | - |
| Cu | 0,80 | - | - | - | - |
| Zn | 6,09 | - | - | - | - |
| P | - | - | - | - | 2,09 |

## CONCLUSION

The data of physico-chemical studies show that, in all the waste studied, there are minerals $CaCO_3$ (calcium carbonate), $SiO_2$ (quartzite), $CaMg(CO_3)_2$ (dolomite), which under certain conditions can show binding properties, that is, they can be used as active mineral additives for concrete, used as fillers, or replace a certain part of the cement.

In addition, the enrichment waste is a finely ground product that does not require additional grinding before use, this reduces economic costs, that is, in the process of ore enrichment, the uniformity of the material is ensured both in chemical and mineralogical composition. Their widespread use in industrial turnover will increase resource conservation by saving costs for exploration, extraction and processing of mineral raw materials. From the results of the study, a direction will be obtained to minimize the harm caused to the environment, reduce anthropogenic emissions into the atmosphere, improve the habitat of the population, create jobs and, in general, increase the level of resource conservation and lower prices for building materials and products.

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## INFLUENCE OF WASTE TYPE ON THE UNIFORMITY OF VOLUME CHANGE

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**Abstract**

*The article presents the compositions and properties of filling mixtures using marble processing waste and copper smelting slag. It has been established that, in terms of their physical and mechanical characteristics, backfill mixtures made from waste are not inferior to mixtures made from natural materials.*

**Keywords.** *Backfill mixtures; industrial waste; normal thickness; marble processing waste; copper smelting slag.*

### INTRODUCTION

The production activities of the Almalyk Mining and Metallurgical Combine in the Republic of Uzbekistan generate waste that must be disposed of and special dumps created for their storage. Transportation of waste and its storage significantly affects the cost of mining ore materials and finished products. At the same time, issues of environmental protection and the alienation of tens of hectares of arable land for the creation of dumps are of no small importance [1, 2].

Binders, including cements, during hardening should be characterized by a uniform change in volume. Cements with an uneven change in volume lead not only to a decrease in strength during hardening, but even to their destruction [3, 4, 5].

Uneven changes in the volume of cement can be caused by: hydration of free calcium oxide when its content in clinker is more than 1.5-2%; hydration of free magnesium oxide present in clinker in the form of a high-temperature, slowly quenching form - periclase; the formation of a high-sulfate form of calcium hydrosulfoaluminate in hardening cement with an increased content of C3A in the clinker and with the excessive introduction of gypsum into Portland cement during its grinding. The content of free calcium oxide in cement is not regulated by the standard. If there is an excess amount, its negative effect is easily determined by the behavior of cement cake samples when heated in boiling water for 4 hours. The test is carried out one day after the samples are made [6, 7, 8].

**2. Experimental Work**

To study the composition of filling mixtures, the following types of waste generated at the plant itself were selected:

- copper smelting waste;
-marble processing waste generated from the activities of the marble workshop of the plant;
-ash from Novoangrenskaya TPP [9].

For testing, sample cakes were made from the following compositions given in Table 1.

Table 1. Binder compositions

| Train numbers | Component consumption, g | | | | | NGC (mm) | V/C |
|---|---|---|---|---|---|---|---|
| | Portland-cement | Ash | Marble processing waste | Copper Planing Slag | Water | | |
| I | 400 | - | - | - | 100 | 7 | 0,25 |
| II | 320 | 80 | - | - | 100 | 6 | 0,25 |
| III | 320 | - | - | 80 | 100 | 6,5 | 0,25 |
| IV | 320 | - | 80 | - | 100 | 7 | 0,25 |

**RESULTS AND DISCUSSIONS**

For testing, samples of 75 grams each were weighed out of each composition, rolled into balls, and placed on glass plates. Lightly tapping the dough produces flat cakes with a diameter of 7-8 cm and a middle part height of 1 cm. The prepared flat cake samples were stored for 24±2 hours from the moment of production at room temperature in a bath with a hydraulic seal. After time, the diameter of the sample cakes is measured with a caliper [10, 11]. Daily measurement data for cake samples of all compositions are given in Table-2.

Table 2. Test results for flat cake samples

| Compositions | Sample number | Dimensions, cm | |
|---|---|---|---|
| | | Freshly molded | Daily allowance |
| I | 1 | 7,7×7,7 | 7,3×7,4 |
| | 2 | 7,1×7,0 | 7,1×7,0 |
| | 3 | 7,1×7,3 | 7,2×7,1 |
| | 4 | 7,4×7,6 | 7,1×7,4 |
| | 5 | 7,4×7,4 | 7,2×7,3 |
| | 6 | 7,4×7,3 | 7,4×7,2 |
| II | 1 | 6,9×7,0 | 6,8×6,9 |
| | 2 | 7,1×7,2 | 7,1×6,8 |
| | 3 | 7,4×7,6 | 7,4×7,2 |
| | 4 | 7,0×7,1 | 7,3×7,1 |
| | 5 | 7,0×7,2 | 7,0×6,9 |
| | 6 | 7,0×7,1 | 7,0×7,1 |
| III | 1 | 7,0×7,1 | 7,2×7,0 |
| | 2 | 7,5×7,6 | 7,5×7,6 |
| | 3 | 7,5×7,7 | 7,2×7,4 |
| | 4 | 7,4×7,4 | 7,2×7,3 |
| | 5 | 6,7×7,1 | 6,7×7,0 |
| | 6 | 7,4×7,4 | 7,4×7,2 |
| IV | 1 | 7,7×7,5 | 7,6×7,6 |
| | 2 | 7,3×7,6 | 7,0×7,7 |
| | 3 | 7,2×7,5 | 7,2×7,6 |
| | 4 | 7,7×7,0 | 7,3×7,0 |
| | 5 | 7,3×7,4 | 7,2×7,5 |
| | 6 | 7,4×7,4 | 7,4×7,2 |

After a 24-hour test, some of the cake samples were subjected to heat treatment in a water bath for 4 hours, and some were placed in a water bath with a hydraulic seal for 28 days. After the storage period, sample cakes are visually inspected and measured. Test data is given in Table-3.

Table 3. Test results for flat cake samples

| Compositions | Sample number | Dimensions, cm | |
|---|---|---|---|
| | | After heat treatment | 28 days |
| I | 1 | 7,3×7,7 | 7,0×7,2 |
| | 2 | 7,1×7,1 | 7,4×7,1 |
| | 3 | 6,9×7,1 | 7,2×7,1 |
| | 4 | 7,4×7,1 | 7,4×7,1 |
| | 5 | 6,9×7,2 | 6,9×7,2 |
| | 6 | 7,4×7,4 | 7,2×7,3 |
| II | 1 | 6,9×7,0 | 6,9×6,9 |
| | 2 | 7,1×7,0 | 7,1×7,0 |
| | 3 | 7,1×7,5 | 7,4×7,2 |
| | 4 | 7,0×7,1 | 7,3×7,1 |
| | 5 | 7,0×7,2 | 7,0×6,9 |
| | 6 | 7,0×7,1 | 7,0×7,1 |
| III | 1 | 7,0×7,1 | 7,2×7,4 |
| | 2 | 7,5×7,4 | 6,5×7,2 |
| | 3 | 7,0×7,5 | 7,5×7,0 |
| | 4 | 7,4×7,2 | 7,2×6,9 |
| | 5 | 7,0×7,1 | 7,0×7,0 |
| | 6 | 7,4×7,1 | 7,4×7,1 |
| IV | 1 | 7,9×7,6 | 7,0×7,3 |
| | 2 | 7,8×7,1 | 7,0×7,7 |
| | 3 | 7,2×7,5 | 7,2×7,6 |
| | 4 | 7,2×7,0 | 7,1×7,2 |
| | 5 | 7,4×7,1 | 7,2×7,3 |
| | 6 | 7,4×7,4 | 7,3×7,2 |

## CONCLUSIONS

A visual inspection of the samples shows that the cakes do not have radial cracks reaching the edges, a network of small cracks, curvatures and an increase in volume - evidence of a uniform change in the volume of cement.

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## STRAINING CEMENTS BASED ON EXPANDING ADDITIVES USING INDUSTRIAL WASTE AND CONCRETES BASED ON THEM

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***Abstract***
*The article discusses ways to solve the problems of improving the construction and technical characteristics of concrete and reinforced concrete due to the use of expanding binders and, first of all, straining cement (NC). High strength, crack resistance, impermeability and the ability, expanding during hardening, to self-strain (pre-strain) reinforced concrete determine the effectiveness of the use of concrete at the NC in a variety of construction areas.At the same time, NC is produced at only a few enterprises of the CIS republics due to the scarcity and high cost of one of its main components - alumina slag. Therefore, the search for cheaper and more affordable materials based on various natural and man-made aluminum-containing materials to replace alumina slag for its production in the republics of Central Asia acquires particular relevance.*

***Keywords:*** *straining cement, self-stressed reinforced concrete, physical and mechanical properties, strength, crack resistance, impermeability, expanding component, alumina slag, alunite, industrial waste.*

### INTRODUCTION

At the present stage of socio-economic development of the Central Asian countries, the most pressing problems determining scientific and technological progress in the construction complex and, above all, in the production and application of cement binders and concretes include: reducing the energy and material intensity of production and construction, improving the quality of existing and developing new more efficient building materials and structures, intensification of technological processes, extensive use of local raw materials and resources.

According to the level of technical and economic indicators, concrete and reinforced concrete in the XIX century still remain the main structural materials. They occupy priority places in the overall structure of the global production of building structures. Therefore, the improvement of their construction and technical characteristics is especially important and significant for the entire construction complex. One of the actual directions of development and improvement of concrete and reinforced concrete is the development of new approaches and their implementation in the production of binders and concretes of a new generation, ensuring the reliability and durability of structures and structures, their efficiency.

An important reserve in solving this problem and improving the construction and technical properties of reinforced concrete is the elimination or maximum reduction of shrinkage phenomena in concrete. Shrinkage deformations combined with low tensile strength of concrete lead to cracks in reinforced concrete structures, increase their deformability, reduce durability. A lot of research has been devoted to the problem of shrinkage and reducing its impact on the properties of concrete, especially in a dry hot climate, both in our countries and abroad. At the same time, traditional ways to reduce the negative effects of shrinkage differ by a certain complication of concrete and reinforced concrete technology and do not provide a radical solution to the problem.

One of the promising ways to eliminate the negative effects of shrinkage and improve the construction and technical properties of concrete and reinforced concrete is the use of expanding binders and, first of all, straining cement (NC). High strength, crack resistance, impermeability and the ability, expanding during hardening, to self-strain (pre-strain) reinforced concrete determine the effectiveness of using concrete at the NC in a variety of construction areas [1,2,3,4].

Despite the advantages of straining cement, its output in the CIS countries, compared with developed countries, is small. In Russia, the ISOTECH SPb company supplies NC-10 and NC-20 straining cement from the Moscow manufacturing plants Podolsk-Cement and LLC Consolit, as well as its own production [4].Joint Stock Company "Bukhtarma Cement Company" is a leading enterprise of the cement industry of the Republic of Kazakhstan, which has been producing straining cement for more than 55 years. The company's plant is located in the East Kazakhstan region, 125 km from Ust-Kamenogorsk [5]. There is no production of NC in other Central Asian republics.

The limited production of NC is due to the scarcity and high cost of one of its main components – alumina slag. This has led to the urgency of searching for cheaper and more affordable materials based on various natural and technogenic aluminum-containing materials for the production of NC. As a result, steel-refining slags[6], which are a waste of steelmaking production, sulfocements from various wastes[7], alunite rocks [8,9,10] were proposed and used as cheaper raw materials for the production of NC.Despite the positive results, for a number of organizational and industrial reasons, the results of these studies, unfortunately, have not been properly applied. It is extremely important to continue working in this direction, since solving this problem will not only create an additional raw material base for the production of straining and expanding cements, but will also contribute to solving an equally significant environmental problem – waste disposal and environmental protection.

Tashkent University of Architecture and Civil Engineering, M. Auezov National Research University and SUE “Fan vaTarakkiet” TASHSTU has been creatively cooperating for many years in solving many modern problems and tasks in the field of construction materials science, in training engineering and scientific personnel. Recently, they have continued scientific cooperation in a promising direction - obtaining expanding binders and additives to Portland cement by searching and complex processing of various natural and man-made aluminum-containing materials of Kazakhstan and Uzbekistan.

## METHODS OF RESEARCH AND EXPERIMENTS

To conduct experimental and theoretical research on the search for raw materials and man-made materials as an aluminum-containing component for the development of technological bases for the production and production of NC, materials were selected taking into account their availability and economic feasibility. The study and analysis of natural materials and industrial wastes have shown that the most researched and promising among them are alunite rocks and kaolin, high–iron waste from copper smelting, as well as phosphogypsum - waste from phosphoric acid production. Research to identify other materials is ongoing.

Physicochemical methods (X-ray phase, differential thermal and electron microscopic) were used in laboratory studies to study the phase composition and features of the formation of the structure of cement stone. To determine the physical and mechanical properties of NC and concretes based on it, standard or other proven methods were used.

## RESULTS AND DISCUSSION

Before presenting the results of these studies, we considered it advisable to briefly dwell on the theoretical ideas about the nature of the expansion of cement compositions. As it was shown above, the hardening of conventional cements in air is accompanied by shrinkage deformations, which negatively affects the quality and durability of concrete and reinforced concrete structures. Therefore, many researchers have worked on the creation of non-shrinking and expanding cements. Since the 30s of the last century, many different compositions have been proposed. In most compositions, the expanding phase in the hardening cement is crystals of calcium hydrosulfoaluminate - ettringite. In a small part of the proposed formulations, oxide additives – CaO and MgO - are used as an expanding component.

One of the main reasons for the limited production and use of expanding and straining cements is the lack of a theory that can satisfactorily explain the entire complex complex of phenomena occurring in expanding systems. Theoretical ideas about the expansion of cement systems are contradictory. A number of hypotheses are known[11-18.] about the causes of the expansion of cements in the process of their hardening (expansion of cement stone under the action of osmotic forces, electrochemical phenomena, the "solvate" hypothesis, the reaction of formation of calcium sulfate-containing cements, etc.). The opinions of most researchers agree that the basis of the expansion of various sulfate-containing cements is the reaction of formation of calcium hydrosulfoaluminate in the process of their hardening. However, the mechanism of expansion of such cements is interpreted by scientists in different ways.

At the same time, the theoretical concepts formulated in the NIIZHB under the leadership of V.V.Mikhailov [1,13,17] received the greatest practical implementation. According to the hypothesis put forward by V.V.Mikhailov, the expansion of cement stone from straining cement is explained by the fact that when the initial materials are hydrated in a medium saturated with calcium hydroxide, a low-sulfate form of calcium hydrosulfoaluminate$3CaO \cdot Al_2O3 \cdot \cdot CaSO_4 \cdot 12H_2O$is first formed, which then recrystallizes into a high-sulfate form $3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 32H_2O$in an aqueous medium. This process, accompanied by a strong increase in the volume of the starting substances, leads to the expansion of the cement stone.

As it seems to us, many hypotheses explain only certain aspects of the expansion process, whereas in order to fully understand the mechanism of expansion, a detailed consideration of the entire complex of phenomena occurring in deforming structures is necessary. None of the mentioned points of view on the nature of the expansion of cement binders, taken separately, can not only predict, but also explain the whole variety of phenomena occurring, but reflects only some, although important, of their features. Further development of theoretical ideas about the mechanism of volumetric deformations of cement structures can contribute to the creation of a theory of expansion of cement systems that satisfactorily explains the mechanism of their expansion. This, in turn, will allow us to improve the technologies of expanding and straining cements, the creation of new types of these promising binders and their successful implementation in construction.

Research on the creation and study of expanding and straining cements has been conducted in the USA, Japan, Bulgaria and other countries. In the USA, in the sixties of the last century, they began to produce expanding "s", straining "K" [19] and "M" (proposed by V.V.Mikhailov) [20] cements. One of the authors of this article in August – October 1996 took part in the seminar "Standardization in construction" held by the National Institute of Standards and Technology of the USA. During his trips to the USA, he had the opportunity to get acquainted with the experience of using expanding and straining cements in the construction of airfield and road surfaces, floors of buildings for various purposes, stands of sports facilities with high technical and operational characteristics in various regions of the country [21].

A significant expansion of the straining cement occurs after hardening and acquiring strength of the order of 10.0-15.0 MPa.This ability of NC distinguishes it from all other expanding cements, which are able to increase in volume only in the early stages of hardening, when the strength of the cement stone is still insignificant. With such strength, the expanding cement stone stretches the reinforcement embedded in the concrete body, regardless of its location and orientation, which creates a volumetric compression in concrete. Therefore, the prestressing (self-tension) of reinforced concrete due to the expansion of concrete is especially effective for curved structures, as well as where two- and three-axis prestressing is necessary, which is difficult to implement mechanically and often practically impossible [2]. In general, self-tension ensures the formation of a particularly dense concrete structure. Structures based on straining concrete have high strength, crack resistance, water resistance (more than twice the normalized value of -1.2 MPa) and durability.

The experience of the first industrial application of the NC-20, obtained in the period 1972-1974, made it possible to organize regular production of the NC-20 according to TU-21-20-18-74 , developed by NIIZhB and NIITSEMENT, and proceed with the release of NC-40. At the same time, Ust-Kamenogorsk Cement Plant in Kazakhstan was one of the first to produce this type of cement in 1975. Later, the NC also began to produce Podolsk, Dneprodzerzhinsk, Volkovysk, Voskresensky ("Giant") cement plants.The NC production technology provided for the joint grinding of Portland cement clinker, alumina slag, gypsum and lime taken in certain ratios.

Thanks to the use of self-stressed reinforced concrete, seamless coatings of ice skating tracks and stadium fields were carried out without additional waterproofing in the MEDEO near Alma-Ata [2]. Straining cement was widely used in the construction of a number of objects of the Olympic Games–80, in particular, the stands of stadiums in Moscow, Leningrad, Kiev, as well as swimming pools in Luzhniki and the Olympic Village sports complex [18], as well as in modern sports facilities[3]. Later, in 1984-1986 – during the reconstruction of the stadium stands in Yerevan (Hrazdan), in 1986-1987. – in Volgograd and Tashkent (VDSO "Labor reserves")[22].

To date, a large number of unique and responsible structures have been erected. These include monolithic and prefabricated-monolithic capacitive, sewage treatment plants, underground structures, road and airfield coverings, roll-free and operated roofs, floors of industrial buildings, reinforced concrete structures for various purposes, for example, large-sized foundations for dynamic loads, etc. Straining cement has also been successfully applied in waterproof coatings of multi-span road bridges in Ukraine, where over thirty bridges have been built with such coatings. In Kiev, a large-span hanging shell of double curvature with a diameter of 160 m with self-stressed radial and annular joints was erected for a garage building for 500 buses. The self-tension achieved in the prefabricated monolithic shell as a result of sealing all its seams with concrete at the NC gave it the necessary crack resistance and rigidity [2,3].Experimental facilities (airfield coverings, roll-free roofs, floors of industrial buildings) from straining concrete were erected in Tashkent and covering a section of the highway along the highway between Tashkent and Samarkand [22].

For many years in TasHNIIEP (now JSC Toshuizhoiliti), the Republican Center for Standardization (now the Institute of Standardization and Standardization) The Ministry of Construction of the Republic of Uzbekistan in close cooperation with NIIZhB and SUE “Fan vatarakkiet” Tashstu, and recently with NOAH YUKU im.Auezov conducted comprehensive research on the study of physical, mechanical and technological properties, structure, strength and deformation characteristics of straining concrete and their application in Central Asia. As a result, high-strength (30.0-70.0 MPa) waterproof (more than 1.6 MPa) frost-resistant (300-400 cycles) concretes on dense and porous aggregates were obtained. On their basis, designs and technologies of reinforced concrete slabs have been developed for roll-free and uncovered roofs of residential buildings, monolithic coatings without surface waterproofing of various structures (operated roof), wear-resistant floor coverings of industrial and public buildings, etc. When using tensioning concretes in the listed structures, tensioning cements of the NC-10 M400 and NC-20 M500 brands of Ust-Kamenogorsk and Kant Cement Plants were used[22,23].

The accumulated experience of using NC in construction due to its special physical and mechanical properties has shown high operational reliability and economic efficiency of self-stressed reinforced concrete. At the same time, due to the high cost and scarcity of alumina slag, the production of NC does not respond to the real needs of construction. Therefore, in recent years, our research has been focused on research and development in the production of NC from other aluminum-containing and other materials that would fully replace alumina slag.

As a result of these studies, alunite rocks of the Shushsay deposit, the proven reserves of which amount to more than 130 million tons, were proposed and used as cheaper raw materials for the production of NC.It is also important that the deposit is located in the easily accessible Angren-Almalyk mining district.To date, about 15 of more than 20 alunite deposits have been explored in Uzbekistan.Alunite is a natural mineral that is a source of alumina and belongs to the group of basic sulfates.

Physico-chemical studies of structural changes occurring during thermal activation of alunite-containing rock have established that thermal activation at a temperature of 600-700$^{o}$C is optimal and leads to significant changes in the phase composition of the alunite rock, from which crystallization water is removed; kaolinite is dehydrated and turns into gelenite; alunite is dehydrated; silica and alumina pass into a highly reactive state.The burnt alunite acquires a high solubility in water and, when closed, becomes a source of supply of $Al_3$+, , K+ and $Al_2O_3$ ions to the liquid phase of the cement – alunite – water system and thereby ensures their active interaction with $Ca_2$+ ions released during hydration and hydrolysis of C3S clinker. As a result, calcium hydrosulfoaluminate of the three-sulfate form is formed, which can cause the expansion of the hardening system.

Studies of the compositions of expanding cements (RC) with different contents of Portland cement clinker and thermally activated alunite rock, gypsum and lime allowed us to determine the conditions for regulating the level of expansion and self-tension of binding compositions. By varying the firing temperature and the ratio of components, it is possible to obtain expanding and straining cements with different expansion and self-tension energies.

As a result, optimal ratios of components for the production of alunite expansion cements – ANTS-10, ANTS-20 and ARTS, respectively, designed to compensate for concrete shrinkage, create self-tension, fill joints and caulk joints of various structures to ensure waterproofness, were established. Table 1 shows the results of testing the physical and mechanical properties of concrete on the ANC.

Table 1-Compositions and basic physical and mechanicalproperties of concretes at the ANC

| Brand ofcement | Materialconsumption, per /m$^3$ | | | | Physical and mechanical properties at the age of 28 days | | |
|---|---|---|---|---|---|---|---|
| | Cement, kg | Crushedstone, kg | Sand, L/кg | Water, l | Strength, MPa | Self -conjugation, MPa | Water-permeability container |
| ANC-10 | 400 | 950/1350 | 350/515 | 176 | 39,0 | 0,5 | > W12 |
| ANC-20 | 400 | - " - | - " - | - " - | 44,2 | 0,8 | > W12 |
| ANC-20 | 500 | 875/1243 | 360/530 | 190 | 51,0 | 1,2 | > W12 |
| ARC | 600 | - | 800/1170 | 238 | 35,0 | 0,3 | > W12 |

There are no proven reserves of alunite rocks in Kazakhstan. At the same time, there are large reserves of kaolin, bauxite, waste from the metallurgical industry, which contain aluminum oxides and hydroxides and may well be suitable for obtaining an expanding component of RC and NC. For example, there are a number of explored kaolin deposits.The largest deposits are Alekseevskoye and Eltayskoye in the North, and Soyuznoye in Western Kazakhstan. In addition, there are also deposits Valentinovskoye, Sasykkol, Mitrofanovskoye, etc. The total recorded reserves of kaolin by deposits are significant. Only in the Alekseevsky and Eltai balance reserves amount to 220 million tons, off–balance - more than 20 million tons[24].

In [25], an analysis of waste from metallurgical enterprises of the Pavlodar region was carried out and it was revealed that red bauxite sludge, waste from an Aluminum plant, can find its application in building materials, as a binder. As it seems to us, when conducting appropriate research, and in this case, it is possible to develop the technology and compositions of the expanding component for expanding binders.

Recently, to compensate for shrinkage and create self-stress of reinforced concrete, expansion additives (RD) to Portland cement have been used, which are introduced during the preparation of the concrete mixture directly on the construction site. They can be obtained both by firing and non-firing technologies using various industrial wastes [26,27]. This greatly simplifies the technology of obtaining expanding binders, their transportation and storage.

In studies [28], medium-aluminum Portland cement M400 without mineral additives was used.Experimental batches of an expanding additive based on sulfoaluminate and sulfoferrite were obtained under semi-productive conditions with low-temperature firing. The introduction of an expanding additive into ordinary Portland cement allows it to be transferred to the category of special- non-shrinking, expanding and straining cements with varying degrees of expansion and self-tension.The features of the technology, the formation of the structure and properties of concrete with RD are studied. It is shown that concretes with an expanding additive obey the laws established for concretes based on straining cements.The compositions of the studied concretes and the test results of their physical and mechanical properties are shown in Table 2.

Table 2. Compositions and basic physical and mechanical properties of concrete with an expanding additive

| Brand ofcement | Materialconsumption, per /$m^3$ | | | | Physical and mechanical properties at the age of 28 days | | |
|---|---|---|---|---|---|---|---|
| | Cement, кg | Crushed stone, кg | sand, l/кg | Water, L | Strength, MPa | Self-voltage, MPa | Water resistance |
| ConcreteswithsulfoaluminateEA | | | | | | | |
| PC+EA-1 | 400 | 950/1350 | 350/515 | 176 | 37,2 | 0,2 | >W12 |
| PC+EA-1 | 500 | 875/1243 | 360/530 | 190 | 41,5 | 0,4 | >W12 |
| PC+EA-2 | 400 | 950/1350 | 350/575 | 176 | 43,6 | 0,8 | >W12 |
| PC+EA-2 | 500 | 875/1243 | 360/530 | 190 | 49,1 | 1,1 | >W12 |
| PC+EA-3 | 400 | 950/1350 | 350/515 | 176 | 44,4 | 0,1 | >W12 |
| PC+EA-3 | 500 | 875/1243 | 360/530 | 190 | 51,4 | 0,4 | >W12 |
| PC+TAP (ANC-10) | 400 | 950/1243 | 360/530 | 176 | 37,8 | 0,4 | >W12 |
| PC+TAP | 400 | 950/1243 | 360/530 | 176 | 41,5 | 0,7 | >W12 |
| (ANC-20) | 500 | 875/1350 | 350/515 | 190 | 48,8 | 1,0 | >W12 |

In the development of this promising direction, joint research will be continued on the search, complex processing and application of aluminum-containing raw materials and industrial wastes of Kazakhstan and Uzbekistan, taking into account their availability and economic feasibility.

## CONCLUSION

One of the actual directions of development and improvement of concrete and reinforced concrete is the development of new approaches and their implementation in the production of binders and concretes of a new generation, ensuring the reliability and durability of structures and structures, their efficiency. A promising way to improve the construction and technical properties of concrete and reinforced concrete is the use of expanding binders and, first of all, straining cement (NC). High strength, crack resistance, impermeability and the ability, expanding during hardening, to self-strain (pre-strain) reinforced concrete determine the effectiveness of the use of concrete at the NC in a variety of construction areas.

At the same time, despite the indisputable prospects, expanding and straining cements have not yet been widely used.One of the main reasons for this is the scarcity and high cost of one of its main components – alumina slag, which led to the search for more affordable raw materials and industrial waste for the production of NC.

In recent years, in foreign practice, along with the use of expanding and straining cements of industrial manufacture, expanding additives to ordinary Portland cement, introduced directly during the preparation of concrete by analogy with other mineral, plasticizing and other additives, have begun to be used. This greatly simplifies the production of binders with stable properties and the technology of concrete with adjustable properties.

Chemical and physico-chemical studies of raw materials for the production of expanding additives to cement have established that the favorable chemical and mineralogical composition of local aluminosilicate (kaolin clays and alunite-containing rocks), ferrite-containing (natural hematite ores and processed ferrite-containing slag of copper smelting) and sulfate-containing (gypsum stone, phosphogypsum) of materials allows them to be used as components of a raw mixture for the organization of production of expanding additives to Portland cement in order to obtain concretes with compensated shrinkage and straining concretes.The development of the technology of concrete with an expanding additive, the study of its physico-mechanical properties depending on various factors have shown that the use of an expanding additive to produce concretes obeys the laws established for concretes based on NC-10 (to compensate for shrinkage) and NC-20 (to obtain self-tension with low energy).

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## EXPANSION OF VERMICULITE CONCENTRATE BY THERMAL METHOD AND DETERMINATION OF THE COEFFICIENT OF EXPANSION OF VERMICULITE

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***Abstract***

*This article discusses the need to accelerate scientific research aimed at the production of new types of import-substituting building materials from local raw materials and secondary resources, the production of demanded materials based on the widespread and targeted use of industrial waste in production. In the implementation of these tasks, scientific research aimed at developing the optimal composition of heat-protective vermiculite slabs and the technology of their production using local raw materials and secondary resources are also of particular importance. In this regard, the issues of creating effective building materials from vermiculite slabs, heat-insulating, sound-absorbing, refractory especially light concretes with functional properties obtained on the basis of expanded vermiculite and the study of their properties are considered. Reproduction of vermiculite under laboratory conditions, swelling temperatures and the general swelling process. Methods for determining the multiplication coefficient of expanded vermiculite, the relationship between its bulk density and the expansion coefficient as a result of the reproduction of vermiculite concentrate, the dependence of their bulk density on changes in the fractions of vermiculite concentrate.*

***Keywords*: *expanded vermiculite, Portland cement, liquid glass, thermal conductivity, strength, foaming coefficient, pressing, drying.***

### INTRODUCTION

The fact that the problems of using secondary resources systematically exist in our republic, especially in the construction industry and in the construction materials industry, requires the search for solutions aimed at solving them, modernization of the production of building materials and products, effective use of local and secondary resources. raw materials in the production of building materials. At the same time, a number of measures are being implemented in the construction industry, such as increasing the widespread use of modern energy-efficient building materials and certain achievements are being achieved.

It should be noted that at this stage there is a need to accelerate scientific research aimed at the production of new types of import-substituting building materials from local raw materials and secondary resources, the production of demanded materials based on the widespread and targeted use of industrial waste in production. In the implementation of these tasks, scientific research aimed at developing the optimal composition of heat-protective vermiculite slabs and the technology of their production using local raw materials and secondary resources are also of particular importance.

Decree of the President of the Republic of Uzbekistan No. PF-60 dated January 28, 2022 "On the new development Strategy of Uzbekistan for 2022-2026", Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 327 dated May 27, 2021 "On expanding in 2021-2022 the raw material base for deep processing of natural and mineral resources of the Republic of Karakalpakstan and additional measures to create on this basis the basis of the value chain" and the results of this study serve to a certain extent to implement the tasks defined in all regulatory legal documents related to this activity.

**EXPERIMENTAL PART**

When reproducing vermiculite, it is important to determine the coefficient of its reproduction, and it is the main indicator of the quality of the propagated vermiculite. The coefficient of expansion of vermiculite was determined according to GOST 12865-67 Expanded vermiculite.

The reproduction of vermiculite was carried out in a laboratory muffle furnace at a temperature of 850 ± 900 ° C, the temperature was controlled using a thermocouple. The muffle furnace together with the ceramic crucible was heated to a temperature of 850-900 ° C, the crucible was removed from the furnace using a metal clamp, a pre-weighed mass of unopened vermiculite was placed in the furnace and the furnace door was closed. The process of burning (reproduction) was carried out within 3-5 minutes. After the specified time, the ceramic crucible was removed from the furnace using a special clamp, and the accumulated grains of vermiculite were left on a metal sheet until it cooled.

Then the volumetric mass of the expanded vermiculite in the cooled state was determined. Considering that the volume of vermiculite concentrate before swelling is 10 cm3, we compared the volume of expanded vermiculite after swelling and calculated the expansion coefficient Kvsp = V1/V. The results obtained during the research are presented in Table 1 [1,2,3,4].

Table 1Preparation of vermiculite concentrate andreproduction coefficients of vermiculite

| № | Grain fraction size of vermiculite concentrate, mm | Bulk density of vermiculite concentrate, kg/$m^3$ | Bulk density of expanded vermiculite, kg/$m^3$ | Swelling coefficient |
|---|---|---|---|---|
| 1. | 0,8÷1,6 | 748 | 279 | 2,68 |
| 2. | 1,6÷2,2 | 871 | 237 | 3,67 |
| 3. | 2,2÷3,0 | 814 | 206 | 3,95 |
| 4. | 3,0÷4,0 | 835 | 175 | 4,77 |
| 5. | 5 | 788 | 150 | 5,25 |
| 6. | 6 | 777 | 141 | 5,51 |
| 7. | 7 | 923 | 121 | 7,62 |

The multiplication coefficient of expanded vermiculite should be in the range of 2-8 according to the above method. This is one of the important characteristics of vermiculite. Since in the main areas of application of expanded vermiculite as a component of raw materials, including in the production of building materials, this indicator is the main indicator of the quality of expanded vermiculite (Fig. 1).

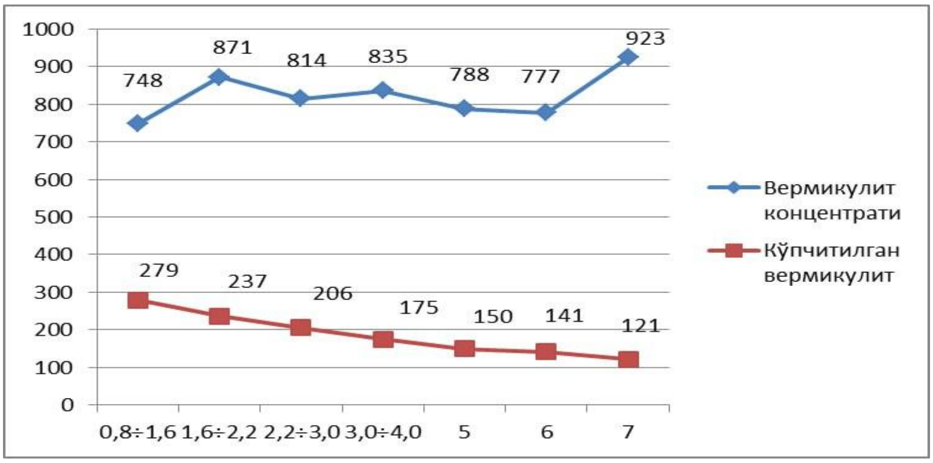


Fig. 1. Change in the relationship in the grain section between the bulk density of vermiculite concentrate and expanded vermiculite

When studying the reproduction of vermiculite concentrate and the multiplication coefficient of propagated vermiculite, it was 2.68 in small fractions, 4.77 in medium fractions and 7.62 in the largest fraction of 7 mm. It can be seen that with an increase in the grain size of the fractions of vermiculite concentrate, the bulk density value decreases accordingly, and the expansion coefficient increases by almost 3 times.

**Conclusion.** Analyzing the above data and the relationship between its bulk density and the expansion coefficient as a result of the reproduction of vermiculite concentrate, it is possible to determine the dynamics of change. That is, if we analyze the relationship between the bulk density of vermiculite concentrate and expanded vermiculite and their multiplication coefficients, then depending on the change in the fractions of vermiculite concentrate, their bulk density does not change linearly, and their value is in the range of 748-923 kg/m$^3$.

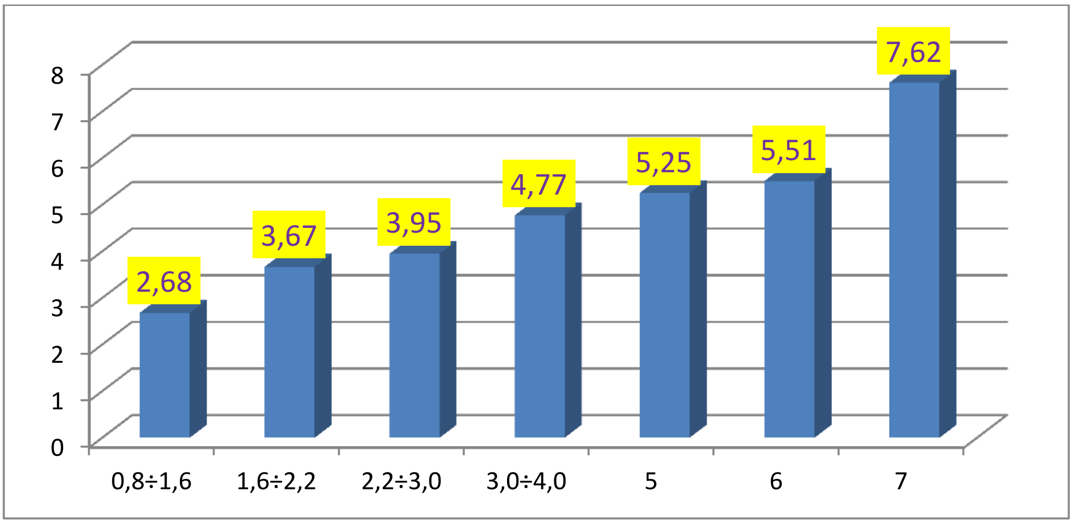


Fig. 2. Change in the relationship between the bulk density of expanded vermiculite and the coefficient of swelling of vermiculite concentrate

As the size of the expanded vermiculite fraction increases, their bulk density has a linear change and decreases from 279 to 121 kg/m$^3$, respectively.

It was found that their multiplication coefficient also increases from 2.68 to 7.62, respectively, with an increase in the size of the grain fraction.

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# THE USE OF INDUSTRIAL WASTE AS MICROFIBRE IN THE PRODUCTION OF AERATED CONCRETE

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***Abstract***

*The article discusses the formation of asbestos-cement waste, which is constantly formed at enterprises producing asbestos products, the possibility of their use as secondary raw materials for aerated concrete blocks in the disposal of industrial waste. Also, experimental work was carried out at the Jizzakh Polytechnic Institute on the preparation of aerated concrete samples using asbestos cement waste from Next group stroy LLC as fiber. On the example of the technological line for the production of aerated concrete of the ASM-200 KA brand without the autoclave production method of the Altaystroymash company, proposals were made for the preparation of fibrogas concrete with additional cross-straightening of the line.*

***Keywords****: asbestos cement, recycling, asbestos fiber, aerated concrete fiber, screw dispenser, processing line, conveyor belt.*

## INTRODUCTION

According to statistics, the number of people in the world is growing every year, which leads to an increase in demand for timely housing. The main residential building under construction is multi-storey. Cellular concrete is widely used in the construction of new buildings. The additional use of industrial waste in the production of materials and products used in construction makes it possible to find a positive solution to this problem. Currently, much attention is being paid to the disposal of asbestos-cement waste, which is primarily due to the lack of almost ubiquitous raw materials and rising prices for them. At the same time, asbestos cement waste contains compounds that are suitable for the production of building materials for various purposes. The problem of disposal of asbestos cement waste is also relevant because its solution reduces environmental pollution [1].

Asbestos-cement waste and sludge in their composition have components suitable for obtaining building materials for various purposes on their basis. It is undeniably true to note another reason why much attention is currently being paid to the issues of their utilization: the shortage of natural raw materials and their widespread rise in price[2,5].

We can consider this as an effective way to obtain fibro-gas concrete by adding fiber to the composition of the mixture to improve the physico-chemical properties of aerated concrete. Currently, various fibers are used for the manufacture of concrete. In particular, scientific research was carried out on the introduction of dispersed reinforcement of aerated concrete due to asbestos fibers. In particular, in her scientific work, R.G.Dolotova suggests introducing asbestos fibers in an amount of 6% into the composition of cellular concrete. As a result, asbestos has a high adsorption capacity based on the results of hydration of Portland cement, activating the chemical processes of interaction between the components of cellular concrete masses, which leads to an increase in the strength properties of cellular concrete.

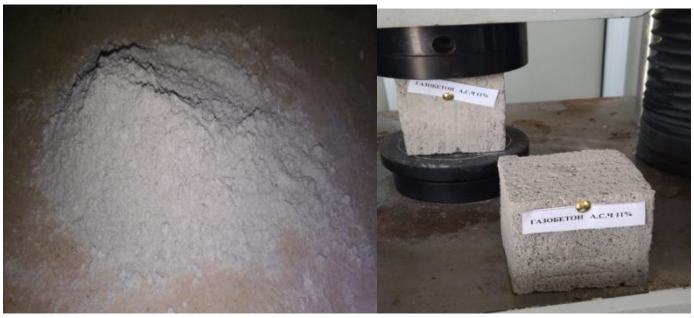
According to the EAEU statistics, in the first half of 2020, Kazakhstan exported 89.9 thousand tons of chrysotile asbestos, during which Uzbekistan received 45,8% of products. The estimated intake of 90,000 tons of chrysotile asbestos per year as imports and the formation of 2,5-4% of man-made waste in the production of products by enterprises is about 9,000-14,400 tons.

According to the enterprises of the asbestos industry, the volume of waste sludge in the process of technological water purification is 1,5-2% compared to the mass of raw materials [3,7]. Wet asbestos waste accumulates in settling tanks, as a result of which these wastes occupy large areas.

In the asbestos products industry, in addition to wet asbestos waste, a large amount of dry waste is generated. These wastes constantly appear in the production of pipes and slate products. In the technological process of production of enterprises, when receiving products, it is impossible to fully use the mixture of cement + water + asbestos fiber (in recuperators), if the period of hydration of cement with water exceeds 2 hours, with a decrease in the quality of this mixture, the residual mixture is discharged into the equipment.

## EXPERIMENTAL METHODS

In the laboratory of the Department of "Building Materials and Structures" of the Jizzakh Polytechnic Institute, research is underway on the preparation of fibro-gas concrete using asbestos waste as fiber. The humidity of wet asbestos cement waste (sludge) brought from enterprises during the study was 19%, the typical density after drying to a constant mass in the drying cabinet was determined in laboratory conditions at the level of 345 kg/m$^3$[6,7].



a) b)

Fig-1. a) asbestos cement. b) aerated concrete

Chrysotile asbestos contained in asbestos waste belongs to grades 5-6 and was produced by JSC "Kostanay Minerals" of the Republic of Kazakhstan[5,8]. The chemical composition of the waste of LLC "Next group stroy" (Jizzakh region) installed in the radiofluorescence spectrometer for asbestos waste of the ARL Perform'X series is shown in Table 1.

1-table. Chemical composition of asbestos cement waste

| **$SiO_2$** | **$Al_2O_3$** | **$Fe_2O_3$** | **CaO** | **MgO** | **$SO_3$** | **$Na_2O$** | **$K_2O$** | **$TiO_2$** | **$Cr_2O_3$** | **$Mn_2O_3$** | **$P_2O_5$** | **PPP** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14,9 | 3,01 | 2,10 | 36,6 | 2,54 | 1,43 | 0,00 | 0,85 | 0,07 | 0,0052 | 0,0348 | 0,0062 | 32,88 |

The physicomechanical properties of fibro-gas concrete samples prepared under laboratory conditions have been studied. Taking into account the fact that today the disposal of industrial waste on the way of expanding the development of small businesses is considered an urgent problem, solutions have been developed for the additional installation of equipment on the production line. That is, the inclusion of industrial waste in the form of microfibre in the composition of aerated concrete was considered on the example of the technological line ASM-200 KA conveyor method of the company "Altaystroymash" (Russian Federation).

## RESULTS AND DISCUSSION

In the laboratory of the Department of "Building Materials and Structures" of the Jizzakh Polytechnic Institute, experimental work is being carried out to study the thermal conductivity properties of various wall materials[8]. The samples belong to the group of thermal insulation structural aerated concrete grade D 600.

When preparing the selected samples of aerated concrete, waste asbestos cement and silica (Uzmetkombinat JSC) were used as a wall material to improve the properties of the material. The samples were prepared from wet man-made waste from the enterprises of LLC “NEXT GROUP STROY” (in the city of Gagarin) and LLC “Boston stroy shifer" (in the city of Buston), which is a slate manufacturer in the Jizzakh region.

Cement of the CEM II/A-0 32,5 N grade produced at the Jizzakh cement Plant of AGMK was used as a binder. The specific surface area of cement is 3217 $cm^2/g$, the actual density is 3,16 $g/cm^3$, and the comparative weight is 1200 $g/dm^3$. The chemical composition of cement grade CEM II/A-0 32,5 N is shown in the table below.

Table-2. The amount of oxides contained in microsilicon.

| **Micro-silica** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|---|
| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ | $Na_2O$ |
| | 87.92 | 1.28 | 1.43 | 0.92 | 0.84 | 0.04 | 0.25 |
| | 8 | 9 | 10 | 11 | 12 | 13 | |
| | $K_2O$ | $TiO_2$ | $Cr_2O_3$ | $Mn_2O_3$ | $P_2O_5$ | Calcination losses | |
| | 0.41 | 0.03 | 0.0184 | 0.6089 | 0.0402 | 2.640 | |

Table-3. The amount of oxides contained in cement.

| | **1.** | **2.** | **3.** | **4.** | **5.** | **6.** | **7.** |
|---|---|---|---|---|---|---|---|
| **SEM II/A-0 32,5 N** | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ | $Na_2O$ |
| | 12.91 | 3.81 | 3.19 | 63.39 | 1.76 | 1.96 | 0.09 |
| | 8. | 9. | 10. | 11. | 12. | 13. | 14. |
| | $K_2O$ | $TiO_2$ | $Cr_2O_3$ | $Mn_2O_3$ | Calcina-tion losses | $\sum$ | Amount of limestone |
| | 0.60 | 0.20 | 0.004 | 0.05 | 9.59 | 97.55 | 16.0 |

Sand (the Maysky deposit of the Tashkent region) and gas-forming components were also used as a filler. The sand size modulus is equal to 1.22 according to GOST 31424-2010. During the experiment, samples of 300x300x50 mm aerated concrete with the addition of silica and asbestos cement waste were prepared. The samples were tested on XND-2-3030C equipment (flat thermal conductor, flat plate thermal conductivity instrument, Nanchang Xi'nan Laboratory Apparatus Manufacturing CO.,LTD.), their thermal conductivity and thermal resistance coefficients were determined.

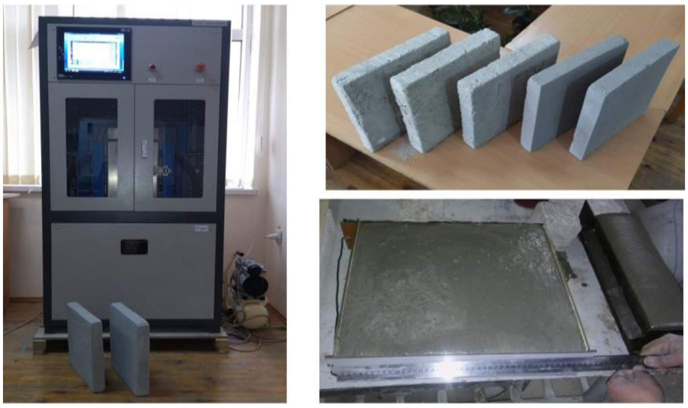


Fig 2. Equipment XND-2-3030C flat thermal conductor and prepared test samples.

In particular, the use of this equipment was considered the most optimal option, choosing a screw dispenser for volumetric dosing of wet asbestos cement waste into a landfill, a conveyor with a toothed feed belt and a waste hopper. There was a misl that the technological production line of fibro-gas concrete blocks can be improved by adding a screw dispenser and a toothed belt conveyor to the technological line, in the place used for pouring cement and sand into agitators. Further, production is carried out in the same way, without changing other technological processes of aerated concrete [4].


Fig-3. ACM-200KA processing line (screw dispenser, conveyor belt included).
1-belt conveyor; 2 -mixer for suspension; 3-weight dispenser of components; 4-mixer; 5-water tank; 6-remote control of dispenser units; 8-screw type dispenser for cement; 8-screw type dispenser for waste; 9-trolley; 10-mold; 11-vibrating screen.

## CONCLUSION

In conclusion, we can say that there are options for using asbestos waste in the production of aerated concrete as a microfiber. In the production of aerated concrete, it is possible to change the existing technological line to a technological line for the production of fibro-gas concrete with additional installation of the required equipment. Non-autoclaved cellular concrete on cement binder and sand grade D 600 in a dry state, the coefficient of thermal conductivity shows 0,17. And in non-autoclaved cellular concrete on TPP ash, the thermal conductivity index is 0,14. If we compare the thermal conductivity of the selected samples, which were found to be optimal according to GOST 25485, the thermal conductivity coefficient was noted to be 34-38% lower.

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## ENERGY SAVING IN CONCRETE PRODUCTION

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***Abstract***

*In the domestic industry one of the significant consumers of fuel and energy is construction, and among its branches - prefabricated reinforced concrete enterprises, of which there are several thousand in the country. Analysis of the work of these enterprises has shown that their energy consumption can be significantly reduced. Almost in any production there are real reserves of energy saving. If these reserves are identified and technological processes are organized more rationally, energy consumption can be reduced at least by 1.5 times. This will give the national economy of the country a huge economic effect. The relevance of the work is also caused by the fact that still many enterprises in our country use heat carriers from centralized suppliers that are outside the enterprise. Thus, the problem of energy saving depends on the heat supply system created more than half a century ago, under completely different economic conditions.*

***Keywords****: concrete, cement, energy-intensive, superplasticizers, structures, mixture, minerals*

### INTRODUCTION

Concrete, possessing many remarkable qualities, at the same time belongs to very energy-intensive materials. For production of 1 m3 of prefabricated reinforced concrete on the average 470 thousand kcal is spent; for production of separate constructions on the polygons, and also at imperfect technological processes this consumption increases up to 1 million kcal and more. If we take into account that the annual energy demand of the prefabricated reinforced concrete industry is about 12 million tons of fuel equivalent, it becomes clear that even a small percentage of its saving will release a large amount of fuel. The need in energy resources for production of 1 $m^3$ of prefabricated reinforced concrete products does not take into account the energy consumption necessary for production of concrete components (cement, aggregates) and reinforcement, which are characterized by even greater energy intensity [1-3].

Considering the problem of rational energy consumption in the production of prefabricated reinforced concrete, it is necessary to take into account the energy consumption for the production of cement and reinforcement. These are the most expensive, scarce and energy-intensive materials, and their competent use, excluding fuel overconsumption, will lead to energy saving. Special attention abroad is paid to chemical additives. Superplasticizers are the most widely produced additives. However, to obtain a concrete mixture of the required mobility, in addition to the superplasticizer, fractionated aggregates, a good system of dosing components and strictly maintained composition of the mixture are needed [4-5].

According to calculations, heating 1 $m^3$ of concrete in a steel form to 80 degrees Celsius (isothermal holding temperature) requires about 60 thousand kcal. Since heating occurs gradually - at a rate of no more than 20 degrees per hour, this process is inevitably accompanied by a significant release of heat into the environment. With serviceable equipment necessary for heat treatment of products, these losses reach 150 thousand kcal, which is 2-2.5 times more useful heat. In case of faulty or carelessly operated equipment, as well as with unjustifiably overestimated duration of heat treatment, unproductive losses are added to mandatory (planned) losses. They vary within very wide limits and at some plants reach almost 200 thousand kcal per 1 $m^3$ of concrete. Thus, the total heat losses are several times higher than the amount of heat spent on heating the concrete with the mold [6].

In foreign industrial and civil construction, concrete and reinforced concrete structures firmly occupy a leading position compared to other materials and structures. The main focus of attention and efforts of companies is to ensure high quality of manufactured and erected structures. Only taking into account these requirements they develop technological solutions that require the lowest labor, energy and material costs. Abroad, saving of resources should in no case harm the quality and durability of structures. Special attention is paid to the quality of cement and aggregates.

Abroad, the whole organization of construction is subordinated to the economical use of resources, starting with the provision of concrete and mortar for construction sites, and the methods of energy-saving technologies used in foreign practice are very rational from the point of view of material resources expenditure and ensuring high quality of structures and products.

## MATERIALS AND METHODS

Heat losses during heat treatment of products can be reduced by preventing equipment malfunctions. Steam steaming pit chambers very often work with faulty lids - water closures do not work or do not work well, as a result of which the lids are skewed, which leads to high steam losses. In the shop for workers create unfavorable hygienic conditions, high humidity contributes to rapid corrosion of metal structures, equipment. It is possible to avoid large heat losses by timely repair and preventive inspection of chambers.

In recent years abroad widely advertised method of preheating concrete mixes directly in mixers using steam: the mixer is loaded with aggregates and cement and in the process of mixing them steam is supplied. Heating the concrete mixture, the steam cools and condenses. The amount of steam consumed is calculated in such a way that after its complete condensation, the water-cement ratio of the concrete corresponds to the design ratio. In the mixer, the concrete mixture is heated to a temperature of no more than 60 degrees Celsius, after which it is delivered to the place where the products are molded.

It is possible to reduce energy costs during heat treatment or heating of concrete by using all cement varieties used. However, the greatest efficiency is provided by the binders, which by mineralogical composition can be attributed to cements of the alite-aluminate group, i.e. the total content of $C_3S+C_3A \geq 60\%$.

Table 1. Characteristics of Portland cement

| plant no. | champs | Activity, MPa | Mineralogical composition, % | | | | K | Setting time, hour : min | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $C_3S$ | $C_3A$ | $C_2S$ | $C_4AF$ | | start | finish |
| 1 | 500 | 48 | 54,0 | 5,0 | 21,0 | 16,0 | 0,26 | 3:15 | 3:55 |
| 2 | 400 | 42 | 51,0 | 4,5 | 26,0 | 15,0 | 0,27 | 3:20 | 5:10 |
| 3 | 500 | 51 | 55,0 | 4,7 | 20,0 | 15,0 | 0,26 | 2:05 | 3:17 |
| 4 | 400 | 42 | 52,0 | 3,8 | 22,0 | 17,5 | 0,27 | 2:30 | 3:40 |

Table 1, which summarizes the characteristics of the cements. These binders have the highest exotherm, as the specific heat of hydration of clinker minerals for the first 3 days is for $C_3A$ - 592; $C_3S$ - 407; $C_4AF$ - 186; $C_2S$ - 63 kJ/kg. As a result, as it will be shown, the concrete prepared on binders with high content of C3S and C3A, to a greater extent shows the effect of self-heating during curing both without heat treatment and by low-energy technology.

Heat and humidity treatment of concrete and reinforced concrete products is the most important part of the technological process of concrete production at the enterprises of the construction industry. The costs of steam production for heat and humidity treatment can reach 80-90% of the total heat energy costs of the enterprise. Constantly rising energy prices lead to an increase in the cost of heat energy production.

## RESULTS AND DISCUSSIONS

The mechanism of influence of chemical additives of hardening gas pedals on the processes of hydration, setting and hardening of cement is a complex of physical and chemical phenomena, as a result of which the rate increases and the time of transition of cement dough from viscoplastic to stone-like state is reduced, the density and strength of cement stone and concrete as a whole are increased. Having a significant energy potential, ions of the additive substance are able to penetrate with water molecules into the adsorption layers of the liquid, into the zone of its contact with the surface of the binder. Due to their own energy field, which is much larger than that of water molecules, the presence of such ions leads to an increase in the forces that ensure the dissolution of clinker minerals with an increase in the intensity of this process [7,8].

The phenomenon of partial binding of cement hydration products, calcium hydroxide, hydra aluminates and hydra ferrites by the additive substance leads to a similar result, which also accelerates the dissolution process. In addition, the effect is shown by deepening the phenomenon of peptization of cement floccules. The presence of electrolyte ions in water significantly increases the force of repulsion of homonymously charged liquid films by the adsorption surface of cement grains that make up the floccula, which is manifested in the intensity of the development of their disintegration process and, as a consequence, is accompanied by the involvement of additional surface of the binder in the reaction with water, contributes to the growth of density and strength of concrete.

Table 2. Variation of concrete strength depending on cement efficiency group

| Concrete heating temperature, 0 $^0$C | Thermostatic holding time, hour | Concrete strength in % of grade after heating for M400 cement efficiency groups: | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| 30 | 8<br>12<br>16<br>20 | 65<br>73<br>77<br>80 | 50<br>59<br>64<br>67 | 38<br>41<br>44<br>47 |
| 40 | 8<br>12<br>16<br>20 | 74<br>82<br>88<br>92 | 59<br>70<br>74<br>77 | 48<br>55<br>59<br>62 |
| 50 | 8<br>12<br>16<br>20 | 82<br>89<br>94<br>98 | 67<br>76<br>80<br>85 | 55<br>67<br>70<br>73 |

Table 2 shows the variation of concrete strength depending on cement efficiency group, heating temperature and duration of thermostatic curing in the chamber.

Figure 1 shows the kinetics of strength growth of freshly made concrete (R) during 28 days of curing at temperatures from +20 to - 20 $^0$C (% of $R_{28}$).

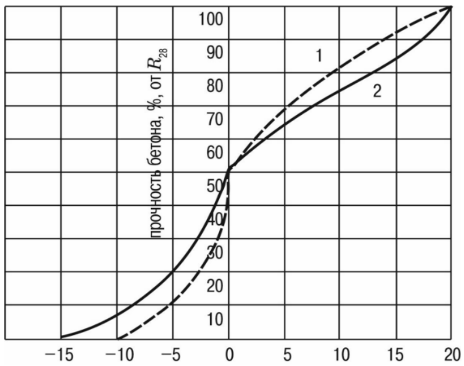


Fig. 1. 1 - heavy concrete, 2 - lightweight concrete

## CONCLUSIONS

The heat introduced into the concrete during the preparation of the concrete mixture or its additional heating prior to placement in the structure and the exothermic heat released by the cement during the concrete curing process are retained through thermal insulation of the enclosing structure. To reduce the energy intensity of the process two ways are used: reduce the requirements for the temperature of the mixture while maintaining a high rate of curing and providing the necessary strength of concrete; increase the efficiency of the process by electric heating. The main techniques in the movement are: mechanical activation of cement batter, cement mortar and concrete mixture, vibration mixing of the mixture; use of special additives.

The use of low-energy technology allows for 14-18 hours of concrete curing with initial heating to achieve strength at the level of 70-80% of the design strength with heat energy consumption in the manufacture of precast products 125000-250000 kJ (0.03-0.06 Gcal) per 1 m3 of concrete, these data are confirmed by practice.

Realization of energy-saving technologies, with the greatest efficiency estimated by the reduction of energy costs and accelerated turnover of formwork, requires compliance with a number of conditions related to the choice of cement, corresponding to the purpose of chemical additives, related to the creation of the temperature regime of concrete curing and the resolution of other problems.

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## THE PROBLEM OF ENSURING OF SEISMIC SAFETY IN KAZAKHSTAN

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***Abstract***

*The current state of seismic risk reduction is described. We discuss three approaches to this problem: seismic zoning and earthquake engineering, short-term earthquake prediction and artificial discharge of tectonic stresses. An attempt to understand the causes of chronic failures to forecast short-term destructive of seismic events is considered. Critically discussed the key tenets of theoretical geophysics, as well as some results of mathematical modeling of earthquake focuses. We emphasize the need for a common scientific methodology of short-term forecasting and technologies of seismic process management by artificial energy sources, we indicate to a close mutual relation of these ways in solving problems of seismic safety. It is proposed to conduct a large-scale geophysical experiment in seismically active regions of the Far East, providing wide scientific and research studies, development of new geophysical equipment, geophysical monitoring and artificial discharge of tectonic stresses in the framework of a unified concept of seismic safety.*

***Keywords:*** *earthquakes, seismic safety, earthquake-prone regions, seismic microzoning*

## INTRODUCTION

Processes of change in nature - sometimes smooth, sometimes abrupt - have always occurred. According to the modern theory of plate tectonics, the entire surface of the Earth is divided into six main plates: African, Atlantic, Indian, American, Eurasian and Pacific. Each of these plates is divided into even smaller megablocks and slabs. These plates are in constant motion due to exogenous and endogenous (cosmogenic and intraterrestrial) processes. When plates come into mutual contact, colossal pressure occurs in the contact zone of one plate with another. Unable to withstand this pressure, the contact zone of the plates collapses sharply. As a result, powerful earthquakes occur[1].

Thus, in this period of time, three types of earthquakes have been identified: tectonic, volcanic and landslide. The strongest are tectonic earthquakes. In second place are volcanic earthquakes, they are less strong. But sometimes earthquakes from these impacts are very destructive. Thus, during the eruption of the Krakatoa volcano in Indonesia in 1883, according to the description of Academician Obruchev, stones with the size of a man's head flew at a distance of up to 20 kilometers from the epicenter, and stones with the size of a fist flew at a distance of up to 40 kilometers. Its consequences were especially terrible in the form of a tsunami that swept the entire Pacific coast. The approximate number of victims then was about 36 thousand people. Earthquakes of landslide nature due to intensive mining are currently becoming more frequent. This issue has become more acute over the years, especially in Kazakhstan [2].

In Kazakhstan, the territories of the south and southeast of Kazakhstan, where up to 40 percent of the population of our country live, are earthquake-prone. These are the territories of Almaty, Zhambyl, South Kazakhstan and East Kazakhstan regions with all cities and towns located in these territories. Currently, the areas where earthquakes are possible have expanded due to the occurrence of technogenic earthquakes.

Recent decades have been characterized by unprecedented human intervention in the natural geological environment, which provokes strong earthquakes, sometimes in strength and consequences significantly exceeding natural ones. Evidence of this is the colossal number of strong and catastrophic earthquakes in developed deposits of hydrocarbons and solid minerals.

Along with the exploitation of hydrocarbon deposits, strong earthquakes are also provoked by the construction and operation of large hydraulic structures. The fact is that alternating changes in pressure on the geological environment, as well as the penetration of water through cracks in the rock, which acts as a lubricant along the strike line of tectonic faults, create conditions for the occurrence of strong earthquakes.

The problem of ensuring of seismic safety in earthquake-prone regions of Kazakhstan has always been and remains relevant. Problem solution consists of solving a number of primary issues such as assessement of seismic hazard through the development of seismic zoning maps for the entire country, as well as individual regions and large cities located in a seismic zone. These maps must be scientifically based and serve for design and construction in earthquake-prone regions.

In Kazakhstan, three types of seismic zoning are carried out: general, detailed and seismic microzoning. Maps of general seismic zoning serve for the purposes of planning the development of the national economy and maintaining the reasonable construction policy, as well as construction in seismic regions on the scale of Kazakhstan. Detailed seismic zoning is the compilation of seismic zoning maps of individual areas. Seismic microzoning is carried out for the purpose of assessing local engineering and geological conditions, such as the composition, structure of the soil, groundwater level, on the seismic effect for cities and large settlements, as well as particularly important industrial and strategic facilities. Maps of seismic microzoning of the territory of cities in Kazakhstan have also been developed. Seismic zoning maps are the basis for the design and construction of buildings and structures in earthquake-prone regions [3].

Tasks that are accomplished thanks to seismic microzoning:

- searching for new construction sites;
- obtaining of sufficient and reliable data to select the optimal option for location of structures;
- providing the design organizations with all the necessary information to take into account when designing the expected parameters of seismic ground motion, including displacements along active faults to ensure the safe operation of enterprises, buildings and structures, pipeline transport and field operation, and reconstruction, overhaul and restoration of facilities, including buildings and structures in seismically active areas.

It should be noted that the State Construction Committee under the akimats has the authority to control the progress of construction and the principle of observing the seismic resistance of buildings, regardless of the type of property. All newly constructed buildings must be built according to the designs of organizations that have the appropriate licenses, and also be built by organizations that have licenses. Only tough measures can discipline developers and contractors. Both the SASK and the leading research organization of Kazakhstan, KazNIISA, should actively work in this direction [4].

## CONCLUSION

To ensure seismic safety, attempts are being made to predict earthquakes in many countries, but there is still no coherent system for real short-term earthquake forecasting. This refers to forecasting hours and the next day before a strong earthquake. At the same time, certain hopes are placed on various predictive parameters for this purpose. These are hydrogeodynamic, hydrogeochemical, and geophysical parameters. Data are even used on changes in the behavior of various animals, birds and reptiles. For your information: only the Institute of Seismology of Kazakhstan has a harmonious system for tracking animals, birds and reptiles. At one time, during the collapse of the Union, we with great difficulty preserved seismic stations, hydrogeochemical, hydrogeodynamic and geophysical observation points and biostationaries. There are five biological hospitals in Kazakhstan. According to the data obtained from these stations, points and biological stations, after collecting, processing, analyzing and interpreting the material, we are able to predict earthquakes in the long term (up to 5 years) and medium term (up to a year), and also use the results to develop seismic zoning maps .

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# ARCHITECTURE AS A MONUMENT OF CULTURE AND HISTORY

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***Abstract***

*This article examines the architectural style and the totality of the main features, signs of architecture of a certain time and place, manifested in the features of its functional, constructive and artistic sides, the purpose of buildings, building materials and structures, techniques of architectural composition. Unlike the fine arts - painting and sculpture, which express a certain ideological content in real images that reproduce the sensory-perceptible world, the "language of architecture" is not pictorial, and therefore its interpretation is more difficult. An "architectural image" can never be revealed as a kind of "literary" semantic "content" embodied in a given monument.*

***Keywords:*** *Architectural style, architectural composition, Architectural image, Architectural art, function, history*

## INTRODUCTION

Architecture is most closely connected with the development of the material productive forces of society, with the level of technological development, which find their most vivid expression in monumental construction. This close connection between architecture and production is reflected in the use of this or that building material, the application of certain structures, in this or that organization of construction and the provision of personnel of architects and ordinary builders, in the mobilization of craftsmen of other craft specialties for construction, etc.

This determines the particularly high cognitive value of architectural monuments as historical sources - analysis of the material and technical qualities of these monuments allows us to judge almost directly the productive forces of society, its technical equipment and knowledge.

Such a study of architectural monuments begins, in fact, only now, with the development of architectural and archaeological research: before that, researchers were mainly interested in the formally artistic side of the monument

Architecture is classified as a spatial spatio-temporal art form, since the architect organizes masses, volumes, lines, silhouettes not only in three-dimensional space, but also in the time of perception of the composition by the viewer. Only in movement, that is, in the time and direction of the unfolding of the composition in space, with points of view changing in a certain sequence, and the viewer passing along, around and inside the building, is the design, idea and artistic image of the architectural composition revealed.

The main styles in the history of architecture are: Gothic; classicism; neoclassicism; baroque; neo-baroque. Architectural art differs from other types of arts in that it embodies the artistic views of society in works that, as a rule, have a utilitarian, material and practical purpose: dwellings, palaces, fortifications, temples, mausoleums, etc. The types of architectural monuments are very clear reflect the character of a given society.


Fig. 1. ARCHITECTURAL STYLES

As is known, the law of uneven development of art forms, formulated in his time by G. Hegel, is manifested in the fact that the hierarchy of art forms is very flexible and is often weakly connected with changes in the socio-political and economic aspects of social life. As a result, a dominant type of art appears in the cultural field, which to one degree or another "adjusts" artistic activity as a whole, imprinting its specificity on it.

But at every moment of time, artistic culture is a dynamic and self-consistent system with elements interacting with each other. As a result of the emergence of new elements - for example, types of art based on the achievements of scientific and technological progress - the structure of the cultural system and the functions of its individual elements change, but in one form or another, all elements of culture, including the most archaic ones, are still preserved, although, perhaps be, and in a modified form.

The promotion of a certain type of art to the top of the hierarchy is apparently associated with its ability to most fully and adequately represent the prevailing picture of the world in society. So, for example, the medieval picture of the world with a weakened time coordinate most fully corresponds to spatial forms of art - temples decorated with sculpture. The dominant position in the picture of the world of modern man of the time factor leads to the foregrounding of temporary and spatio-temporal forms of art.

Architecture is an artistic and imaginative organization of space based on building structures. It is necessary to distinguish utilitarian construction and the concept of construction corresponding to this technical activity from architecture as artistic creation in stone, wood and clay. The architect operates with the concept of composition and uses expressive (compositional) means: meter and rhythm, symmetry and asymmetry, relationships of magnitudes and proportions. These means correspond to the techniques of accentuation, balancing, and proportioning.

Architecture is classified as a bifunctional (dual) art, the composition of which combines utilitarian and artistic functions. Their combination and interaction are determined by the genre of architectural creativity (sacred, or temple, architecture, palace, residential buildings, technical structures).

Architecture is also classified as a spatial art form, or more precisely, a spatio-temporal one. Since the architect organizes masses, volumes, lines, silhouettes not only in three-dimensional space, but also in the time of perception of the composition by the viewer. Only in movement, that is, in the time and direction of the unfolding of the composition in space, with points of view changing in a certain sequence, and the viewer passing along, around and inside the building, is the design, idea and artistic image of the architectural composition revealed. Accordingly, all architectural compositions can be divided into two types: "staying in space" and "moving in space." The first type includes centric and hall compositions, the second - alleys, galleries, enfilades, arcades. The classification of architecture as a "non-fine arts" is highly controversial. In comparison with painting, sculpture, and graphics, the architect really (with the exception of decorative details) does not depict specific objects. But architecture is capable of not only expressing, but also depicting abstract, sublime ideas and images: ascension, elevation of spirit, flight of soul, strength, power, calmness, confidence. Neither a painter nor a sculptor can convey such images directly, bypassing the Aesopian language of allegory. Therefore, B. R. Wipper called architecture "a highly fine art" [2]. The artistic meaning of the art of architecture thus lies in the transformation of a utilitarian building structure into a composition. For example, a support pillar that can withstand the weight of the ceiling is an optimal, strong and reliable building structure, and a column that expresses the idea of spiritual resistance to gravity and ascension to heaven is an architectural image, a composition.

Outwardly, these forms look almost the same, but their content is different. This difference is defined in architectural theory by the concept of order. This is where the boundaries of architecture as an artistic creation lie. Hence also the traditional comparisons of architecture with the cosmos emerging from chaos, "humanized matter," the stone book of humanity, frozen music.

It is necessary to strictly distinguish between two sides in architecture, which have their own patterns of development: its engineering and technical material basis, which was discussed above, and its actual artistic side, the art of architecture itself. Construction production, with its technical methods and experience, with its materials and system of organizing work, does not, of course, relate to superstructure phenomena. The same construction technique can sometimes be the basis of different stages in the history of architectural art, different eras. True, new artistic views, new ideological tasks put forward to architecture, have a certain influence on the development of technology and structures. In turn, new technical techniques and the progress of construction technology make it possible to pose and solve new artistic and architectural problems, that is, both sides of construction act in dialectical unity and interaction. However, construction technology, the system of empirically mastered laws of statics of structures, known properties of materials, etc. are not "cancelled" with the transition from one stage of the historical development of society to another [6].

The very composition, number and development of the types of these structures and their features in themselves speak with sufficient clarity about the character of a given society, and the placement of buildings, for example, inside a medieval city, provides invaluable material for illuminating not only its topography, but sometimes also its character. The types of architectural monuments very clearly reflect the character of a given society. The artistic views of society are reflected here in a more general, abstract form. At the same time, it must be emphasized that therefore the architectural image is less individual; it embodies not private, fleeting "trends of the times," but more typical, leading artistic views and tastes of society. These qualities of the architectural image also determine the outstanding significance of the architectural monument as a historical source: it conveys to us in its content not accidental, but typical, not private, but the main thing in the artistic views of a given era.  At the same time, this historically conditioned level of culture technique of determining the forms of a new building with the help of reference to previous architectural monuments - “samples” - was one of the conditions for the accumulation and growth of national features in architecture, its originality, since in the process of changing the artistic views of society from past architectural experience, the most valuable and most relevant to new needs was selected.

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# CLASSIFICATION AND TYPES OF ARCHITECTURAL SPACE


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***Abstract***

*The article deals with the interrelationship of composite tools that make up the general architectural space, their features, proportional compatibility, units of measurement and formats In architecture, space is interpreted as a combination of internal, surrounding and external. Internal space is functional-typological, it is an architectural object, the "soul" of an architectural object. The surrounding material-constructive space is the body of the architectural object. External space is an information and energy field, the process of birth of an architectural object that lives in historical infinity and is "fed". The connection between the mass of the structure and the empty space, which limits or surrounds it, is one of the first emotional sensations when getting to know the space. The shape of the volume of the building usually depends on the features of the internal structure. Such a connection is usually observed in one-story buildings with a flat roof. However, the form of the facade does not necessarily correspond to its internal structure. Undoubtedly, the difference is determined not only by the thickness of the walls and other facades, but also by the spaces used for constructive and technical purposes.*



***Keywords:*** *Architectural space, architectural form, relationship, proportion, symmetry, color, scale, interior space, exterior space*


## INTRODUCTION

The composition in the architectural space is created in three main ways: placement in the architectural space; relationship, proportion, symmetry, color, scale of architectural forms and their parts; addition and use of elements of painting, sculpture, landscape design. [1]

Volumetric-spatial composition is based on the features of human visual perception. Forms and planes that we perceive consist of intersecting lines. Flatness creates volume, and volume creates space. The feature of the architectural space is directly related to the person standing in this space, regardless of whether he is inside or watching from the outside. Not only the elements, the surrounding space, but the space itself has an aesthetic value. The connection between the mass of the structure and the empty space, which limits or surrounds it, is one of the first emotional sensations when getting to know the space. The shape of the volume of the building usually depends on the features of the internal structure. Such a connection is usually observed in one-story buildings with a flat roof. However, the form of the facade does not necessarily correspond to its internal structure. Undoubtedly, the difference is determined not only by the thickness of the walls and other facades, but also by the spaces used for constructive and technical purposes. Space in architecture is understood as a combination of internal, enclosing and external. Internal space is functionally typological, it is the essence of architecture, the "soul" of an architectural object. Enclosing material – constructive space is the physical body of an architectural object. External space is an information and energy field that exists in historical infinity, "feeding" the act of creating an architectural object. It follows from the definition of architecture as an artificially created material-spatial environment that has certain image-aesthetic qualities that the architectural environment itself is a complex phenomenon that includes various components: mass, space, lighting, sound, air movement, etc. The concept of "architectural space" as an element of the environment appears in the unity of its constituent material components - spatial form, plane fences and subject environment [1, p.172].

The system "architectural space" is represented as subsystems of different levels, of architectural objects with certain material and spatial characteristics. 26 Space in architecture is understood as concrete - historical space, as a set of internal, enclosing and external [2, c. 7]. Internal space is functionally typological, it is the essence of architecture, the "soul" of an architectural object. The inner space is saturated with vital energy and provides conditions for the normal functioning of the object. The need of a person in the inner space, which has special qualities different from the natural space, was the initial prerequisite for the emergence of the architectural and construction activity of a person. The only possible way to create a special internal space is to use a kind of shell - enclosing space - in the form of a material-constructive substructure. Therefore, the inner and surrounding spaces are consequences of human and social activity. Enclosing space - material - constructive. This is the physical body of an architectural object. The enclosing space is formed by a "dense" space of constructions, building materials, and engineering equipment. The "material shell" of the enclosing space ensures the normal activity of people in the architectural object. External space - natural, urban - is a prerequisite for the existence of an architectural object as a unity of internal and surrounding spaces. It forms the spirit of an architectural object.

External space is an information and energy field that exists in historical infinity, "feeding" the act of creating an architectural object. Thus, all three types of space (external, enclosing and internal) in their unity form an architectural space. However, they also have relative freedom and independence. Each component element of the architectural space has its own conditions and patterns of existence.

Architectural space is always socially determined, as it is based on a socially significant process (function) from the sphere of public activity. Coordinates, plasticity of the architectural space organize the function for which it is intended. In this regard, there are different types of spaces: spaces of action, spaces of contacts, spaces for movement, etc. A special function of the space is the awakening of aesthetic emotions. The artistic image of the space is connected with its content (monumentality, chamber, public purpose: for recreation and entertainment, housing, etc.). In some cases, the boundaries of the architectural space are defined by architectural forms. In others, the insular location of the natural area in free space turns it into an architectural space, creating a "zone of compositional 27 attraction" around the volume. The architectural space can be organized by placing several architectural volumes in it, the borders can be fixed with green plantings, etc. In contrast to the objectively existing physical space, which has themes or other abstract geometrical characteristics, the architectural space as meaningful, perceived, mastered, is always psychologically uneven. The architectural environment, being continuous, fluid, is simultaneously perceived as spatially closed, semantically localized, visible in its compositional completeness, having a "beginning" and "end". Acting as a spatial expression of the forms of human activity, architecture amazingly accurately captures this "spirit of the era" characteristic of each time. The spatial field of human activity formed by means of architecture is always semantically framed. The most important socio-cultural areas of the space are considered the most "organized". Revealing the semantic potential of space in the structure of the object and their corresponding material design form the basis of professional creativity. Operating with space, architectural creativity acts as meaning creation, constantly "encoding" the content of human activity in spatial structures. This reflection in the architecture of the active nature of a person is very diverse in content, form, methods and character. The architect's understanding of the hierarchy of life manifestations of a person leads him to realize the importance of relations between the elements of space in the structure of the whole as a complexly organized sociocultural formation.

## CONCLUSION

Thus, the object of design becomes not only the architectural object itself, but also its entire spatial and temporal context. That is why the psychological meaning of the architectural space is fundamentally not reducible only to visual impressions. From the psychological point of view, the establishment of any professional activity in the proper sense of the word is always the formation of a professionally determined way of understanding the objective world, which thanks to this turns into "the subject of the activity of this specialist".

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# FORMATION OF AESTHETICAL STANDARDS OF ARCHITECTURAL-SPATIAL ORGANIZATION OF TERRITORIES

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***Abstract***

*Architecture is an artistic and imaginative organization of space based on building structures. It is necessary to distinguish utilitarian construction and the concept of construction corresponding to this technical activity from architecture as artistic creation in stone, wood and clay. The architect operates with the concept of composition and uses expressive compositional means: meter and rhythm, symmetry and asymmetry, relationships of magnitudes and proportions. These means correspond to the techniques of accentuation, balancing, proportioning. Their combination and interaction are determined by the genre of architectural creativity - sacred, or temple, architecture, palace, residential buildings, technical structures. Architecture is a source of rich information about the life of society, its economy, scientific and technical potential, politics and social relations, ideology and art, and cultural contacts of people who lived hundreds of centuries ago.*

***Keywords:*** *architecture, accent, art, proportion, composition, structures, architectural object, artistic image, space.*

## INTRODUCTION

Architecture is an artistic and imaginative organization of space based on building structures. It is necessary to distinguish utilitarian construction and the concept of construction corresponding to this technical activity from architecture as artistic creation in stone, wood and clay. The architect operates with the concept of composition and uses expressive compositional means: meter and rhythm, symmetry and asymmetry, relationships of magnitudes and proportions. These means correspond to the techniques of accentuation, balancing, and proportioning. Architecture is classified as a bifunctional dual art, the composition of which combines utilitarian and artistic functions. Their combination and interaction are determined by the genre of architectural creativity - sacred, or temple, architecture, palace, residential buildings, technical structures.

Architecture is also classified as a spatial art form, or more precisely, it would be spatio-temporal. Since the architect organizes masses, volumes, lines, silhouettes not only in three-dimensional space, but also in the time of perception of the composition by the viewer. Only in movement, that is, in the time and direction of the unfolding of the composition in space, with points of view changing in a certain sequence, and the viewer passing along, around and inside the building, is the design, idea and artistic image of the architectural composition revealed. In this sense, as architectural theorist A.I. Nekrasov noted, it is not stone or wood, but space and time that are the compositional material, and the main artistic means is the organization of movement [1].

Architecture is a source of rich information about the life of society, its economy, scientific and technical potential, politics and social relations, ideology and art, and cultural contacts of people who lived hundreds of centuries ago. The study of the remains of architectural objects, as an integral social and cultural phenomenon, allows us to highlight the originality of architectural solutions. In modern conditions of the development of interest in the cultural heritage of previous eras, the important role of the revival of the culture of spectacle in many regions of Kazakhstan is revealed. There is a need for a detailed study and systematization of the rich world experience in the construction of sports and entertainment facilities and methods of organizing entertainment spaces. At the same time, the regional appearance of architectural structures is intended to reflect the historical roots of the formation of the cultural heritage of the state. This problem has arisen quite acutely in Kazakhstan, where national sports spectacles are being cultivated and revived everywhere, and they are given the status of cultural and historical heritage. Modern sports facilities often do not bear regional characteristics in their appearance and functional planning organization, determined by cultural and historical characteristics. A historical analysis of the construction industry in the region allows us to most fully cover those cultural layers that contribute to the formation of aesthetic norms for the architectural and spatial organization of territories of cultural and mass entertainment events. A detailed consideration of the cultural heritage will allow us to gradually follow the development of the architectural language of forms and will help to shape the regional appearance of sports and entertainment architecture for the modern practice of design and construction of sports and entertainment facilities in Kazakhstan. An analysis of global experience in the construction of sports facilities will lead to the consideration of the most progressive design methods and the formation of the fundamental principles of the architectural, subject-spatial and functional organization of modern sports and entertainment facilities, taking into account national specifics. Research and analysis of the traditional architectural and planning organization of the space of national sports and entertainment events will contribute to the integrated conduct of architectural and construction events, since the multifunctionality of such spatial structures stems from the historical experience of holding long-term mass entertainment events associated with the cultures of various peoples of Kazakhstan. A detailed study of the layout and architectural and artistic means of organizing spaces is necessary for a more complete and comprehensive study of the history of national architecture and art of Kazakhstan. An analysis of the planning features of the organization will allow us to identify the main typological aspects of the architectural appearance of the entertainment structure, which bears the features of regional affiliation, as well as to determine the means of forming the artistic aesthetics of entertainment spaces. Residential, commercial buildings and religious buildings as architectural monuments of the Central Asian peoples have been studied by archaeologists for over two hundred years. They have long attracted the attention of travelers, military men and researchers. The first information about the life, culture and cities of the nomadic peoples of Central Asia in the XIII th century. given by the European monks of Plano Carpini and Guillaume de Rubruck, the Venetian Marco Polo and the Chinese traveler Zhang Dehui. These authors paint a picture of the life, customs, and appearance of the inhabitants of medieval Central Asia, and describe architectural monuments. There have never been “purely nomadic” peoples, and most of the so-called. "nomadic" societies were in fact semi-nomadic, i.e. On winter nomadic camps there were permanent dwellings. Often, part of the clan, unable to roam, remained on winter pastures and engaged in irrigated agriculture in the floodplains. Such forms of farming were especially common in the Syr Darya basin, in Central Kazakhstan. There were separate centers of agriculture in Zhetysu and Northern Kazakhstan. Permanent, year-round nomadism was rare, an exception to the rule, and was associated with extreme conditions - wars, loss of main pastures due to sudden climate changes, etc. Thus, for some time, the Oghuz-Seljuks were engaged in year-round nomadism, and during the resettlement to Khorasan - the Western Kangars - after the loss of winter pastures on the northern shore of the Caspian due to flooding in the 9th-10th centuries. Routes of nomadism and pastures were stable for a long time and were formed in the process of long-term development of the steppe expanses. Thus, Guillaume Rubruk noted that “every boss knows the boundaries of his pastures, as well as where he should graze his flocks in winter, summer, spring and autumn.” Two- and four-wheeled carts - kyime - were used as transport during nomadism. These carts were harnessed to bulls, horses or camels. As Plano Carpini noted, to transport some of them “one ox was sufficient, for large ones three, four or even more.”

Herd composition. Medieval authors note that the Turkic-speaking tribes of the steppes bred horses, sheep, goats, cows, and camels. In nomadic conditions, the horse was an indispensable animal due to its exceptional mobility and endurance. The nomads had rules for joint and sequential grazing of livestock in the winter, when, after the horses had been driven out, other types of animals were grazed in the pastures. This method led to the predominance of horses and sheep in the herd. The semi-sedentary population kept cattle and goats. The camel was distributed throughout Kazakhstan, except for the northern regions with a cold climate.

Thanks to “Divan lugat at-Turk” by Mahmud Kashgari and Arab-Kypchak dictionaries of the 13th-14th centuries. Many terms and lexical expressions have reached us, reflecting the economic and livestock realities that existed in this era. Under the leadership of the great scientist A.Kh. Margulan in Central Kazakhstan carried out archaeological research, which paid great attention to the architectural significance of ancient monuments. At the same time, the Khorezm archaeological and ethnographic expedition (headed by Tolstov S.P.) was engaged in a systematic study of the ancient architectural monuments of Ustyurt and the Eastern Aral Sea region. And at the same time, the issues of organizing the architectural and spatial environment of national sports and entertainment entertainment facilities are not widely covered. And were the latter as widespread as other civil buildings, such as baths, madrassas, 20 and at a later time - mektebs, administrative and management, hospital and health centers, station buildings, entertainment institutions, which, as we know, had place in the 19th – early 20th centuries. On the territory of Kazakhstan, a significant number of monuments of monumental architecture dating back to various periods of the history of Kazakhstan and its territory have been preserved. The Kazakhs, using the cultural heritage of these predecessors, along with their wonderful works in the field of music, oral literature and applied art, created their own original creations of architecture, which embodied construction techniques and architectural and artistic means developed as a result of centuries of experience in construction activities. The variety of forms and clearly defined plans of Bronze Age buildings in Central Kazakhstan indicate the beginnings of ideas in the organization of buildings. Residential buildings in the settlements of Ata-Su, Akbaur, Buguly (Shopa), Shortandy, Tagibay (Bayash-Aul) and Karkaraly give a clear idea of the designs of residential buildings of the Bronze Age. A large amount of factual material about dwellings was obtained during the study of Andronovo settlements (Alekseevsky and Sadchikovsky), located in the ancient floodplain of the Upper Tobol River, 40 km south of the city of Kustanai. The megalithic buildings of Kazakhstan combine in their name groups of structures, the simplest forms of which are menhirs, cromlechs, dolmens, cists, tiled fences, etc.

## CONCLUSION

The latter are most common in Central and South-Eastern Kazakhstan (Tarbagatai) and Semirechye. Religious buildings - menhirs - reflect the rituals of ancient pastoralists associated with spring lambing and breeding of the herd, as well as agricultural rituals related to sowing or harvesting. The first stone structures on the territory of Kazakhstan are megalithic in nature and attract attention with the grandeur of the stone masses. These structures are built from huge stone slabs, which are distinguished by the colossal size of individual stone blocks. Huge blocks of granite, the general grandeur of the stone masses gave rise to the people, following their imagination, to call these structures “alyptyn orny” (“the dwelling of giants”) or “myktyn uy” (“the house of myks” - the house of strongmen). On the territory of Kazakhstan, significant traces of ancient structures have been preserved, most of which are associated with the history of the Sakas, Usuns, Kanglys, Kipchaks and other tribes. The simplest of them, but significant in volume, are mounds made of large fragments of stones or an earthen embankment in the form of an artificial hill having a hemispherical shape. In their appearance, the mounds are very similar to the shape of a nomadic yurt. Mound structures, with their roots going back to the building traditions of the Bronze Age, are widespread throughout Kazakhstan and the adjacent regions of Southern Siberia, the Urals and Central Asia.

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# ASSESSMENT OF THE EFFECTIVENESS OF DECISION MAKING IN JUSTIFYING STRENGTHENING THE CAPACITY OF RAILWAYS OF UZBEKISTAN IN PROBABILISTICALLY-DETERMINED CONDITIONS

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***Abstract***

*Today, under the conditions of probability and certainty, the justification for increasing the capacity of Uzbekistan's railways remain one of the most important tasks. The proposed methodology is based on increasing the capacity of Uzbekistan's railways in the context of the possibility of increasing transit cargo between China and Central Asia and South Asia. In particular, the developed methodology makes it possible to justify the strengthening of the capacity of Uzbekistan's railways, taking into account the transit cargo flow between China and Central and South Asia, in order to assess the investment decisions made in different economic situations in the region.*

***Keywords:****strengthening the power of railways, probabilistically-determined conditions, integral effect, Markov chains, Monte Carlo, Uzbekistan, corridor*

## INTRODUCTION

It is very important for our country to diversify transport corridors, quickly and freely enter the world markets, therefore the leader of our country always raises this issue at international conferences and puts forward practical initiatives. Projects are being accelerated in cooperation with neighboring and interested countries. One of them is the construction of the 454-kilometer Uzbekistan-Kyrgyzstan-China railway (Fig.1). It is known that a three-way exchange memorandum on this project was signed at the meeting of the Shanghai organization held in Samarkand on September 14 of this year. According to the technical and economic indicators of this project, there are 1421 transport structures, including 29 tunnels, 90 large and small bridges, 6 overpasses and 1296 water crossings. It is planned to build pipelines [1-4].

Another regional project in the field is the Termiz-Mazari-Sharif-Kabul-Peshwar railway (Fig.1). The Termiz-Mazari-Sharif-Kabul-Peshwar railway line is 765 kilometers long and provides Central Asia with the shortest access to the ports of the Indian Ocean and the Persian Gulf, and connects South and Southeast Asia with Chinese markets. According to the technical and economic indicators of this project, there are 912 transport structures with a total length of 111.5 kilometers, of which 7 are tunnels, 264 are bridges and overpasses, and 641 It is planned to build water pipes. Due to the fact that the Termiz - Mazari-Sharif - Kabul - Peshavor railway line passes through a mountainous area from the geographical point of view, it is planned to build a tunnel with a total length of 78.5 kilometers [5-9].

With such a stage-by-stage reinforcement of the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia in time, it is a process in which, for each moment in time, the probability of any state of the system in the future depends only on the state of the system at the present time and does not depend on how the system came to this condition. Such processes are called Markov processes [10-13].

Step-by-step strengthening of the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia has, in general, a changing transition probability according to the steps of the process and depending on the length of the step of the process. The number of variants of the technical condition of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia in the *t*-th year is a finite number, i.e. the Markov process in this case is also characterized by a finite number of states. The process of step-by-step strengthening of the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia is discrete in time. Such Markov processes are called Markov chains.

Fig 1. The scheme of railway corridors of the countries of Central and South Asia

## EXPERIMENTAL METHODS

It is known that [14] when specifying the initial data in a probabilistically defined form, the assessment of the economic efficiency of an investment project can be carried out using the mathematical expectation of the efficiency indicator. The dependence of the mathematical expectation of the integral effect on the probability of changes in the dynamics of freight traffic for the option of increasing the capacity of the railways of Uzbekistan in order to switch transit cargo flows between China, Central and South Asia can be written as follows:

$$M(\text{Э}_{\text{ожд}}) = \sum_{t=0}^{\text{Т}_{\text{р}}} \left( (\sum_{i=1}^{n_t^{(r)}} R_{it} P_{it}^{(r)} - \sum_{i=1}^{n_t^{(k)}} K_{it} P_{it}^{(k)}) \eta_t \right) \quad 1)$$

where$n_t^{(r)}$ – the number of possible values of the results that are estimated by the probabilistic characteristic; $n_t^{(\text{к})}$- also on investments; $R_{it}$- economic result in the *t*-th year with the *i*-th probability; $P_{ij}^{(r)}$- *i*-th probability that in the *t*-th year the result will be equal to$R_{it}$; $\text{К}_{it}$- investments in the *t*-th year with the *i*-th probability.

The probability values necessary to determine the mathematical expectation of the integral effect according to formula (1) can be identified using an export survey or using the Monte Carlo method, playing out parameters that determine the size of investments and operating costs in the area of their possible changes, taking into account their distribution. The assessment of the economic efficiency of the investment project in probabilistically determined conditions of step-by-step strengthening of the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia can be carried out using the following approach. A variant of deterministic initial information is assigned in the range of its possible fluctuations. A dependency can be used for this purpose.

$$r_t = \min r_t + \xi\ (\max r_t - \min r_t) \quad 2)$$

where$r_t$ – the indicator of the initial information in the *t*-th year; min $r_t$,max $r_t$- the boundary values of the range of possible fluctuations of the indicator $r_t t$-th year; ξ – random numbers of a given distribution law in the interval (0;1).

The law of distribution of random numbers ξ must correspond to the law of distribution of the indicator $r_t$ in the range of its possible change. If such a law is not established, then ξ are accepted evenly distributed.

With a sufficient number of such options for step-by-step strengthening of the capacity of the railways of Uzbekistan in order to switch transit cargo flows between China, Central and South Asia, it is possible to determine the transition probabilities $P_{ij}^{(t)}$- the probability that the railways of Uzbekistan in order to switch transit cargo flows between China, Central and South Asia, located in *i*-the m state in the (*t*-1) th year, in the *t*-th year will be characterized by the *j*-th state.

The transition probabilities are determined by the formula

$$P_{ij}= N_{ij}^{(t)}/N_{i}^{(t)} \tag{3}$$

where$N_{ij}^{(t)}$- the number of static variants in which, after the *i*-th reconstructive event in the (*t*-1)th year, the *t*-th year of the *j*-th event is held; $N_{i}^{(t)}$- the number of options for strengthening the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia in the *t*-th year, the transition to which from the (*t*-1) th year occurred from the *i*-th event.

Transitional probabilities have been found, the choice of the final option of step-by-step enhancement of the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia can be carried out using the dynamic programming method in this case requires monotonically recursive decision selection criteria. When considering the stages of increasing the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia in the form of Markov chains, such a criterion is the formula.

$$P_{ij}= \text{мах}\ (\mathrm{P}_{i\tau}^{(t-\rho)}\ ...\ \mathrm{P}_{\tau i}^{(t)}) \tag{4}$$

where $(\mathrm{P}_{i\tau}^{(t-\rho)}, \mathrm{P}_{\tau i}^{(t)})$ – probabilities of a simple Markov chain path.

Dependence presupposes the choice of simple paths (the beginning of which is characterized by the *i*-th technical condition of the railways of Uzbekistan in order to switch transit cargo flows between China, Central and South Asia in the (*t*-p)–th year, and the end - the *j*-th state in the *t*-th year) of the path that has the maximum probability achievements. The most probable path is the period $T_{cal}$ and is the desired option for step–by-step strengthening of the capacity of Uzbekistan's railways in order to switch transit cargo flows between China, Central and South Asia, which can be considered effective for the *i*-th initial state.

If there are several initial states, then the most economical option is determined by comparing these options with each other, taking into account the most likely stages of reconstruction of railways of Uzbekistan found along Markov chains in order to switch transit cargo flows between China, Central and South Asia for each of the initial options being compared. In this case, the mathematical expectation of the integral efficiency of the options can be determined by the formula (1).

Compliance coefficient

$$\Delta_t= C_a^{(t)}/\ C_p^{(t)}, \tag{5}$$

where$C_a^{(t)}$- actual load capacity; $C_p^{(t)}, -$ load load in the *t*-th year in this direction, adopted when justifying the design decision.

In this case, the range of possible changes in load load in the *t*-th year can be established by approximating confidence intervals.

$$I_C^{(t)}= \left[\tilde{\Delta}_t \pm t_\beta \sigma_\Delta^{(t)}\right] C_p^{(t)} \tag{6}$$

где$\tilde{\Delta}_t$- the arithmetic mean of the correspondence coefficient; $t_\beta$- Student characteristics; $\sigma_\Delta^{(t)}$- the mean square deviation $\Delta_t$.

Table 1 shows the values of $\tilde{\Delta}_t, \sigma_\Delta^{(t)}$ and $I_г^{(t)}$ for single-track railways.

The load tension in the freight direction and the range of its change in the perspective period at $\beta = 0{,}9$ along the analyzed Angren-Pap railway line are shown in Table 2 and Figure 1.

Risk and uncertainty factors in substantiating the strengthening of the railway capacity of Uzbekistan are currently not taken into account as indicators requiring special attention. At substantiating the strengthening of the capacity of the railways of Uzbekistan with the purpose of switching transit freight traffic between China, Central and Southern Asia, which exert influence on decision-making the following types of uncertainty and risks are represented [15, 16].

1. The uncertainty associated with time of switching of transit freight traffics between China, Central and Southern Asia.

2. Uncertainty of volumes of freight traffic, risk with instability of the current economic situation in China, Central and Southern Asia.

Based on the developed mathematical model, the following results of the freight traffic forecast from 2020 to 2035 were obtained [17]:

projected freight traffic by the railways between China, South Korea and Uzbekistan for 2020 - 4,30 million tons, for 2025 - 4,84 million tons and for 2035 - 6,61 million tons;

projected freight traffic between China and Tajikistan, Turkmenistan, Afghanistan and Iran for 2020 - 2,82 million tons, for 2025 - 3,47 million tons and for 2035 - 6,17 million tons;

projected local freight traffic through the pass of Kamchik for 2020 - 8,87 million tons, for 2025 - 10,43 million tons and for 2035 - 15,16 million tons.

Table 1 - Load tension in the cargo direction and its range of variation

| Year of operation of the line | $\tilde{\Delta}_t$ | $\sigma_{\Delta}^{(t)}$ | $I_{\Gamma}^{(t)}$with confidence probability $\beta = 0{,}9$ |
|---|---|---|---|
| 2024 | 0,65 | 0,52 | [0,01 $C_p^{(5)}$; 1,5 $C_p^{(5)}$] |
| 2025 | 0,54 | 0,27 | [0,01 $\Gamma_p^{(10)}$; 0,98 $\Gamma_p^{(10)}$] |
| 2034 | 0,85 | 0,61 | [0,01 $C_p^{(15)}$; 1,85 $C_p^{(15)}$] |

Table 2 - Load tension in the cargo direction and its range of variation

| Year of operation | Load capacity, million tons km/km | | |
|---|---|---|---|
| | $C_a^{(t)}$ | $C_{a\ min}^{t}$ | $C_{a\ max}^{t}$ |
| 2024 | 19,1 | 17,2 | 18,2 |
| 2025 | 24,4 | 18,9 | 21,7 |
| 2034 | 33,0 | 20,4 | 26,7 |

## RESULTS AND DISCUSSION

The results of the obvious presentation of thetask of choosing the most competitive schemes for mastering rail transportation and the optimal way to increase the capacity of the Angren-Pap line with the aim of switching transit freight traffic between China, Central and Southern Asia are presented on graphics for mastering traffic. Two schemes (Fig. 2) are considered[18, 19].

According to the scheme I it is assumed (1 → 2 → 4 → 6): 1 - the initial state; 2 - introduction of the third section of the VL locomotive 80c (an increase in the mass of the composition to a possible by useful length along the pick-and-drop ways); 4 – the device of automatic block system and organization of train traffic with partially batch schedule; 6 - construction of the second tunnel.

According to the scheme II it is assumed (1 → 3 → 5): 1 -the initial state; 3 - construction in a tunnel of a double-sided insert, the device of automatic block system and use of additional locomotives on stages "Halt 2 - Halt 3" and "Halt 3 - the st.Koshminar"; 5 - introduction of the third section of the VL 80c locomotive (an increase in mass of structure to a possible by useful length along the pick-and-drop ways) at preservation of a double-sided insert.

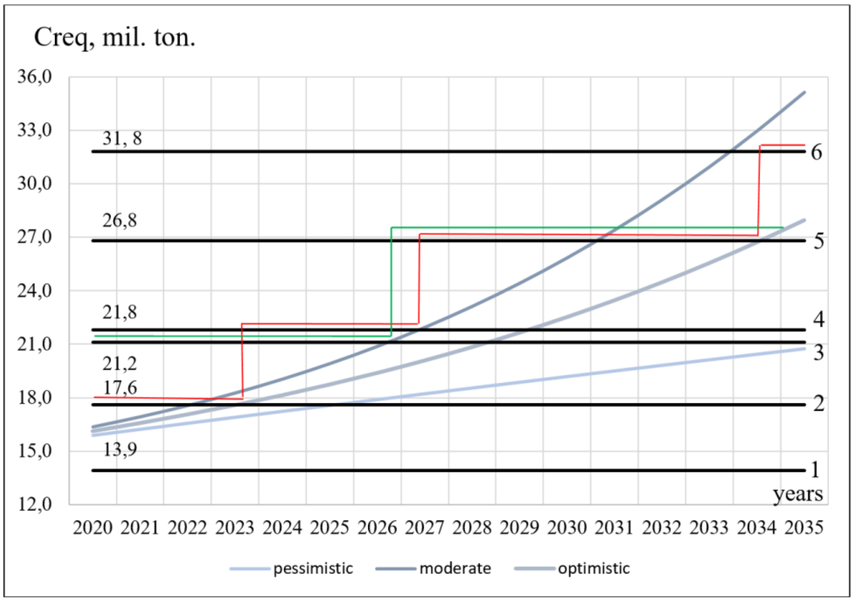


Fig. 2. The schedule of acquirement transportations in each calculation case

To assess the effectiveness of the compared options, taking into account the stochastic nature of the dynamics of traffic volumes, 100 options for changing the load load over time in the range of its possible fluctuations were assigned based on the following dependencies:

$$C^{(t)} = \min I_r^{(t)} + \xi_\rho(\max I_r^{(t)} - \min I_r^{(t)};$$

$$C^{(t+1)} = \min I_r^{(t+1)} + \xi_\rho(\max I_r^{(t+1)} - \min I_r^{(t+1)}$$

при

$$C^{(t)} < \min I_r^{(t+1)}$$

$$C^{(t+1)} = \Gamma^{(t)} + \xi_\rho(\max I_r^{(t+1)} - \Gamma^{(t)}$$

by

$$C^{(t)} > \min I_r^{(t+1)},$$

where $C^{(t)}$ - cargo load in the cargo direction in the *t*-th year.

For each variant of changing the load load, the rational stage of increasing the power of the Angren-Pap railway line was determined for two initial states. The transient probabilities of increasing the power of the Angren-Pape railway, determined by the formula (1.4) for both initial states are shown in Fig. 2.

Search for the most probable path by identifying the maximum probabilities of transition to each technical condition of the railway line in the year under consideration.

$$P_1 = \text{мах}/\mathrm{P}_1^{(1)}\mathrm{P}_{1-2}^{(2)}\ldots\ldots\mathrm{P}_{1-2}^{(6)}\mathrm{P}_{2-4}^{(7)}\mathrm{P}_{2-6}^{(8)}=0{,}16;$$

Therefore, for the 10th year $P_2$=1,0; $P_{2-4}$=0,5; $P_{2-6}$=0,5. Having the maximum probabilities of transition, it is possible to determine the most probable scheme of the phasing of the power amplification of the Angren-Pape railway line for each variant of the initial parameters. To do this, movement is carried out along the Markov chain from the final state having the maximum value of the transition probability. Movement from *t*-th to (*t*-1)-th year occurs through the technical condition of the railway, having max $P_{ij}$ in the *t*-th year.

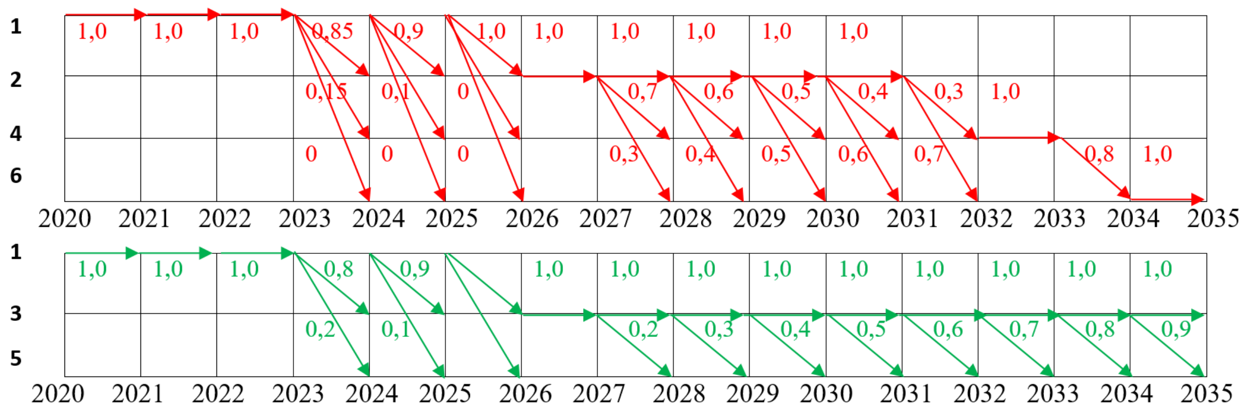


Fig. 3. Railway power amplification under probabilistically-defined conditions

Table 3 - Railway power amplification under probabilistically-defined conditions

| Yers | Strengthening the capacity of railways | |
|---|---|---|
| | The first option | The second option |
| 2020 | $P_1$=1,0; | $P_1$=1,0; |
| 2021 | $P_1$=1,0; | $P_1$=1,0; |
| 2022 | $P_1$=1,0; | $P_1$=1,0; |
| 2023 | $P_{1-2}$=0,85; $P_{1-4}$=0,15; $P_{1-6}$=0; | $P_{1-3}$=0,8; $P_{1-5}$=0,2; |
| 2024 | $P_{1-2}$=0,9; $P_{1-4}$=0,1; $P_{1-6}$=0; | $P_{1-3}$=0,9; $P_{1-5}$=0,1; |
| 2025 | $P_{1-2}$=1,0; $P_{1-4}$=0; $P_{1-6}$=0; | $P_{1-3}$=1,0; $P_{1-5}$=0; |
| 2026 | $P_2$=1,0; | $P_3$=1,0; |
| 2027 | $P_2$=1,0; $P_{2-4}$=0,7; $P_{2-6}$=0,3; | $P_3$=1,0; $P_{3-5}$=0,2; |
| 2028 | $P_2$=1,0; $P_{2-4}$=0,6; $P_{2-6}$=0,4; | $P_3$=1,0; $P_{3-5}$=0,3; |

| | | |
|---|---|---|
| 2029 | $P_2$=1,0; $P_{2-4}$=0,5; $P_{2-6}$=0,5; | $P_3$=1,0; $P_{3-5}$=0,4; |
| 2030 | $P_2$=1,0; $P_{2-4}$=0,4; $P_{2-6}$=0,6; | $P_3$=1,0; $P_{3-5}$=0,5; |
| 2031 | $P_2$=1,0; $P_{2-4}$=0,3; $P_{2-6}$=0,7; | $P_3$=1,0; $P_{3-5}$=0,6; |
| 2032 | $P_4$=1,0; | $P_3$=1,0; $P_{3-5}$=0,7; |
| 2033 | $P_{4-6}$=0,8; | $P_3$=1,0; $P_{3-5}$=0,8; |
| 2034 | $P_6$=1,0; | $P_3$=1,0; $P_{3-5}$=0,9; |
| 2035 | $P_6$=1,0; | $P_5$=1,0; |

Evaluation of the solutions for the phased increase of the Angren-Pap railway line capacity with the aim of switching transit freight traffic between China, Central and Southern Asia with a change in freight traffic dynamics taking into account various options for the mathematical expectation of the integral effect are given in table.4.

Table 4. The mathematical expectation of the integral effect when changing the dynamics of freight traffic,

| $p$=0,5 | $p$=0,6 | $p$=0,7 | $p$=0,8 | $p$=0,9 |
|---|---|---|---|---|
| For the first version of the phased strengthening scheme | | | | |
| 3885 | 5641 | 7392 | 9161 | 10331 |
| For the second version of the phased strengthening scheme | | | | |
| 3911 | 5510 | 7266 | 9015 | 10768 |

Let's assume that depending on instability of various economic conditions at change of growth rates of GDP in the region in general three versions of the made decisions in justifying the strengthening of railway capacity of Uzbekistan in order to switch transit freight traffics between China and Central and Southern Asia. 1. "The pessimistic scenario" when growth rates of GDP in the region do not exceed 5-6%. 2. "The moderate scenario" when growth rates of GDP in the region reach 6,1 - 7%. 3. "The optimistic scenario" when growth rates of GDP in the region make 7,1 - 9%. As a result of the executed calculations, scenario trees were obtained for both options with a change in the GDP growth rate in the region. NPV values of a total series are given in table.5.

Table 5 - NPV values with a change in the GDP growth rate in the region

| Growth rate of GDP in the region, % | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\delta$=1% | $\delta$=2% | $\delta$=3% | $\delta$=4% | $\delta$=5% | $\delta$=6% | $\delta$=7% | $\delta$=8% | $\delta$=9% |
| For the first version of the phased power amplification scheme, the NPV value,one billion ammount | | | | | | | | |
| 8636 | 9112 | 9655 | 10250 | 10760 | 11007 | 11741 | 12599 | 13480 |
| For the second version of the phased power amplification scheme, the NPV value,one billionammount | | | | | | | | |
| 8441 | 8937 | 9481 | 10077 | 10723 | 11438 | 12222 | 13085 | 13956 |

From table. 5 it can be seen that at the GDP growth rate of thisregion in the first version of the phased capacity amplification scheme of scheme of1%-5% and in the second option - 5,1%-9%, NPV is more efficient.

The analysis of development scenarios assumes the consideration, as a rule, of three scenarios of events,decision-making when substantiatingthe strengthening of the railway capacity of Uzbekistan in order to switch transit freights between China, Central and Southern Asia: "pessimistic", "moderate" and "optimistic". Processing of the received NPV values according to the scenario variants yielded the following results. Results are presented in table. 6.

Table 6 - The expected integrated effect at change of growth rates of GDP in the region

| Number of option | Type of an initial element of a tree of the scenario | SizeSize$Эexp$ ,one billion ammount |
|---|---|---|
| I | pessimistic | 10908 |
| | moderate | 11446 |
| | optimistic | 12784 |
| II | pessimistic | 11152 |
| | moderate | 11908 |
| | optimistic | 13262 |

From table. 6 it is visible that the second option of the staged capacity increase of the Angren-Pap railway line is more expedient for eah development scenario in China, Central and Southern Asia.

## CONCLUSION

1. A scheme of options for stepwise power amplification of a railway line in probabilistically-defined conditions has been developed.

2. The investment efficiency of projects for each of the considered schemes of step-by-step reinforcement of the railway line capacity is determined.

3. The proposed option of step–by-step strengthening of the capacity of the Angren- Pape railway line is appropriate, provided that the probability of the predicted cargo flow is 0.875.

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# ON THE QUESTION OF PARABOLIC INVOLUTION

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***Abstract***

*We are studying the involution of projective series with a common carrier and its geometric interpretation. By using a special case of geometric interpretation, we can construct a parabolic involution that is between elliptic and hyperbolic involution. We demonstrate how the parabolic involution elements participate in the process of obtaining elliptic and hyperbolic involution. A proposal is being considered for selecting projective corresponding points to perform geometric transformations. A family of circles exists that is orthogonal to the circles of elliptic, hyperbolic, and parabolic involutions, respectively. There are three circles in this family, each with centers incident to the radical axes of the circles of elliptic, hyperbolic, and parabolic involution respectively. They share a common tangent, $t_i$, which passes through the point of convergence, F. The circles will have a common tangent if the tangent points belong to the circle f and the centers belong to the tangent of the circle f.*

***Keywords**: Geometric transformations, involution, harmonically conjugate points, circle of double points, elliptic involution, hyperbolic involution, parabolic involution.*

## INTRODUCTION

In previous works [1, 2], we explored common elements and the relationship between elliptic and hyperbolic involution with common carriers. This paper presents an extension of the subject matter by introducing parabolic involution. We will demonstrate the position and function of parabolic involution in geometric transformations.

Quadratic involution, which is based on the harmonic relations of four points on a straight line, has both theoretical and practical significance. When combined with classical methods of projective geometry, it can be used effectively to provide accurate and constructive solutions to a variety of geometric modelling problems[3].

The term parabola originates from the Greek word παραβολη meaning 'adjacent arrangement', having been derived from the Latin term parabola. The nature of a parabola determines its adjacent arrangement with the ellipse and the hyperbola in all of their forms. When a plane intersects just one cavity of the surface of a circular cone, an ellipse is produced. If the plane intersects both cavities, resulting in the secant not passing through the vertex, a hyperbola is created. And only in one position, when the secant is parallel to one of its forms - the parabola.

In projective geometry, when examining involution, the order remains consistent. Concerning the geometric interpretation of involution, when line *u* is coincident with the line of centers of the specified circles, three positions arise: hyperbolic (see Fig. 1a), elliptic (see Fig. 1b), and parabolic involution (see Fig. 1c). The line u intersects the coincident points P and Q (parabolic involution). Then, each point A corresponds to a point A' that coincides with a point P ≡ Q. Similarly, points B', C', and so on, which correspond to points B and C, coincide with the point *P ≡ Q*. Therefore, the point *P ≡ Q* corresponds to all other points on the line *u*.

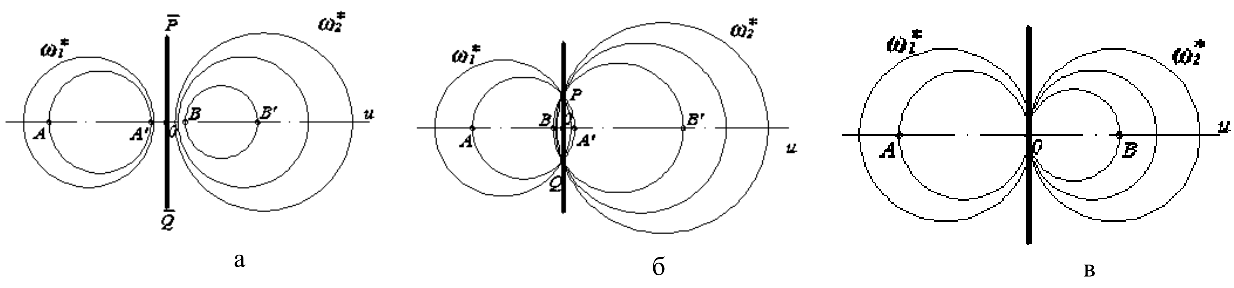


Fig. 1

And here, parabolic involution occupies a position that is both adjacent and intermediate.

## EXPERIMENTAL METHODS

Our paper aims to demonstrate that the parabola is not only adjacent but also an integral component of all types of involution.

The shared features of elliptic and hyperbolic involution were outlined in references [4,5,6,7]. Expanding on this, we shall now examine the connection between elliptic, hyperbolic, and parabolic involution.

Suppose we have a harmonic quadrilateral of points. The tangents $t_1$, $t_2$ to the circles drawn through the corresponding pairs of points converge at one point $F$ on the line of centers of these circles (refer to Fig. 2). (In the case of elliptic involution, Figure 2 shows the locations of points $A$, $A'$ *and* $B$, $B'$. In the case of elliptic involution, Figure 2 shows the locations of points $A$, $A'$ *and* $B$, $B'$. If it is a hyperbolic involution, points $A'$ *and* $B$ change places).

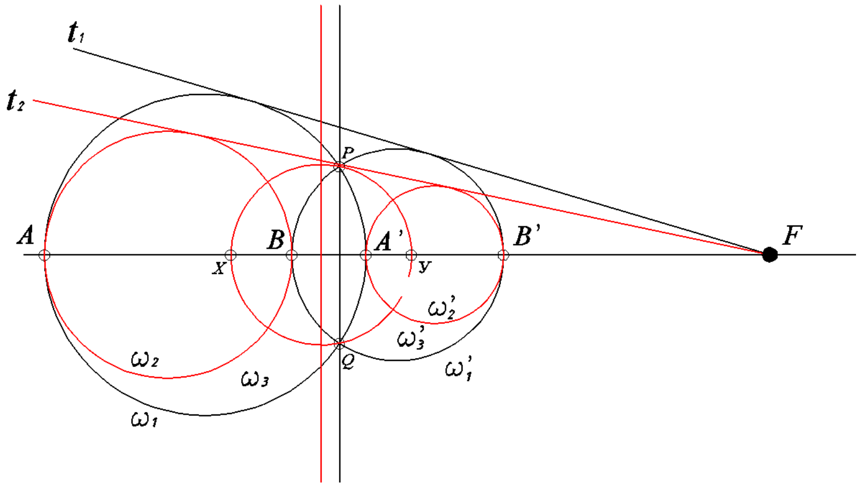


Fig. 2 It has been observed that the points $P$ *and* $Q$ lie at the intersection of the circles $\omega_1$ *and* $\omega_1'$, as well as at the double points of hyperbolic involution $\omega_2$ and $\omega_2'$. These points are part of the circle of double points.

If we draw a circle with its center at point $F$ and passing through point $P$ $(Q)$, the radical center (and radical axis - highlighted in green) of the parabolic involution for the specified points $A$ and $B'$ (see Fig. 3) is obtained at the point of its intersection with the line of centers. The tangent $t_3$ to the circles that define the parabolic involution also passes through point $F$.

In geometric transformations, selecting the projectively corresponding points is crucial. A family of circles that are orthogonal to the circles of elliptic, hyperbolic, and parabolic involution, respectively, exists. Three circles are chosen from this family, and their centers coincide with the radical axes of the circles of elliptic, hyperbolic, and parabolic involution, respectively. In addition, they have a joint tangent $t_i$, passing through the point of tangents convergence $F$ (Fig. 4). The circles will share a tangent if the points of contact are on circle $f$ and the tangents' centers reside on the same circle. Each of these circles intersects a pair of involution circles at two legitimate points: $K$, $K'$( $L$, $L'$ and $M$, $M'$).

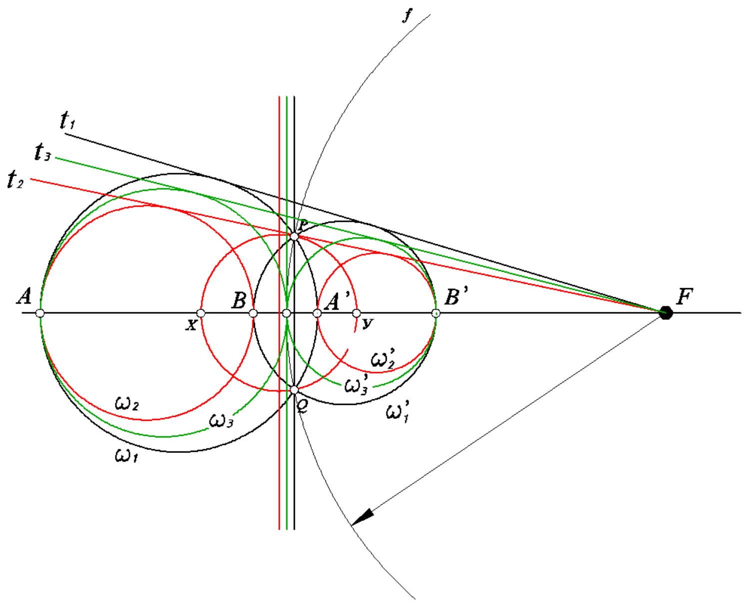


Fig. 3

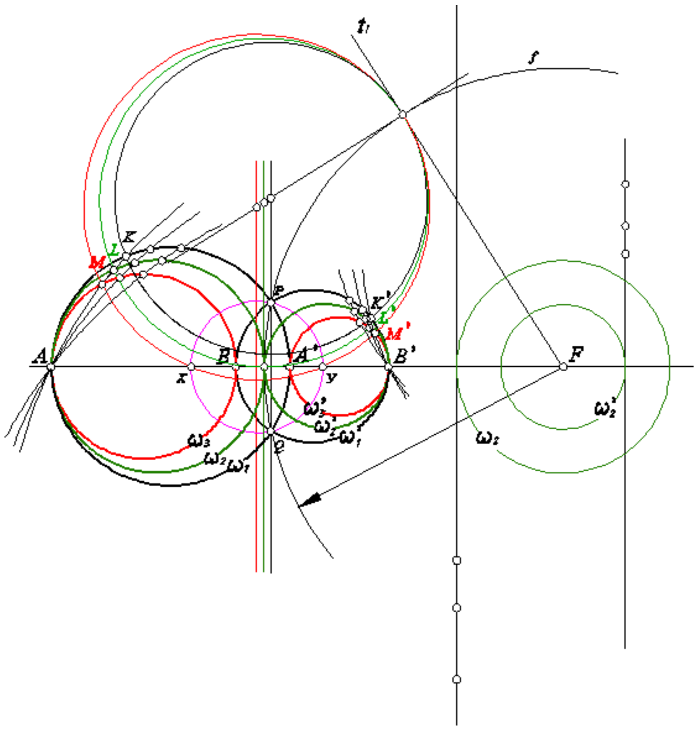


Fig. 4

From the given points *K*, *L*, *M* and *K'*, *L'*, *M'*, we can draw circles. One circle goes through point *A* and the other through *B*'. Both circles also pass through the common tangent point of the orthogonal circles at $t_i$. Furthermore, if we create a set of points *K, L, M (K', L', M')*, the centers of all circles related to *K, L, M (K', L', M')* align to form a line of centers. This straight line is situated at a distance equal to the radius of the circle of parabolic involution from the point where tangents *F* converge, towards the side with the position of points *K, L, M* (*K', L', M'*) from the radical axis.

## RESULTS AND DISCUSSION

From the above constructions, it can be concluded that *two circles intersecting at right angles on the line of their centers create an elliptic involution of harmonically conjugate points*.

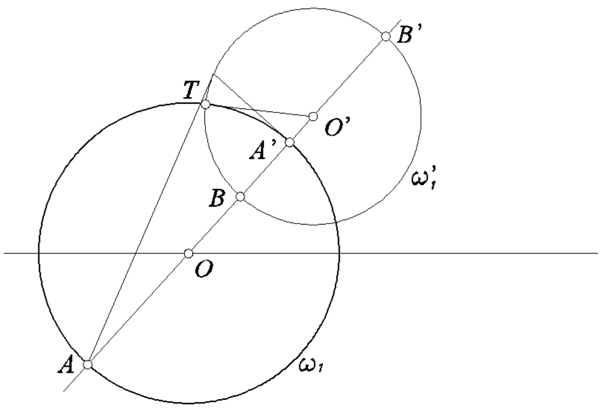


Fig. 5

For instance, consider a circle $\omega_1$ with its center at point *O* and another point *O'* situated outside of the circle $\omega_1$ (refer to Fig. 5). From point *O*', draw a straight line tangent to $\omega_1$. Draw circle $\omega_1'$, centered at O', which passes through the tangent point *T*. Notice that circles $\omega_1$ and $\omega_1'$ are orthogonal. Draw the line of centers *OO'* and identify the points of intersection of circles $\omega_1$ and $\omega_1'$ with the line of centers *OO'*. Finally, obtain the harmonic conjugate points *A*, *A'* and *B*, *B'* of elliptic involution.

Let it be stated as follows: within a triangle whose interior angles at vertices are less than 90°, we can construct the sole feasible elliptic involution with harmonically conjugate points along the sides.

Take any triangle Δ*KLM* where the angles at the vertices are less than 90° (refer to Figure 6).

From vertices *K*, *L* and *M*, draw perpendiculars to the opposite sides of the triangle. These lines represent the radical axes of the constructed circles *a*, *b*, *c*, and their intersection point forms the radical center *R*. A circle *p*is then drawn, centered on side *KL* of the triangle with a diameter equal to segment *KL*. The point of intersection between this line and the perpendicular drawn to *KL* from point *M* is where the sought circles *a* and *b* intersect on their radical axis. In this setup, circles *a* and*b* are at right angles to each other. Thus, their respective diametral points *A, A′* and *B, B′* on the line of their centers *m* form *a* set of harmonically separated points of elliptic involution.

Next, draw circle *c*, centered at point *M*, passing through the point of intersection of circles *a* and *b*. The radical axis should be drawn from point *L(K)*, opposite to the perpendicular side of *KM*(*LM*). After locating all diametrical points of circles *a*, *b*, and *c* with lines of centers *m*, *k*, and *l*, respectively, three elliptic involutions with harmonically located points will be obtained.

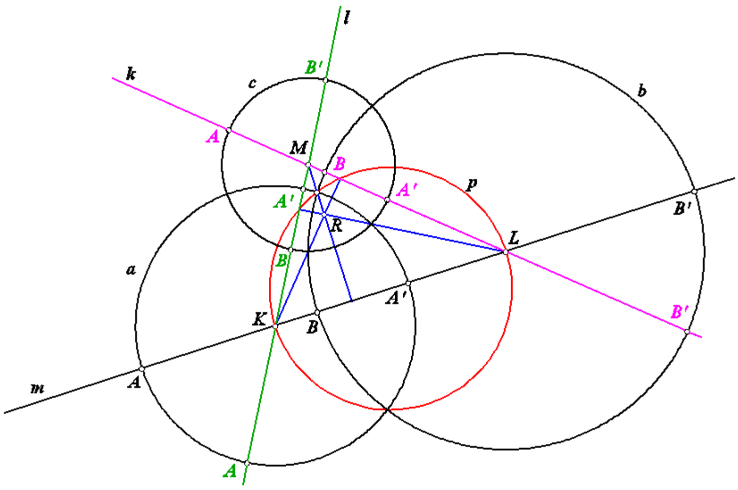


Fig. 6

## CONCLUSION

Thus, this paper presents the role of parabolic involution in geometric transformations and offers recommendations for selecting projectively corresponding points.

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UDC 453.68

## APPLICATION OF SHEEP WOOL IN MODERN THERMAL INSULATION MATERIALS

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***Abstract***

*The article covers the issues of using thermal insulation materials in construction, requirements for them, and the use of sheep wool for these purposes.*

***Keywords.*** *Construction, building, thermal insulation, requirements, effectiveness, sheep wool, insulation, natural material, sound insulation, properties, ecological cleanliness.*

### INTRODUCTION

Modern buildings have great potential for increasing their thermal efficiency based on the formation of thermal and air conditions, optimization of heat and mass flows both in rooms and enclosing structures [1,2].

The main weapon in the fight for energy savings and reduction of heat loss is the correctly selected thermal insulation material. Therefore, the role of thermal insulation materials in ensuring the energy efficiency of buildings is great. The use of thermal insulation materials allows reducing the thickness and weight of walls and enclosing structures and reducing the main building materials (cement, metal, brick). Reducing the weight of a structure is especially important in seismic areas, since it reduces the seismic loads associated with the weight of buildings. When choosing effective thermal insulation materials, it is necessary to take into account their thermal insulation properties, technological features, environmental safety, cost, volume of their production in the country and other factors [3]. Therefore, when choosing effective thermal insulation materials, an integrated approach is required, taking into account their social, economic and environmental significance. In this regard, research into effective thermal insulation materials (especially using local raw materials and waste) to ensure energy efficiency of buildings is very relevant.

### RESULT AND DISCUSSION

Recently, the construction industry has paid a lot of attention to the quality and naturalness of thermal insulation materials. And this is not surprising, because creating a human-friendly environment and a comfortable climate in any room are the main requirements when designing any residential or public building. On average, Europeans spend up to 90% of their time indoors. However, the indoor microclimate does not always have the best effect on humans. Dry air, increased concentration of volatile impurities from building materials (binders, varnishes, paints), increased background noise can often lead to various diseases [4,5].

An innovative solution in the use of thermal insulation materials is the use of material made from natural sheep wool. These are environmentally friendly materials with excellent properties.

In Uzbekistan, since ancient times, sheep's wool has been used as bedding for the floors of residential buildings, to protect against moisture and create indoor comfort, as well as for thermal insulation of walls and roofs. Also, sheep wool was used in the production of clay ovens (tandoor - for baking flat cakes) as a reinforcing element in clays. Currently, a small part of sheep wool is used in small volumes for the production of insulating felt. If we consider that at the beginning of 2022, the total number of sheep in Uzbekistan exceeded 23 million heads (from the wool of which 13 thousand tons of raw materials can be made), then a significant part of it is not used.

The picture is the same in Kazakhstan. As of recent years, about 30 thousand tons of wool are produced in Kazakhstan, and barely 2 thousand tons are processed; the rest of the raw materials are exported uncontrollably. About 43% of wool is not processed and is lost. Because of this, a significant part of the proceeds ends up in shadow circulation. As a result, the state annually loses more than 6 million US dollars [10].

According to the National Union of Sheep Breeders (NSO), there are now 24.5 million sheep and goats in Russia, of which only 4.6 million - about 19% - are kept in agricultural enterprises, the rest of the herd is in personal or farm holdings. The main trend in sheep farming in the world is the industry’s turn to increase the share of meat and reduce wool production.

Sheep wool is used as a thermal insulation material in South America, New Zealand, China, India and other countries.

Sheep wool is one of the natural insulating materials and has environmental qualities. Sheep wool insulation provides very good thermal insulation capabilities and excellent sound as well as thermal protection. It is permeable, relatively durable and versatile. Pure sheep's wool is used to produce sheep wool insulation. The raw wool for this purpose comes almost exclusively from Europe. After shearing with special shearing machines for sheep, it is washed, degreased and provides long-term protection against moths. The wool is then broken down into individual fibers, which become the starting material for fine nonwovens. To produce insulating mats, they are stacked and stitched with needles. Sheep wool insulation boards are thermally densified with 10 cm thick synthetic fibers. Alternatively, natural products such as coconut fibers are used for stabilization.

The use of natural wool material reduces changes in temperature and humidity, muffles sounds in the air and structures, and reduces the amount of pollutants, toxins and odors carried through the air.

The materials are an environmentally friendly solution, made entirely from pure sheep wool. Thermal insulation material is used:

– as wool insulation for walls when installing new buildings to improve thermal insulation in summer and winter;

– as a sealant for joints of logs when installing walls of wooden houses;

– as breathable internal insulation without a vapor barrier layer for use in cold walls during the renovation of old buildings;

– as an integral part of the design of floors and partitions to improve indoor acoustics;

– for the reconstruction of new and old buildings contaminated with various substances;

– to improve the climate in residential premises;

– for special use as technical insulation (under vibration and shock loads.

## CONCLUSION

1. In conclusion, it can be noted that sheep wool is a 100% natural material, it does not contain any impurities and is made from renewable raw materials. In addition, wool has a number of important undeniable advantages over other materials. First of all, it is an excellent ability to quickly absorb moisture in high humidity and release it when necessary (for example: in a bath or shower); has a high density and, therefore, high heat storage capacity; as well as unique soundproofing properties in floor coverings and the invariability of the insulation structure before and after installation.

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UDC 625

# ENVIRONMENT TEMPERATURE AS A FACTOR IN THE DESTRUCTION OF ASPHALT CONCRETE COVERING

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***Abstract***

*The article notes the relevance of solving problems related to ensuring the smoothness of asphalt concrete roads operated in the conditions of Uzbekistan. Project documentation for the design of road pavement provides for the provision of operational and technical parameters of the road. However, in practice, premature destruction of the road surface occurs. One of the types of deterioration in the smoothness of roads is the formation of waves. This is due to the plasticity of the coating material, which depends on the temperature factor. It is shown that the design temperature of atmospheric air, taken when designing a road structure in accordance with current regulatory documents, is lower in value than the actual exposure temperature. When designing flexible road pavements, it is recommended to take into account heat from natural and anthropogenic heat sources: solar radiation of the area, thermal emissions of vehicle traffic, heat generated as a result of the interaction of the tire with the road surface, thermal emissions from manufacturing enterprises in the region where the road is routed.*

***Keywords:*** *road construction, asphalt, traffic intensity, atmospheric air, temperature, heat, environment, pollutants, transport emissions.*

## INTRODUCTION

The regulatory documents state that *"the main task of research in the field of calculation of flexible road pavements is to most fully study the patterns that govern the operation of road pavements in real conditions, and on the basis of these patterns to develop a calculation methodology that can significantly increase the reliability of the designed pavements in combination with their efficiency. This problem can be successfully solved only if design parameters are introduced into the theoretical dependencies that sufficiently accurately correspond to the specific conditions for which clothing is designed. Therefore, more and more attention is paid to the selection and justification of design parameters based on extensive field and laboratory studies"* [1].

For many years, many scientists have been studying quite a multifaceted road under different technological conditions of road operation, but until now a reliable model of its deformation and destruction has not been developed [2, 3, 4], etc.

The most significant indicator of flexible pavements is the smoothness of road surfaces. Evenness has a significant impact on the speed, convenience and safety of vehicle movement, on throughput and travel time, on the consumption of fuel and lubricants, wear of tires and all main components of the vehicle, and in general, on the cost of transportation. One type of deterioration in the smoothness of roads is waves. This is when in the longitudinal direction, after 0.5...2 m, an alternation of depressions and ridges is observed on the road surface. The reason for the formation of waves may be excessive plasticity of the coating material. In turn, the plasticity of the building material - asphalt concrete mixture - depends on the temperature factor, which has a significant effect on layers of bonded materials containing organic binders. The elastic modulus of asphalt concrete decreases with increasing coating temperature [5].

The aim of the study was to analyze temperatures affecting the evenness of asphalt concrete pavement.

## EXPERIMENTAL METHODS

We have carried out a theoretical analysis of scientific and regulatory literature on taking into account the influence of temperature on the strength of road surfaces at the design stage. Field observations and studies of the technical condition of some asphalt concrete roads in Uzbekistan were carried out.

## RESULTS AND DISCUSSION

The Law of the Republic of Uzbekistan states: «*A highway is a complex structures designed for the movement of vehicles, ensuring their continuous and safe movement at a set speed, load, dimensions, as well as land plots provided for the placement of this complex, and the space above it in established limits*» [6]

In Uzbekistan, the total length of the public road network is 209 thousand km. Despite all the reconstruction work that is regularly carried out on asphalt concrete roads, a visual observation of the road network has shown that a number of them need to be improved in their transport and operational condition.

When designing highways, one of the main design parameters in current regulatory documents is the temperature factor. When calculating road pavement, the ambient air temperature is taken as the design temperature [7, 8].

We believe that this value is different from the actual temperature value affecting the surface of the roadway. Since the road structure in the conditions of Uzbekistan warms up under the influence of solar radiation, it is influenced by heat sources: emissions from traffic flow, heat generated as a result of the interaction of a tire with the road surface, thermal pollution from industrial enterprises in the region, and other heat sources are not excluded.

Let's consider some thermal effects on the road surface.

*1) exposure to solar radiation.*

It is known that on the territory of Uzbekistan the average daylight hours are about 10 hours, and the number of sunny days per year is more than 300. The annual amount of total solar radiation falling on one square meter of surface is equivalent to the energy obtained by burning 200 kg of organic fuel.

In the Jizzakh region, fluctuations in atmospheric air temperature are observed from year to year in daily and annual periods. The difference between the average temperature, $t_{av}$, of the coldest and warmest months is 26…30°C. The difference between the absolute maximum and the absolute minimum is 77…0°C. The winter period is characterized by weather instability, cloudiness, frequent precipitation and changes in air temperature. The average monthly temperature in January, the coldest month of the year, ranges from 0 to -5.4°C. Low temperatures are observed in the northern part of the region and in the mountains. The absolute minimum air temperatures range from -29 to -34°C, the average absolute minimums from -18 to -26°C. A significant part of the territory of the Jizzakh region is characterized by moderate frosts. Winter is mild in most of the flat territory of the region, and in the far north and in the mountains it is moderately cold. Significant fluctuations in air temperature with light snow cover from 4 to 8 cm in 10 days on average 30…34 days lead to freezing of the soil. The greatest freezing depth reaches 57 cm. The frost-free period is long for 210…223 days.

The period with air temperature above 0°C averages 319…345 days across the territory. A significant role in the formation of summer weather is played by the processes of transformation of air masses and the formation of local tropical masses over desert areas. Summer is hot and dry. The average monthly temperature in July, the warmest month, is 26.8…31.2°C in the flat area, and 16.2°C in the mountainous areas. The absolute maximum air temperature throughout the territory reaches 45…47 °C. During the hot summer period, the maximum temperature of the asphalt concrete pavement reaches more than 60°C and remains for two hours after the maximum solar radiation. During this time, asphalt concrete pavements are highly susceptible to shear deformations. The strength of asphalt concrete at a temperature of 70°C decreases in comparison with its strength at a temperature of 50°C by 20...50%, depending on the type of asphalt concrete and the amount of free bitumen contained in it [9].

Thus, rising temperatures and long periods of heat lead to softening of the asphalt pavement.

*2) impact of thermal emissions from vehicle traffic.*

It is known that during the operation of transport, the process of combustion of hydrocarbon fuel occurs, which is accompanied by the formation of heat. More than 2 million vehicles move on the roads of Uzbekistan, of which 44% run on gasoline, 15% on diesel fuel and 41% on gas fuel [10].

In engineering calculations, the height of vehicle emissions above the road surface is taken depending on the percentage of passenger cars in the traffic flow: if the number is more than 70% - 0.4 m; from 45...70% - 0.5 m; less than 45% - 0.6 m. Depending on the composition of the traffic flow, the amount of heat emission is 50...80 $^{0}$C [11];

*3) exposure to heat generated by the interaction of the tire with the road surface.*

The amount of heat generated as a result of the interaction of the tire with the road surface was determined by Russian scientists in the range from 0.348...2.946 J [11];

*4) the impact of thermal emissions from manufacturing enterprises in the region where the road is routed.*

Thermal pollution from anthropogenic activities in a region depends on the number and types of activities. Thus, the dominant industry in the Jizzakh region is the production of building materials. There is also production of plastic products and other enterprises associated with thermal pollution of atmospheric air [9].

## CONCLUSION

Timely implementation of work to identify and eliminate the causes leading to deformation of the surface of asphalt concrete roads does not lose its relevance.

Based on the results of our research, theoretical and field, we believe that the road surface is affected by a temperature higher than that accepted when calculating structural strength indicators. In this regard, it can be assumed that the design temperature does not correspond to the operating temperature.

We recommend that the temperature factor of the impact on the surface of the road surface when designing asphalt concrete roads should be taken as a design temperature value equal to, based on the natural conditions of the area (solar radiation, etc.) and anthropogenic factors (thermal emissions from the traffic flow, heat generated as a result of the interaction of the tire with road surfaces, thermal emissions from manufacturing enterprises in the region, road routing locations, etc.).

Also take into account short-term and relatively long-term temporal rhythms of temperature fluctuations on the territory of Uzbekistan.

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# INFLUENCE OF SMALL MASSES ON A METAL BEAM OF A RAILWAY BRIDGE


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***Abstract***

*The article presents the results of measurements of vibrations of a metal girder superstructure of a railway bridge under the influence of small masses (human jumps). The results obtained can be used to determine the period of natural vibrations of the span for comparison with the normalized range.*


***Keywords:*** *metal railway bridge, beam span structure, amplitude-time dependencies, vibration displacement*.

## INTRODUCTION

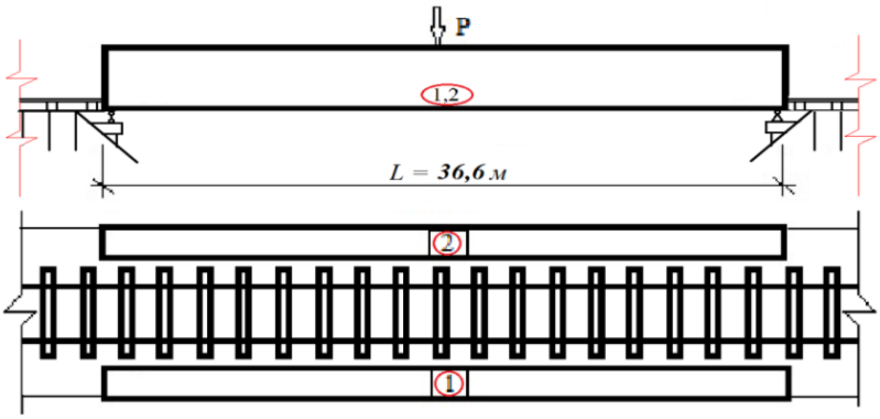
To assess the stress-strain state (SSS) of bridges during testing, it is necessary to measure stresses from the test load in characteristic sections of the most loaded elements, deflections of spans, periods of their free vibrations, and dynamic coefficients. In some cases, it is also necessary to determine the vibration decrements, and in cable-stayed and suspension bridges also the forces in the ropes. There may also be a need to determine the stresses in the supports and the amount of deflection of the top of the supports during sudden braking of a moving test load or from changes in ambient temperature. When testing operating bridges, sometimes there is a need to determine the dependence of crack opening or displacement of some blocks of the span relative to others on the magnitude and position of the test load. For the mentioned measurements, special instruments are used: strain gauges, deflectometers, inclinometers, various geodetic instruments, etc. To assess the SSS of bridge structures, even in our computer age, a variety of mechanical devices continue to be widely used. The main disadvantages of mechanical instruments are: the inability to record in real time and the need to have an observer near each instrument or a compactly located group of instruments during testing who must record their readings. In this case, the probability of subjective errors is quite high (incorrect reading of instrument readings, recording errors, etc.). If devices are installed in hard-to-reach places, then taking readings takes considerable time, which leads to an increase in test time, and therefore to an increase in their cost. In addition, this method of recording data makes it difficult to carry out express analysis directly during testing.

## EXPERIMENTAL METHODS

Thus, the use of a vibration-dynamic software and hardware complex (VHAK) for collecting and processing data during testing is becoming increasingly relevant. If it is necessary to carry out monitoring, such as long-term observation of the state of the structure under study, then VPAK turns out to be the only acceptable one, since it allows not only to completely eliminate numerous observers, but can also be equipped with a decision-making system for automatically preventing emergency situations.

Thus, at the present stage, the study of the stress-strain state of bridge structures is most effective using VPAK. This allows you to analyze experimental data more deeply and find optimal solutions to improve their reliability. Figure 1 shows a general view of the beam span structure of a metal bridge and a railway track laid on wooden beams with a ride underneath, on which the authors conducted research on a section of the Almaty railway. Figure 2 shows a diagram of the metal bridge span and the location of the seismometers

Fig. 1. General view of the beam superstructure of a metal bridge and a railway track laid on wooden beams with a ride on the bottom




1 and 2 – seismometers installed in the middle of the span; P – load from one person (impulse – jumping)

Fig. 2. Diagram of the metal bridge span and location of seismometers

A simple and, at the same time, very effective method for selecting the peak values of the vibration spectra of a bridge structure is based only on the analysis of the spectra. In accordance with this method, the natural frequencies of oscillations are determined from the peak values of the averaged reduced power spectral densities (SPD). For this purpose, a discrete Fourier transform of vibration displacements, vibration velocities and vibration accelerations is used. The peak selection method does not require the use of complex algorithms for its implementation. Within this method, to construct a graphical representation of the spectral density function, various modifications of the fast Fourier transform (FFT), described in detail in the specialized literature [1], are used. The mentioned method has been successfully tested in Austria and Switzerland on a large number of structures.

## RESULTS AND DISCUSSION

In this work, the object of study is the metal girder superstructure of a railway bridge across the river. Sarybulak (Fig. 1), railway line Ainabulak-Almaty, with a span l = 27 m, diagram in Fig. 2.

A mobile vibration measuring complex with a package of application programs for data processing and visualization was used as a measuring instrument; technical characteristics, software and signal processing techniques are given in sufficient detail in [2].

Of particular interest when conducting research are both amplitude-time dependencies and amplitude-frequency characteristics (AFC), determined from the corresponding spectral density graphs [3,4], obtained from the impact on the structure of the bridge span as a result of jumps of one in the middle of the span . As an example, in Fig. 3 and 5 show the amplitude-time dependences of vibration displacements of a beam metal span - with one jump and five jumps, respectively, and in Fig. 4 and 6 are the corresponding spectral density graphs.

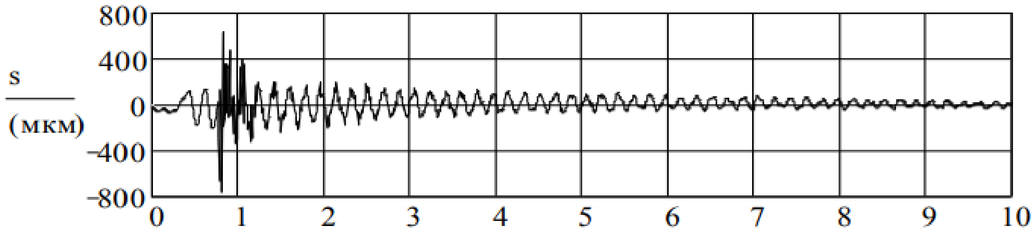



Fig. 3. Oscillogram of vibration displacement of the span structure of a metal bridge, seismic receiver №1

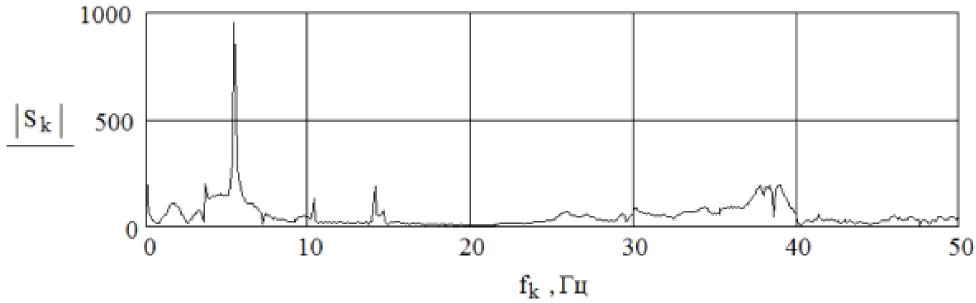



Fig. 4. Spectrum of vibration displacement of the superstructure of a metal bridge, seismic receiver №1, maximum spectral surge at a frequency of 5.47 Hz

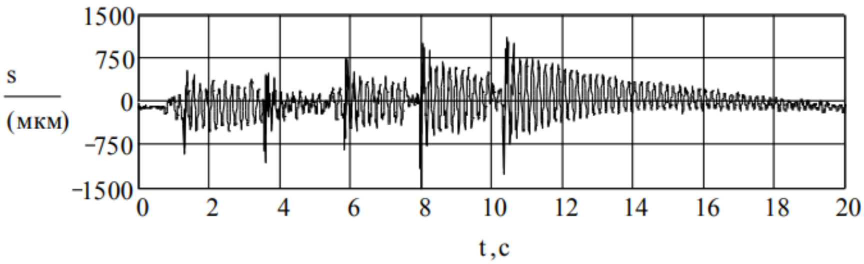



Fig. 5. Graph of vertical displacements of a 27-meter metal beam, geophone №1

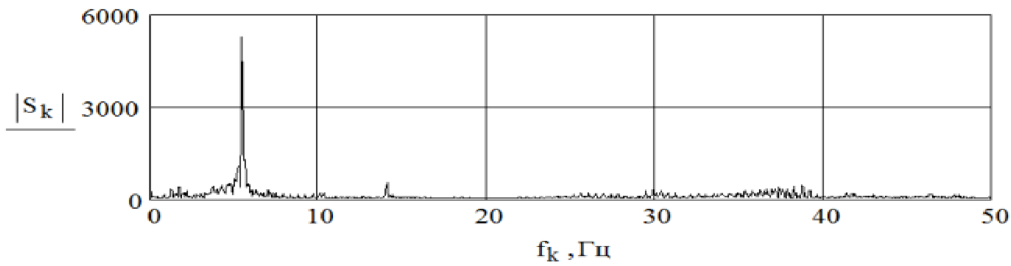



Fig. 6. Spectrum of vertical movements of a 27-meter metal beam, geophone №1, maximum spectral surge at a frequency of 5.52 Hz

Table 1. Data obtained during the experimental tests

| Number of jumps | Peak values of vibration displacements, μm | Predominant frequency on the spectral plane, Hz |
|---|---|---|
| Beam №1 | | |
| 1 | -762 | 5,47 |
| 2 | -1145 | 5,52 |
| 3 | -1814 | 5,47 |
| 5 | -1275 | 5,52 |
| Beam №2 | | |
| 1 | 189 | 5,47 |
| 2 | 5281 | 5,47 |
| 3 | 165 | 5,47 |
| 5 | 366 | 5,52 |

As a result of the analysis of the tests carried out, the following was revealed:

- when small masses (human jumps) influence the beam metal bridge superstructure, the natural frequencies of the given superstructure are in the range f = 5.47÷5.52 Hz. These frequencies determine the period of natural vibrations of the beam metal superstructure of the bridge [1-6].

Analysis of experimental data characterizing the response of a structure to the impact of small masses (human jumps) made it possible to establish the parameters of free (natural) vibrations of unloaded spans. The dominant frequencies in the dispersion spectral density graph are identical, regardless of the number of jumps, that is, the frequency of impact, if the time between jumps corresponds to the complete damping of the oscillations.

## CONCLUSION

From the analysis of measurements of vibrations of a beam metal superstructure of a bridge using the fast Fourier transform as a signal processing tool, it follows that to determine the period of natural vibrations of the superstructure for the purpose of comparison with the normalized range, it is possible to use the impact on the structure caused by a human jump, provided that the measuring sensitivity is sufficient equipment.

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# FEATURES OF CALCULATION OF REINFORCED CONCRETE PILES OF AGRICULTURAL BUILDINGS IN AGGRESSIVE GROUND CONDITIONS

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***Abstract***

*The influence of aggressiveness and variability of physical and mechanical properties of saline soil on the operation of horizontally loaded piles of agricultural buildings is investigated. When exposed to horizontal loads, piles are exposed to aggressive environmental influences stacked with saline soils and groundwater, which leads to concrete corrosion. The importance of the correct consideration of the parameters of saline soil in the near pile space, the influence of corrosion products and concrete impregnation in the design of piles are proposed and an idea is given about the calculation of the behavior of piles with a horizontal load. The problems we can solve, the parameters of the rigidity of the saline soil of the k-th conditional support in the natural, soaked and leached state and the bending stiffness of the pile, taking into account the predicted depth of concrete corrosion, were adopted. The change in the deformation properties of soils due to soaking and desalting qualitatively and quantitatively changes the deformation state of reinforced concrete piles. The movement of the upper end of the pile increases, there is a redistribution of bending moments, rebuff and cutting forces along the length of the pile trunk. Corrosion processes in concrete under the influence of aggressive environments on highly saline soils affect the operation of horizontally loaded piles.*

***Keywords:*** *pile, horizontal load, saline soils, suffusion, soil stiffness coefficient, Winkler model, concrete corrosion.*

## INTRODUCTION

The construction and operation of buildings on saline soils belongs to the category of construction in complex engineering and geological conditions arising from the specific features of such soils.

Construction in these territories is complicated by a decrease in the bearing capacity of the foundations due to moisture and salt leaching, as well as corrosion processes in the foundation body. Irrigation construction and irrigation of agricultural crops cause the rise of groundwater, as a result of which the foundations of many buildings become waterlogged. Therefore, for the successful design of foundations in saline soils, a correct assessment of their physical and mechanical properties is needed, taking into account the possibility of watering.

In addition, it is important to choose the right foundation material, anti-corrosion measures, taking into account their effectiveness and durability.

The experience of construction on such soils has shown that buildings and structures erected on shallow foundations are more often subjected to uneven deformation of the foundations as a result of their watering and salt leaching [4,9]. In addition, labor and time spent on the construction of foundations, including the construction of drainage systems to regulate the rise of groundwater, account for a large share of expenses.

In saline soils, the most economical options for foundations in the form of piles, of various designs, can be more widely used.

When exposed to horizontal loads associated with structural features of buildings or seismic forces, piles experience bending moments and transverse forces that must be taken into account in the design process. In addition, piles can be exposed to aggressive environmental influences stacked with saline soils and groundwater, which leads to concrete corrosion. Thus, taking into account the predicted depth of concrete corrosion becomes crucial when calculating the durability and safety of underground elements of buildings, including reinforced concrete piles. The paper examines the importance of proper consideration of the parameters of saline soil in the near-pile space, the influence of corrosion products and concrete impregnation in the design of piles and gives an idea of the calculation of the behavior of piles with horizontal load.

The model of calculation of reinforced concrete piles for horizontal loading was previously considered in relation to the calculation of pile columns[1]. In this paper, the problem is solved taking into account the variable characteristics of soil stiffness and reinforced concrete piles up to 4 m long and up to 25 cm in cross-section, used for agricultural industrial buildings. The proposed improved calculation method allows us to take into account the peculiarities of the work of piles in aggressive ground conditions, taking into account the possible prolonged soaking of the bases and the corrosive effect of the aggressive environment [2,3,4,6,7].

## METHODOLOGY OF THE EXPERIMENT

To solve the problem, the parameters of the rigidity of the saline soil and the bending stiffness of its conditional support are taken into account, taking into account the predicted depth of concrete corrosion. We determine the stiffness coefficients of $C_0(x_k)$ taking into account the most unfavorable condition of the saline soil around the pile and the decrease in bearing capacity due to the influence of moisture, including:

1. Direct testing of the pile using strain gauges and mesdoz and pile probes in the soaked state of the soil;
2. Based on the results of stamp or compression-filtration tests of soil samples from different depths.

Of these, the most reliable is the first method, where numerical values of stiffness coefficients can be established directly from the pile test materials. The first method of determining the stiffness coefficient of elastic supports is long and time-consuming. Therefore, let us consider the possibilities of describing the stiffness coefficient of the conditional support located at a depth of x, through the modulus of total soil deformation $E(x_k)$. In this case, the calculation of a horizontally loaded pile according to M. Gorbunov-Posadov and B. Laine is consistent with the analytical solutions of the Winkler model [1,10]. Based on this, the stiffness coefficient of elastic supports:

$$C(x_k) = \frac{k_0 E_{0r}(X_k)}{[\mathrm{I} - \mu_0^2(X_k)]\sqrt{\mathrm{F} * \omega}}$$

Here: $k_0$ - experimental parameter, for clay soils, $\boldsymbol{\kappa_o = 0,65;}$

$\mu_0^2(X_k)$ -Poisson's ratio for a conditional support;

$E_{0r}(X_k)$ –average modulus of soil deformation of the conditional support, kPa;

$F = h_e b(x)$ – effective surface area of contact of piles with soil, $m^2$;

$h_e$ - effective contact surface length, m;

$b(x)$ - the width of the cross-section of the pile, taking into account the corrosion damage of concrete, m.

$$b_i(X_k) = b_0 - 2L(\tau)(1 - \frac{a_i}{l})$$

where, $b_0$ – cross section of the pile, m;

$a_i$ - the height of the considered section, m;

$l$ -pile length, m;

$L(\tau)$ –expected depth of concrete corrosion, m.

The effective length of the contact surface of the soil with the pile can be determined by the expression:

$$h_e = z_o - a_{cheg.}$$

here: $z_o$ is the height to the point of zero displacement, m;

a b

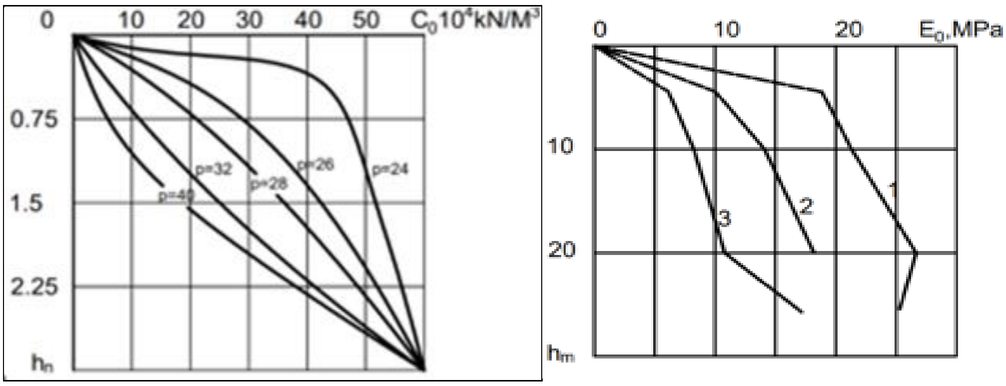


Fig.1. (a) The depth deformation modules of the soil at natural (1), soaked (2) and desalinated (3) and the nature of the distribution of the stiffness coefficient $C(x_k)$ in depth depending on the steps of the applied forces (for example, Central Fergana).

$\boldsymbol{a_{prev} = 1.5b(x)}$-the maximum thickness of the zero resistance of the soil at the surface [4].

To select the stiffness coefficient C $(x_k)$, we determine the modulus of total deformation of the natural ($E_{pr}$), soaked ($E_{vl}$) and desalinated ($E_c$) soil conditions (Fig.1).

The average modulus of soil deformation of the **k** conditional support along the length of the pile can be taken [2]:

$$E_i(x_k) = E_o Z^n$$

here: soil deformation modules $E_0$ at a depth of 1.0 m;

***z*** - is the depth of the considered layer, m;

***n***– is the coefficient with which the distribution plot changes

$\boldsymbol{E_0}$ in depth becomes a constant (n = 0), a convex parabola (n<1<1), a triangle (n=1) a concave parabola (n>I).

Taking into account (1) and experimental data, the nonlinear law of change With $\boldsymbol{C(x_k)}$ in depth can be represented in the following form:

$$C(x_k) = \frac{k_0 E_i(X_k)(\frac{Z}{Z_0})^n}{[\mathrm{I} - \mu_0^2(X_k)]\sqrt{F * \omega}}$$

In this case, the parameter **n**can be considered as a function of the movements of the pile head $\mathbf{V_0}$ with different immersion of piles and different combinations of forces (Fig.2).

a b

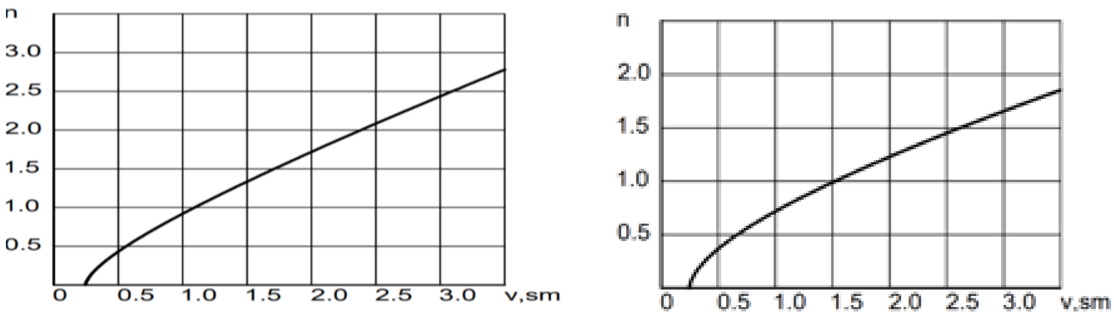


Fig.2. Parameter **n** for flexible (a) and rigid (b) piles.

It should be noted that in highly saline soils with a close occurrence of the groundwater level, a reinforced concrete pile may eventually collapse due to concrete corrosion. At the same time, the expected depth of concrete corrosion *L(□)*for the estimated period of operation of buildings or structures can be determined by the dependence [8]:

$$L_\tau = \sqrt{\beta_k[\tau]qMf}$$

where: $\beta_k -$ the coefficient determining the resistance of the aggressive medium of the material (concrete) in the underground part of the structure, determined by laboratory method [7].

$[\tau]$ - the standard period of operation of buildings, year;

q - a coefficient that takes into account the influence of lateral soil pressure in the nearpile array on the corrosion damage of concrete (Table 1).

M–coefficient that takes into account the water-cement ratio of concrete (Table 2).

f = 0.8 -a reliability coefficient that takes into account the heterogeneity of concrete, the variability of the concentration of aggressive media and the spread of experimental data.

Table 1.Correction factor **g**, which takes into account the influence of lateral soil pressure in the near-pile array on the corrosion damage of concrete

| Aggressive environment | ***g,****at lateral pressure,****MPa*** | | |
|---|---|---|---|
| | 0,2 | 0,002 | 0,004 |
| Sulphate | 0,05 | 0,06 | 0,10 |
| Chloride-sulfate | 0,2 | 0,37 | 0,42 |

Table 2 - Correction factor **M**, taking into account the water-cement ratio of concrete

| Water-cement relations | 0,3 | 0,4 | 0,5 | 0,6 | 0,7 |
|---|---|---|---|---|---|
| Correction factor | 0,6 | 0,8 | 1,0 | 1,2 | 1,4 |

Based on the data obtained , the values of the shear resistance f0 of concrete corrosion products within the normal pressure $\boldsymbol{\sigma}$ =***0,0 -0,3МПа***can be represented as follows:$\boldsymbol{f_0 = 0{,}05\sigma + 7}$

Rigidity of the material of a horizontally loaded pile, taking into account the effect of corrosion,$\boldsymbol{E`_b I = (0{,}8..........0{,}85)E_b I_k}$

where: 0.8......0.85 coefficient taking into account the plastic properties of concrete;

$I_k$ is the moment of inertia of the cross–section of the pile (taking into account the thickness of corrosion$I_k$during the period of operation of the building).

Taking into account the influence of aggressiveness and variability of the properties of saline soil, we have improved the balance equation for calculating a horizontally loaded pile in matrix form[2,7].

**RESULTS**

To perform the calculation of horizontally loaded piles, the stiffness coefficients of saline soils taken according to (5) in the natural, soaked and leached state were taken as initial data (Fig.3).

A separate task was solved taking into account the possible depth of corrosion damage to concrete over the estimated life of buildings (Fig.4).

The calculation showed that the stress-strain state of the pile foundation depends on the magnitude of the horizontal load, the strength properties of saline soils, as well as the bending and shear stiffness of pile structures. The change in the deformation properties of soils due to soaking of the bases changes the overall picture of the deformed state of piles.

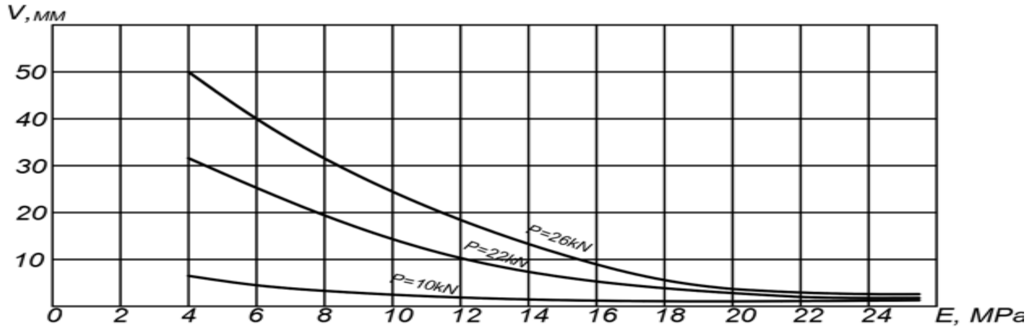


Fig.3.The effect of changes in the modulus of deformation of the soil and the degree of applied forces on the horizontal movements of the pile head.

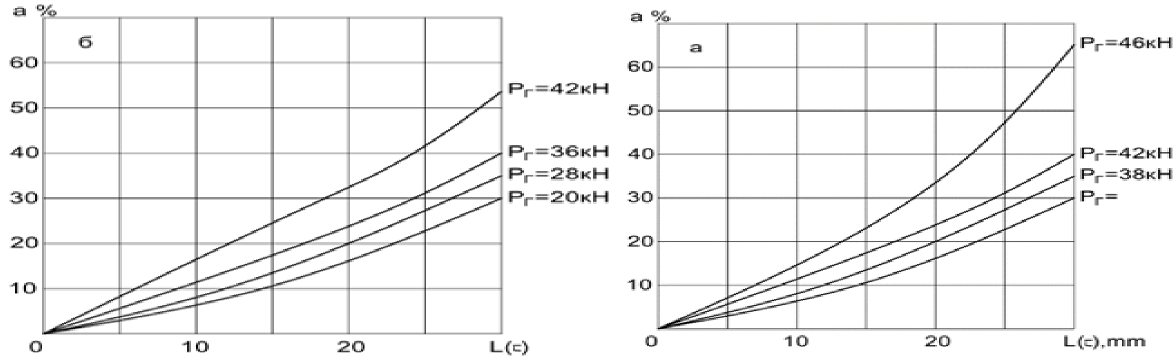


Fig.4. The effect of the predicted depth of concrete corrosion on the horizontal movements of the pile head at different ground conditions: *a*- $C_o= 7,9\cdot10^4 кN/m^3$ ; *в*- $C_o= 6\cdot10^4 кN/m^3$.

Reducing the deformation properties of saline soils significantly affects the horizontal movement of piles. The effect of changes in the strength and deformation of the pile material in this case is less significant. In most cases, in low-moisture saline soils, the maximum bearing capacity of the pile occurs more often on the material of the trunk than on the ground. In this case, the influence of the flexibility of the driven piles is more pronounced, plastic deformations occur more intensively.

## CONCLUSION

The change in the deformation properties of soils due to soaking and desalting qualitatively and quantitatively changes the deformation state of reinforced concrete piles.

The movement of the upper end of the pile increases, there is a redistribution of bending moments, rebuff and cuttingforces along the length of the pile trunk.

Corrosion processes in concrete under the influence of aggressive media significantly affect the operation of horizontally loaded piles. With an increase in the depth of corrosion, the loss of bearing capacity of piles occurs on the material of the trunk more than on the ground. Corrosion damage to concrete in the range of up to 10 mm does not significantly affect the work of piles.

The proposed calculation method closely reflects the actual operation of short driven piles in saline soils.

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UDC 72.006

# INCRESING THE ARCHITECTURAL AND ARTISTIC EXPRESSIVENES OF PUBLIC BUILDINGS THROUGH THE USE OF TRANSCULENT CONCRETE

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***Abstract***

*Researchers have focused on the concept of sustainable development looking forward to innovate something using energy conservation. The undeniable difference of the material in question is its long service life. Translucent lightweight Concrete is a new material with various applications in the construction field, architecture, decoration and even in furniture industry. Despite the fact that the concrete composition has a number of advantages, it is not without its disadvantages. Transculet concrete can become an affordable alternative for both commercial and residential projects. In this article are provided more optimal options for using transparent concrete in the architectural and design space.*

***Keywords:*** *transculet concrete, natural light, artistic patterns, sustainability, artistic expressiveness, architectural environment, cultural significance*

## INTRODUCTION

There are two basic materials used for making transparent concrete, one is from construction field and another from sensing field. First, concrete is one of the most important civil engineering materials with the advantages of rich raw materials, low cost and simple production process and second the optical fiber has good light guiding property which can be arrange to transmit the light and the sun light transmit according to pre- design road without light-heat, light-electrical or photochemical process, and photo elastic effect which can be used to study the stress distribution of structures. Combining the advantages of the concrete and optical fiber, developing a novel functional material called transparent concrete has an important value in the application of construction and sensing[1].

Translucent lightweight Concrete is a new material with various applications in the construction field, architecture, decoration and even in furniture industry[2].

Concrete is one of the most durable building materials, characterized by exceptional reliability and technical characteristics. The undeniable difference of the material in question is its long service life. Despite the fact that the concrete composition has a number of advantages, it is not without its disadvantages.

The main disadvantage of the cement composition is its unattractive appearance; it requires decorative finishing. However, construction technologies are developing by leaps and bounds. As a theory, technology has developed a fundamentally new type of concrete – translucent. This article discusses more advanced use cases of this material.

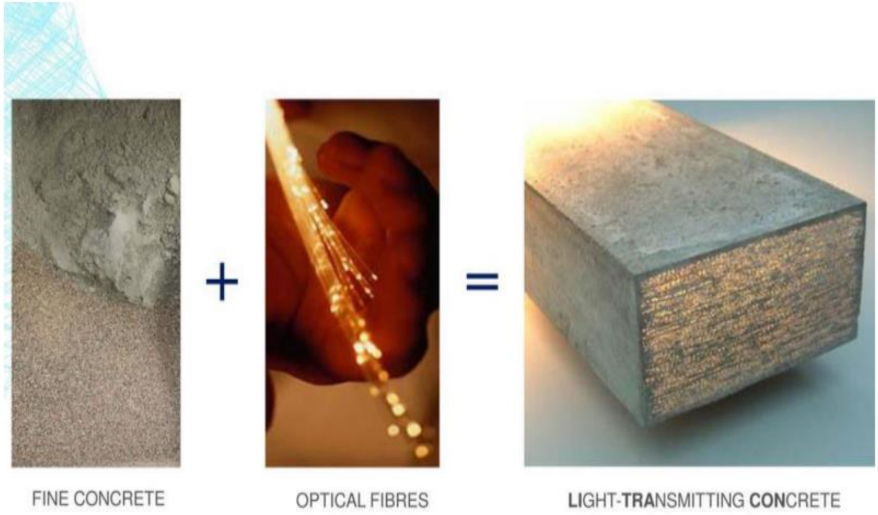


Fig.1. Materials and manufacturing process : a) fine concrete b) optical fibres c) light -transmitting concrete[3].

## EXPERIMENTAL PART

Enhancing the architectural and artistic expressiveness of public buildings through the use of translucent concrete is an innovative and exciting concept. Translucent concrete, also known as light-transmitting concrete or LiTraCon, is a material that allows light to pass through it, creating a visually stunning effect. Based on scientific research, the authors of the article offer some solutions for using transparent concrete in the architectural and design environment:

- Play with Natural Light: Translucent concrete can be used to harness and distribute natural light throughout a building's interior. This not only reduces the need for artificial lighting but also creates a dynamic interplay between light and shadow, which can be a powerful architectural feature.
- Unique Façades: Incorporating translucent concrete into a building's façade can result in a striking and distinctive appearance. The interplay of light and shadow can create ever-changing patterns and textures, making the building stand out as a work of art in its own right.
- Artistic Patterns: Translucent concrete can be customized to feature intricate patterns, designs, or even artworks. Embedded LED lights can also be used to change the colors and intensity of the light, creating a dynamic and artistic display that can be adjusted according to different occasions.
- Privacy with Transparency: Translucent concrete can provide privacy without sacrificing natural light. This is particularly valuable for public buildings like libraries, art galleries, or cultural centers where privacy is needed in certain areas, but the desire for natural light is also strong.
- Integration with Nature: For buildings in natural surroundings, translucent concrete can blend seamlessly with the environment. The transparency can create a visual connection between the interior and exterior, allowing the surrounding landscape to become a part of the building's artistic expression.
- Wayfinding and Signage: Translucent concrete can be used to create wayfinding elements within a building, ensuring that visitors can easily navigate the space. Text, symbols, or directional arrows can be integrated into the material, and illumination can be added for enhanced visibility.
- Sustainability: The use of translucent concrete can align with sustainable building practices by reducing the need for artificial lighting during the day. This can lead to energy savings and a smaller carbon footprint.
- Historical and Cultural Significance: In public buildings with historical or cultural significance, translucent concrete can be used to modernize while respecting the original design. This blend of old and new can be a powerful way to convey a message of continuity and progression.
- Interactive Art Installations: Public buildings can use translucent concrete as a canvas for interactive art installations. The combination of light and artistic expression can engage the public and create a sense of community.
- Educational Opportunities: Public buildings that incorporate translucent concrete can also serve as educational tools, allowing visitors to learn about the innovative materials and design techniques used in the construction.

## RESULTS AND DISCUSSION

Transparent concrete is a unique building material invented by Mr. Loshonzi, one of the leading Hungarian architects. He was looking for the possibility of providing his structures with additional lighting, while the technical characteristics of the cement composition do not deteriorate in any way. As a result, the architect decided to change the internal components of the building material.

After 15 years of incessant searches and experiments, he managed to develop and introduce into the construction industry a fundamentally new decorative and finishing material - transparent concrete. It was named Litrakon. Composite fine-grained compounds based on fiberglass are introduced into the composition of the material. It's important to note that working with translucent concrete requires collaboration between architects, engineers, and material experts. Additionally, the cost and maintenance considerations should be carefully weighed against the artistic and architectural benefits. When used thoughtfully, translucent concrete can significantly enhance the artistic and architectural expressiveness of public buildings, creating iconic and memorable structures. The main disadvantage of transparent concrete is that production is impossible on a large scale and volume, so they are produced mainly in the form of building blocks.

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# RESEARCH OF ANTIOXIDANTS IN CHICKEN MEAT, A PRODUCT FROM UZBEKISTAN


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***Abstract***

*Classification and certification of chicken meat are presented and discussed the results of a scientific study to solve some problems in the classification of chicken meat according to HS, the possibility of a highly effective method of chromatography-mass spectrometry in the certification of chicken meat according to modern requirements, determination by chromatomass spectrometry of antioxidants in the composition of chicken meat produced in Uzbekistan.*



***Keywords:*** *Certification, HS, commodity codes, chicken meat, antibiotic, hormones, quality, cholecalciferol*


## INTRODUCTION

Among the meat products produced in the world, chicken meat occupies one of the leading places in terms of its ease of digestion, the richness of nutrients necessary for the body, relatively low cost and some other parameters, and the daily growth in demand for it [1].

Certification of the quality of chicken meat imported from abroad through supervision based on biochemical, chemical, organoleptic methods, technical specifications, and state standards, sanitary and epidemiological documents is important.

When checking the quality indicators of chicken meat in the world and especially in the CIS countries, the amount of total protein, fat, carbohydrate and water is mainly determined, as well as some heavy metals such as lead, mercury, etc. In recent years, special attention has been paid to the problem of a serious danger to human health of the consumer due to an excessive increase in the content of various antioxidants, antibiotics, hormones in the composition of meat as a result of feeding poultry using the above-mentioned feed additives in order to increase the profitability of meat production. In this regard, the study of the chemical composition of poultry meat using physico-chemical methods to good results in the supervision of their quality [2].

In this regard, there is a need to create and implement modern methods of examination, quality control and certification of meat products in the supervisory state bodies. Uzbekistan has achieved certain results in the development of modern and operational methods for the examination of chicken meat along with other products, in the field of the introduction of world commodity codes based on its chemical composition and improved certification.

In the strategy of actions for the development of the state, priority tasks are "deepening the structural changes and consistent development of agricultural production, further strengthening the country's food security, expanding the production of environmentally friendly products, increasing the export opportunities of the agricultural sector."

## METHODOLOGY OF THE EXPERIMENT

"Classification and certification of chicken meat" presents and discusses the results of a scientific study to solve some problems in the classification of chicken meat according to HS, the possibility of a highly effective method of chromatography-mass spectrometry in the certification of chicken meat according to modern requirements, determination by chromatography-mass spectrometry of antioxidants in chicken meat produced in Uzbekistan and imported from the USA and Brazil [3].

As a result of experimental studies, it has been proved that according to today's rules for determining commodity codes for chicken meat and its offal, the main attention is paid to the condition and parts of meat. Therefore, commodity codes do not reflect the chemical composition of chicken meat. In this regard, they found it expedient to improve the commodity codes in force in the HS on the basis of their chemical composition and developed effective methods of customs examination to determine new commodity codes. [4-5].

Through their mediation, 4 new product codes for chicken meat and its products were proposed, and a description of the notes was developed:

under the name "83% chicken", it is proposed to assign a commodity code to a product cleaned of feathers that are not treated with synthetic means and are not used in the process of feeding them with antioxidants that are environmentally friendly, with a stepped leg, head and semi-finished product. 0207 11 100 1;

under the name "70% chicken" peeled from feathers that are not treated with synthetic means and are not used in the process of their feeding of antioxidants, which are environmentally friendly, without a stepped leg, head and semi-processed product but having a neck, heart, liver and stomach muscles, it is proposed to assign a commodity code 0207 11 300 1;

under the name "63% chicken" or characterized by another name, it is proposed to assign a product code to the product cleaned of feathers, not treated with any synthetic means and not used in the process of feeding them with antioxidants that are environmentally friendly, without a stepped leg, head, neck, heart, liver and gastric muscles 0207 11 900 1;

under the name "70% chicken", peeled from feathers, not treated with any synthetic means and not used in the process of feeding them with antioxidants that are environmentally friendly, without a stepped leg, head and semi-frozen product, but having a neck, heart, liver and gastric muscles, it is proposed to assign the commodity code 0207 12 100 1, which have been adopted for implementation in the practice of customs activities of the Republic of Uzbekistan.

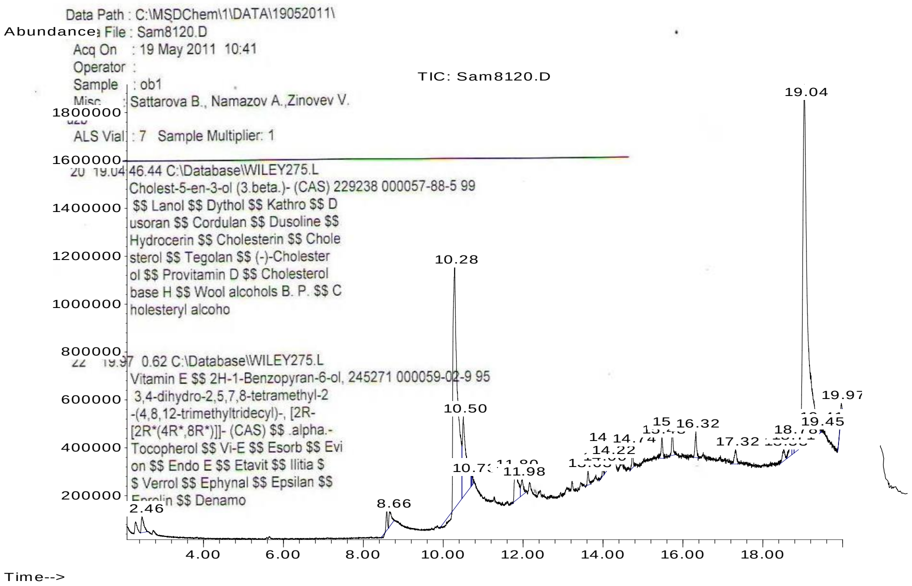


Fig.1. Chromatogram of a sample of local chicken meat from Uzbekistan "GC/MS at 5973 N" obtained on a gas chromatograph mass spectrometer

The classification of chicken meat and its products by the proposed new international code marks will ensure the import of environmentally friendly, high-quality chicken meat and its products. This is important in protecting consumer rights and protecting public health.

## RESULTS AND DISCUSSION

As a control, a chromatogram of a chicken meat sample produced in Uzbekistan is shown in the chromatogram obtained on the GC/MS AT5973N chromatography-mass spectrometer. In a local sample of chicken meat, peaks for the analyzed substances begin to appear mainly after 8.66 minutes.

Chromatogram analysis showed that provitamin D (cholecalciferol) reaches the chromatograph detector in 19.04 minutes, vitamin E (alpha-tocopherol) from antioxidants in 19.07 minutes. The strong intensity of the peak, which appears at 19.04 minutes, shows a sufficient amount of vitamin D in the composition of the analyzed meat.

Vitamin D is important for the body for the development of bone tissue, as phosphorus and calcium salts are well absorbed with the help of this vitamin. The presence of vitamin E (alpha-tocopherol) in chicken meat is common, it is important for the regulation of the reproductive process, and its deficiency leads to a violation of sexual activity. At the same time, vitamin E has antioxidant properties, performs the binding role of free radicals in the body.

## CONCLUSIONS

Repeated analysis-checks of the total amount of antioxidants in chicken meat produced in Uzbekistan showed that their amounts are in the appropriate amounts. Chromatogram of a chicken meat sample produced in Uzbekistan

Vitamin D is important for the body for the development of bone tissue, as phosphorus and calcium salts are well absorbed with the help of this vitamin. The presence of vitamin E (alpha-tocopherol) in chicken meat is common, it is important for the regulation of the reproductive process, and its deficiency leads to a violation of sexual activity. At the same time, vitamin E has antioxidant properties, performs the binding role of free radicals in the body.

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# IMPROVEMENT OF SOYBEAN GRAIN CULTIVATION AND PROCESSING TECHNOLOGIES


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***Abstract***

*The article discusses the issues of studying the chemical composition of grain parts of local soybean varieties grown in Uzbekistan. In particular, the selection of optimal complex processing methods in production conditions, the study of amino acids of proteins in soy grain. To solve the tasks set in the work, well-known modern chemical and physico-chemical methods of amino acid analysis are used.*


***Keywords:*** *soy, amino acids, proteins, soy products, soy milk, lecithin.*

## INTRODUCTION

During the implementation of measures to increase soybean crops and production in the republic, according to the conclusion of scientists and specialists of JSC Uzpakhtaeg, LLC AgroMK, a total of 840 tons of 6 different varieties were imported from the Krasnodar Territory of Russia, 60 tons of 2 different varieties of soybeans from Serbia as part of the pilot project [1].

In 2022, 6 soybean varieties of the SOKO Company of the Russian Federation were planted in the republic, including Selecta-302, Selecto-201, varieties Sparta, Avanta, Arleta and Amigo, varieties Favorit and Victoria of the Research Institute of Field and Vegetable Growing of Serbia. and Orzu, Nafis, Uzbekistan from local varieties, Baraka and Tomaris varieties and tested on large areas. In 2024, 26 thousand 975 hectares (8 thousand hectares of primary and 18 thousand 975 hectares of secondary) are planned to be sown under soybeans. Since soybeans were sown on large areas for the first time, in 2022, 5756 farms sowed 12.3 thousand hectares of soybeans, yielding a harvest of 13,658 tons. This corresponds to an average of 11 c/ha per hectare. In particular, soybean seeds as the main crop were sown in 2111 farms on a total area of 6300 hectares, 10100 tons (16.0/ha) were harvested. 5900 hectares of soybean seeds were sown as a re-crop on the areas of 3545 farms, 3558 tons (6 tons/ha) were collected [2].

In 2024, it is planned to sow 18.5 thousand hectares of soybeans on the main areas and collect a total of 32.375 tons. This will require 1,200 tons of soybean seeds. Of these, local producers have 60 tons of soybean seeds with the SOKO Company of the Russian Federation, only 1 million. 34,000 US dollars (920 US dollars per ton) - varieties "Selecta-302" and "Selecta-201", and 120 tons were brought from the Republic of Kazakhstan, suitable for our local soil and climatic conditions and 60 tons of the "Eureka" variety

In addition, in order to establish soybean production in the republic, 60 tons of soy seeds of the elite class "Selecta-302" were purchased in the amount of 96 thousand US dollars (1 ton – 1600 US dollars).

15 seed crops specified in this decision (no. VM-105) were planted on an area of 676 hectares of the farm. It can be seen that under the harvest of 2025, 1,100 tons of high-quality soybean seeds will be produced in our republic, as well as almost 1 million tons. An import duty in the amount of US dollars is charged.

On the recommendation of field scientists from the Institute of Microbiology of Kazakhstan, 3,700 kilograms of the biological preparation "Rizovit" were obtained and capsule sowing was carried out [1].

As a result, there will be significant savings in foreign currency due to a reduction in imports of vegetable oil.

## METHODOLOGY OF THE EXPERIMENT

To date, soy is processed only in creameries and chicken feed is produced. However, after high-tech industrial processing of soybeans, protein products can be obtained. The solution to these problems was found with the aim of rational use of soybeans grown locally.

Soy flour and its textural forms (soy protein isolate and hydrolysate) can be used as a component of mixed recipes, such as sausages, meat and fish semi-finished products, culinary products.

The following processed soy products are used in food: soy oil, fermented soy products, soy milk and products based on it (miso, tofu, ice cream, mayonnaise).

Soybeans also contain valuable components: lecithin and fructose, which are used in the production of a wide range of products.

In recent years, the presence of biologically active compounds belonging to the group of phytoestrogens - isoflavones and lignans - in leguminous products (in particular, soybeans) has attracted attention.

Lignans (enterodiol and enterolactone) have similar biological activity, but unlike isoflavones, they are found in cereals such as oats, barley, rice, flax seeds, some berries, strawberries, vegetables and fruits: apples, carrots, pomegranates, spinach, drinks such as tea, beer, are also present in coffee and therefore are considered the main phytoestrogens of the diet [4].

All stages of the vital activity of the cell and the organism as a whole proceed with the integral participation of proteins. The largest group of protein molecules acts as a highly specialized catalyst for all chemical reactions and energy metabolism of a substance. As enzymes, proteins are involved in various chemical and photochemical intracellular and intercellular metabolic processes. At the same time, it is not a separate protein that works, but a complex self-governing semi-formal system [5].

Proteins are present in systems that convert light energy into chemical energy and vice versa. Thus, this is the only class of compounds whose molecules have the ability to mutually convert almost all types of energy. Proteins have a number of properties that have a certain effect on the conduct of technological processes during processing. The uniqueness and universality of the use of soy is determined by its chemical composition: the composition of organic and inorganic substances in seeds and green mass.

Soybeans absorb solar energy more efficiently and quickly than other crops. This is due to its high protein content.

Soy proteins are slightly lower in nutritional value than beef proteins, and are equal to milk proteins [5].

## RESULTS AND DISCUSSION

World practice has recognized that soy protein is the most high-quality, widespread and cheap source of vegetable protein. The ratio of protein substances to non-protein substances in potatoes is 1:10, in cereals - 1:6-7, and in soybeans reaches 1:2.

A characteristic feature of soybeans that distinguishes it from field crops is the high content of protein and fat at the same time. The protein content in soybean seeds ranges from 27 to 68%.

Unlike most plant proteins, soy proteins are complete and provide humans and animals with all the amino acids that play the role of building material in the process of cell development and metabolism in the body. In terms of their qualities, they are closest to meat, egg and milk proteins. Thus, the content of lysine, which is the most important and deficient part of proteins in the diet, in the best wheat flour is only 2.5 g per 1 kg, and in soy flour - 27. A person's daily need for lysine cannot be filled. in any case, about 5 g. Soy is the only crop whose consumption in small quantities (150-260 g) allows you to meet the daily need for all amino acids in the absence of other protein sources in the diet.

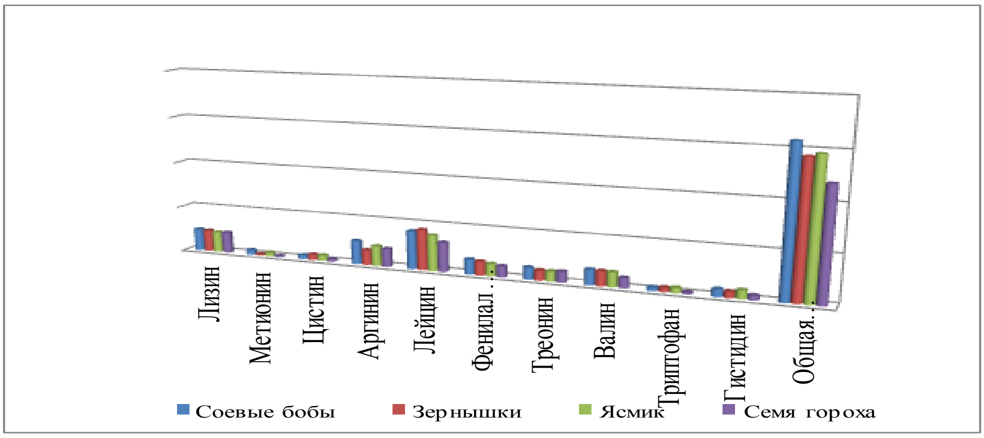


Fig.1. The amount of essential amino acids in leguminous seeds, g/kg of dry matter

Proteins have a number of properties that have a certain effect on the conduct of technological processes during processing.

These features cannot be ignored, as they open up great opportunities for improving technologies and increasing types of products.

Such properties of soy proteins include:

*Hydration.* Under normal conditions, proteins can hold two to three times more water. The ability of proteins to swell plays an important role in food technology.

*Denaturation.* The change in the spatial orientation of a protein molecule with an increase in temperature under the influence of mechanical, chemical and other factors. It plays an important role in technological processes related to the formation of structural systems of semi-finished and finished food products

.

## CONCLUSIONS

In conclusion, we can say that in the near future, with the further expansion of the volume of research and development work in this area will be strengthened. Integration ties and joint work between employees of practical manufacturing enterprises and theoretical scientists will expand

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# THE USEFULNESS OF FISH PRODUCTS FOR THE HUMAN BODY

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***Abstract***

*Fish products are excellent food in terms of protein, vitamin D and trace elements (even in small amounts, which are very important for the human body). The minerals contained in it, such as phosphorus, sulfur and vanadium, ensure human growth and tissue development. This article presents the results of the analysis for the determination of fat-soluble vitamins A, D, E of fish oil and fish products. Photocolorimetric and chromatographic methods were used in the analysis. As a result of the study, the fatty acid composition of fish oil was obtained.*

***Keywords:*** *omega-3, fish, fatty acid, nutrients, polyunsaturated fatty acids.*

## INTRODUCTION

The reason why fish is an important source of nutrients is that it provides the body with essential nutrients and reduces the risk of various diseases. For example, it is known that regular consumption of fish, because it contains omega-3, serves as a protective shield of the body, reduces the risk of heart disease and strengthens the immune system [2].

On the other hand, fish meat promotes the formation of healthy teeth and gums, helps to lighten the complexion and healthy hair growth, and also provides decent protection against bacterial infections. It is also important to prevent a heart attack and has a great impact on maintaining the rhythm of cholesterol levels in the blood. It also has the ability to charge the body with energy, helping it to break down starch and fats. On the other hand, it has a good effect on mental activity. If the required amount of vitamin D and other minerals in fish is not consumed in the required amount, diseases such as rickets (bone mortality), diseases of the teeth and gums and thyroid gland may occur.

## METHODOLOGY OF THE EXPERIMENT

**Methods for the determination of fat-soluble vitamins A, D, E.**

This method uses international standards and current state standards GOST 32043-2012. Based on the requirements of these standards, which will be supplemented and improved by the end of 2018, the amount of vitamins A, D, E contained in agricultural products, food products and animal husbandry will be determined.

The methods are carried out in accordance with the requirements of the above regulatory documents of scientific research, as well as in the laboratories of oil companies. A more realistic analysis begins when the colorimetric state of the solvents reaches 4-6 green units. The solvent concentration can be restored by mixing with a chloroform solution. If necessary, maintaining the amount of trichloride by doubling or tripling the amount of colorimetric solvent. When determining the amount of vitamin A in the amount of A (X1) grams, the amount of 1 g of the product is determined by the following formula:

$$x = \frac{\mathrm{a}.V\ .20\ .125}{\mathrm{m}.1000} \tag{1}$$

Where: a is the number of green units determined based on colorimetry;

V - amount of chloroform solution, cm $^3$;

m - size, g;

20.125} - recalculation of the vitamin A coefficient;

recalculation of the vitamin A coefficient.

The amount of vitamin A (X2) in 1 g of the product in an international unit is determined by the following formula:

$$x = \frac{\mathrm{a}.V\ .20\ .125}{1000.0,3.\mathrm{m}} \tag{2}$$

It contains: 0.3 - vitamin A g. Convert a unit of quantity to a unit of the number of coefficients.

The remaining indicators are determined similarly.

**Colorimetry on an electrophotocolorimeter.**

When determining vitamin A by electrophotocolorimetric method, the following requirements must be observed:

- Providing measurement (reporting) for 5-10 seconds;

- To describe good results, the correct calculation of the calculated concentration of vitamin A in the proportion;

- Ensuring maximum permeability of 620 mg from a monochromatic light filter;

- The presence of a well-tuned galvanometer that allows you to make short digressions;

- - The presence of tubes with an inner diameter of 1 cm made of homogeneous (colored) colorless glass.

Photoelectric colorimeters of the Shibalov type and VNIVI KFE-1 are currently used when performing analytical work in accordance with these requirements. The vitamin A product contained in the analyzed product is dissolved in chloroform. The specified liquid containing the resulting product must contain 100 units of vitamin A per cm3.

After them, the reports put on the galvanometer from the color reactions formed as a result of 5-6 divisions should be on the galvanometer in 40-65 divisions of the scale ($\sum$ = 0,22 - 0,45).

To perform the analysis, it is necessary to prepare a solution consisting of three substances, acetonitrile 42: 50: 8, propyl alcohol and distilled water for chromatography and analysis in accordance with the requirements of GOST 32043-2012. Then 500 cm$^3$ of propyl alcohol, 450 cm3 of acetonitrile and 80 cm$^3$ of distilled water are added to a container (test tube or flask) with a capacity of 1000 cm$^3$. The solution stored for one month is thoroughly mixed for a second analysis, and to find a quiet zero point, removing air from it, the mixture is poured into 20-30 free volumes, 2 syringes per full volume, first a pumping chromatograph. 50 m$^3$/min, then 100 m$^3$/min will be sent. We continue to wash the speaker until we find a quiet zero point. After washing the column, we begin to saturate it with vitamins A and E. To saturate the column, we send a working solution of 7-10 concentrated (working) graduated volumes and determine the peak. Until we find the value and the difference in 3%.

**Preparation of a solution for the extraction of vitamins A, E.**

To prepare a two-component extractant (solvent), pipette a mixture of isopropyl alcohol and distilled water in a volume of 97:3 into a flask per 1000 cm$^3$ using a pipette of 30 cm$^3$ distilled water and pour the remainder with isopropyl alcohol to the point it reaches. not limited to the container.

For a full-fledged experiment, it is necessary to prepare a solution of absolute alcohol. To prepare it, add 500 $cm^3$ of lysine (30 + /-) g of calcium oxide, 250 $cm^3$ of ethanol and boil, refrigerate for 6-8 hours. Then, ethanol is boiled (distilled) at a temperature of 64.70 ℃.

**Determination of copies of mass standards of vitamin A concentration.**

From a standard copy of vitamin A (0,100 +/- 0,002 ) G. By measuring, we prepare a mixture of absolute alcohol in a flask with a capacity of 50 $cm^3$. Pour the mixture of absolute alcohol into the specified point of the flask. 1-2 $cm^3$ of the resulting mixture into a flask with a capacity of 50 $cm^3$, fill part of the flask to the specified point with absolute alcohol and measure the optical density. solution in a spectrophotometer with a wavelength of 326 nm with a layer thickness of 1 cm. A, X g / $cm^3$ Determine the amount of vitamin concentration by the following formula

(3)

$$x = \frac{D.V.V.p}{\text{m.v.100.1550}}$$

here: D-A, e.o. optical density of vitamin in solution;

$V_{1-}$ the initial volume of the standard sample of the mixture in vitamin A, $cm^3$;

$V_{2-}$ the final volume of a standard sample of a mixture with vitamin A, $cm^3$;

P – the density of the standard sample of vitamin A, g / cm $^3$;

m – weight of a standard sample of vitamin A, g.

V – The amount of vitamin A spent on the preparation of the solution, cm $^3$;

100 – conversion factor;

1550 - this is the amount of E14 in absolute alcohol in a 100% vitamin A solution with an absorption capacity of 326 nm.

The amount of vitamin A in 1 cm3 according to GOST 32043-2012: 0.0310-0.0378g (90000-110000 IU); 0.0619-0.0757 g (180000-220000 ME); 0.0774-0.0946 g (225000-275000ME). The results obtained are used to calculate the amount of vitamin A in a standard solution.

**Preparation of liquid chromatography for processing.**

Preparation for chromatography is carried out on the basis of regulatory documents for equipment intended for use. Before starting work, the chromatogram is heated for 15 minutes. Before starting work, the pump is filled with a solution (eluent).The specific ratio of a mixture of hexane and ethanol 99.5: 0.5 is determined as the moving phase. This is done using a light filter with a wavelength of 289 nm. The diagram is removed by straightening the drawing tape to 0.3-0.6 cm / min. The column should show a stable zero line after washing the mixture. To increase the sensitivity and accuracy of each chromatograph, the optimal mode for each chromatography is selected.To fill the columns, it is necessary to add a solution prepared at the request of the standard 7-10 times and determine its peak. After determining the constant point, work can begin: from 3 to 20 $mm^3$ of the analyzed liquid and a standard solution of vitamins A and E. are sequentially injected into the column. We obtain a chromatogram of a photometric detector with a wavelength of 289 nm. Then we install a light filter with a working wavelength of 254 nm, in this case we get a chromatogram of the standard vitamin D2 solution and the analyzed solution. The distance between the peaks is shown by a line. The high value of the analyzed vitamins is used to determine the number of standard samples of vitamins A, D in units of optical density or in millimeters.

Based on the above requirements and regulatory documents, fish oil with vitamins A, D, E and Omega-3 and Omega-6 semi-unsaturated fatty acids was obtained in laboratory conditions at the Department of Food Technology of the Fergana Polytechnic Institute and analyzed at the Institute of Materials Chemistry of the Academy of Sciences of the Republic of Uzbekistan. The results of this analysis are attached below.

**Fish oil analysis results**

Samples: #1 – Unrefined fish oil

No. 2 – Purified fish oil

The composition of fatty acids determined by gas-liquid chromatography is presented in the following table

Table 1. Composition of fatty acids determined by gas-liquid chromatography

| № | Fatty acid | Content,% | |
|---|---|---|---|
| | | №1 | №2 |
| 1. | Lauric acid 12:0 | 0,24 | 0,06 |
| 2. | Myristic 14:0 | 3,96 | 1,53 |
| 3. | Myristolein 14:1 | 0,25 | 0,08 |
| 4. | Pentadecane 15:0 | 0,95 | 0,25 |
| 5. | Pentadecene 15:1 | 0,19 | 0,23 |
| 6. | Palmitic 16:0 | 25,78 | 23,46 |

| | | | |
|---|---|---|---|
| 7. | Palmitoleic acid 16:1 | 16,74 | 10,17 |
| 8. | Margarine 17:0 | 0,81 | 0,33 |
| 9. | Stearic 18:0 | 3,58 | 4,05 |
| 10. | Oleic acid 18:1 ω9 | 41,66 | 49,55 |
| 11. | Linoleic 18:2 ω6 | 3,10 | 9,27 |
| 12. | Linolenic 18:3 ω3 | 1,36 | 0,76 |
| 13. | Stearic 18:4 ω3 | 0,68 | 0,12 |
| 14. | Arachin 20:0 | 0,25 | 0,10 |
| 15. | Eicosene 20:1 | 0,45 | 0,04 |
| | $\sum_{\text{saturated LCD}}$ | 35,57 | 29,78 |
| | $\sum_{\text{monoene LCD}}$ | 59,29 | 60,07 |
| | $\sum_{\text{polyene LCD}}$ ω3 and ω6 with 18 carbon atoms | 5,14 | 10,15 |

## CONCLUSIONS

In conclusion, it should be noted that using the results of the work in practice, it serves to form healthy teeth and gums, helps to lighten the complexion and healthy hair growth, and also provides decent protection from bacterial infections. It is also important to prevent a heart attack and has a great impact on maintaining the rhythm of cholesterol levels in the blood. The obtained results on the composition of fatty acids indicate that the presented fish oil samples contain essential (vital) fatty acids in the range of 5.14 – 10.15% of the amount of fatty acids.

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# ECOLOGICAL EFFICIENCY OF COTTON MEAL PROCESSING

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***Abstract***

*Studies have been carried out and new data have been obtained on hydrodynamics and heat exchange under fluidization conditions when hydrodynamically active jets are applied in a wide range of changes in the humidity of the material, temperature and velocity of the coolant of the general flow and jet. A method for drying wet granules in an energetically efficient region and at a temperature difference between the total coolant flow and the jet within 60-80 ° C. is proposed. A waste-free and energy-efficient technology for obtaining enriched, improved quality and granulometric composition of meal granules, including a high-speed granulator and a jet fluidized bed dryer, is proposed. An ecological analysis of the proposed technology has been carried out and it has been established that this technology makes it possible to eliminate environmental pollution and the loss of valuable oil-containing raw materials.*

***Keywords:*** *cotton meal, hydrodynamics, heat exchange, drying, temperature, coolant, fluidized bed jet, jet. dryer.*

## INTRODUCTION

Cotton meal is a product of processing cotton seeds, is a valuable feed product for animal husbandry. The main indicator of cotton meal as a feed product is the content of soluble protein substances in it. The protein content in the meal depends on the amount of husk in the mint entering the pressing, and the soluble proteins depend on the thermal effect on the protein during the oil production process. There is already reliable information about changes in the proteins of oilseeds in the process of drying seeds, frying mint, pressing pulp and distilling solvent from the meal [1]. It should be emphasized that the loose meal obtained at oil-producing enterprises is not a full-fledged compound feed, because the extractant contained in it worsens the nutritional properties. In addition, the presence of an extractant creates an explosive and fire-hazardous mixture of its vapors with air, which often leads to a fire or explosion of warehouses of oil-producing enterprises.

It is known that drying is one of the most energy-intensive processes; therefore, in the field of drying technology, saving energy resources is always an urgent problem.

It is known that the creation of highly efficient and economical drying machines will significantly reduce the energy intensity of the drying process [2].

In recent years, dryers with active hydrodynamic modes have been increasingly used. Processing of polydisperse materials in the field of centrifugal forces is one of the ways to intensify the heat and mass exchange of the dispersed phase with the coolant [3]. A measure of the activity of the hydrodynamic regime is a complex indicator that takes into account the technological efficiency of the application of this regime and the efficiency of the entire technological process [4].

## METHODOLOGY OF THE EXPERIMENT

It is known that the granulometric composition of the initial meal is of poor quality and does not meet the requirements of the standard for humidity, grain composition, nutritional properties and presentation. As can be seen from the figure, the main share (74%) is fractions up to 5 mm, and fractions of 5-10 mm account for 1/4 part (24%), and accordingly, the fraction of 10-15mm is only 2% of the total mass of the material. It is especially necessary to emphasize the large amount of fine fraction (1/5 part), which creates difficulties in production, during transportation and spraying – pollutes the territory of the enterprise and nearby areas with meal dust. In addition, irretrievable losses of oil-containing particles often occur with this fraction during the spraying process.

The jet fluidized bed dryer is designed for granular and hard-to-loose materials, in particular, for cotton meal granules obtained by high-speed granulation in a turbolast apparatus.

The dryer consists of a cylindrical body with a jacket for feeding flat jets into the material layer. The wet material is loaded through the nozzle "A", which is located in the upper part of the housing.

Two gas distribution grids are installed for uniform distribution of the coolant introduced into the apparatus. The grate has a live cross-section of 25-30%, and the second one, for the convenience of unloading the dried material, is installed at a slight angle (up to 5o) of inclination and has a live cross-section of 6-7%.

A characteristic feature of the proposed dryer is that it provides homogeneous fluidization, and also gives the granule layer a circulation movement. In other words, the particles perform not only reciprocating, but also rotational motion.

The use of flat, hydrodynamically active jets with a relatively high temperature (compared to the general flow "D") leads to a reduction in energy costs by 10-20%. This factor is due to the fact that steady fluidization of cotton meal granules with the imposition of flat jets occurs at fluidization numbers Kw 1,8.

Depending on the degree of flowability of the source material, from 2 to 6 swirlers for flat jets are installed in the cylindrical housing.

The principle of operation of the jet fluidized bed dryer is as follows: wet pellets of cotton meal are introduced through the loading nozzle "A" into the working area of the cylindrical housing and fed to the gas distribution grid.

Here, the source material interacts with the coolant flow, which is fed through the pipes "B" and "D". At an effective coolant velocity corresponding to the fluidization number $Kw_w \leq 1{,}8$, a state of stable fluidization occurs. If you increase the speed of the coolant further, then the destruction of stable fluidization occurs and the entrainment of particles and a smaller fraction begins

This phenomenon of a jet-fluidized bed can be used to classify a layer of bulk materials consisting of particles of various sizes. Then, a smaller fraction will be carried away from the branch pipe "G".

The drying process of wet meal granules is carried out to the final humidity, numerically equal to U = 6÷8%. In order to avoid overspending of the coolant, the drying process is carried out at a layer temperature of 80-85°C, and the temperature difference between the total flow and the jets is 60-80° C.

Jet fluidization is often subjected to materials that have particles of different densities and geometric sizes in their composition. It is known that in such devices there are simultaneously the phenomenon of mixing and segregation of particles. The combination of both phenomena leads to the intensification of the process of heat treatment of wet materials. In addition, the correct organization of the circulation of the entire layer always determines the successful solution of the drying process. And the most successful is the organized, controlled circulation of the entire volume of material. This is achieved under conditions of jet fluidization using hydrodynamic flat jets. This is especially important when operating industrial dryers with a fluidized bed. In such devices, a new portion of wet material is introduced at various points and quickly, efficiently mixed with the material that is already in the layer and subjected to heat treatment.

## RESULTS AND DISCUSSION

Advantages of the jet fluidized bed Dryer:

- high efficiency of mixing the particles of the layer, i.e. reciprocating and circulating movement of particles is carried out simultaneously;

- the process of liquefaction of the material occurs at fluidization numbers $Kw_w \leq 1{,}8$;

- the dryer is structurally simple and technologically advanced, and most importantly adapted to the conditions of machine-building enterprises of the Republic of Uzbekistan;

- very low operating costs and high reliability due to the absence of mechanically rubbing parts and assemblies;

- the conditions for washing particles with a coolant are close to ideal, due to the organization of the movement of particles not only in the reciprocating direction, but also in their rotational motion.

The creation of efficient and waste-free technologies for processing agricultural products in order to maximize their use, while ensuring environmental integrity, remains an urgent problem to this day.

The existing technology of processing cotton seeds does not quite meet the above requirements, i.e. it is morally and physically outdated. In addition, it is energy-intensive, multi-stage, and the resulting products do not meet the increased requirements of modernity. In particular, the cake conditioning department includes operations:

- distillation of extraction gasoline;
- temperature and humidity conditioning;
- transportation to the warehouse.

The hardware design of three operations is carried out by 8 units of equipment.

The proposed technology includes operations:

- high-speed granulation and enrichment;
- heat treatment of wet pellets;
- packaging.

The hardware design of 3 operations according to the proposed technology will be carried out by 4 units of equipment.

It should be particularly noted that according to the existing technology, the commercial meal has a granulometric composition from fine to particles of 15 mm in size. As a result of such a spread in size, small, oil-containing particles are sprayed throughout the territory of the oil-producing plant and nearby areas. In addition, the cake obtained after pressing has low nutritional properties, so it belongs to the category of coarse feed.

Another significant disadvantage is the fact that cotton seed meal has a high hygroscopicity. This, as is known, leads, both during storage and transportation, to the adsorption of moisture from the air, and consequently, to caking. At the same time, large blocks are formed, making it difficult to transport and unload them.

Advantages of the proposed technology:

- firstly, when organizing the process of enriching cotton meal with food industry waste, the nutritional value of the feed unit increases;

- secondly, cotton meal from the category of coarse feed goes into the category of compound feed;

- thirdly, due to high-speed granulation, the presentation improves to the requirements of the world standard for such goods;

- fourth, the traceability of the product is eliminated and it becomes possible to pack it in bags or other containers;

- fifthly, and most importantly, the fine fraction disappears from the composition of the meal, because during granulation this fraction is compacted and is part of the granule as a binding component;

- sixth, the spread of dust-like, oil-containing particles into the environment is eliminated.

In addition to the above advantages, the proposed technology will eliminate irretrievable losses of oil-containing raw materials.

## CONCLUSION

In conclusion, it should be noted that using the results of the work in practice, it is possible to improve the quality and presentation of cotton meal, increasing its competitiveness in the global feed market. A critical analysis of the results allows us to conclude about the economic and environmental efficiency of the proposed technology for processing cotton meal.

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# ALKALINE AND ADSORPTION PURIFICATION OF SOYBEAN OIL MICELLES

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***Abstract***

*The main purpose of cleaning with bleaching earth is the removal of coloring substances. Currently, adsorbents are used to remove phosphatides, free fatty acids, pesticides, metal oxides and oxidation products. In this paper, the technology of adsorption purification of soybean oil with activated carbon in an alkaline-urea medium is investigated. Earthen adsorbents of regular structure are widely used in production. Soil minerals are divided into three main groups: complex minerals – expansive variety, layered – striped materials. The mineral montmorillanite is the main mineral in bentonite and bleaching soils (humbrine, ascanite). The group of siliceous soils includes - diatomites, trepels, opokas. Earthy materials are used in the separation of additives, which involves the separation of dyes in a liquid medium. Hence the name "bleaching soil". Bleaching earths are used in the oil refining industry for purification, regeneration and clarification of refined lubricating oils, transformer and similar oils.*

***Keyword:****Adsorbent, free fatty acids, cottonseed oil, phosphatides, gossypol, alkali, pesticides,soybean oil, mistellasols of heavy metals.*

## INTRODUCTION

Until the late 1970s, the main purpose of cleaning edible oils with bleaching clay was to remove coloring substances. Currently, adsorbents are used to remove phosphatides, free fatty acids, pesticides, metal oxides and oxidation products. In this paper, the technology of adsorption purification with activated carbon of cottonseed oil in an alkaline-urea medium is investigated. It contains scientific and practical recommendations for improving the quality of cottonseed oil and reducing losses. The recommended technology is the purification of cottonseed oil from toxic substances (gossypol, pesticides, heavy metal salts) and with refining technology. that is, reducing the amount of losses in the processes of washing and drying of neutralized oil. When cleaning cottonseed oil, it has been studied that the use of bleaching earth in vacuum conditions is effective in cleaning cottonseed oil. An increase in the duration of bleaching reduces the amount of perkis and the temperature of the formation of corpuscles, increases the yellow color of cottonseed oil, and after the third bleaching, more blue and pink color begins to appear.

## METHODOLOGY OF THE EXPERIMENT

Good results in the bleaching of cottonseed oil were obtained with two-stage bleaching using bleaching clay, in which 3 and 2% of bleaching clay was processed during the first and second technological operations. The authors studied adsorption purification of cottonseed oil, alkaline refining, removal of pesticides from the oil, improvement of its color and improvement of quality as feed oil. The polyphase sorbent used can be successfully used for analytical control of the content of pesticides isolated from cottonseed oil based on UJ.Another method of cleaning cottonseed oil is proposed. This method includes: neutralization with alkaline substances and adsorption purification. The polyphase sorbent used can be successfully used for analytical control of the content of pesticides isolated from cottonseed oil based on UJ.Another method of cleaning cottonseed oil is proposed. This method includes: neutralization with alkaline substances and adsorption purification. The polyphase sorbent used can be successfully used for analytical control of the content of pesticides isolated from cottonseed oil based on UJ.Another method of cleaning cottonseed oil is proposed. This method includes: neutralization with alkaline substances and adsorption purification.

Silica gel was used as an adsorbent in a radius of 75-100 A in order to improve the quality of the oil and increase its yield by reducing the acid number and color of cottonseed oil. Adsorption purification was carried out in oil-silica gel ratios of 4:1 and 250:1. For example, in a ratio of 2:1 of primary fuel oil, prepress and extraction oil (the acid number is 30 mg KOH and the color is not determined in a thickness of 1 cm) was neutralized with an alkali solution with an excess alkali content of 20%, the alkali consumption is 25 kg /t and concentrations of 400 g/l. The resulting mistletoe oil of 50% (thickness 13.5 cm) with 55 red units is passed through the column through an adsorbent with a ratio of 1:4. The speed of Mistella passage through the adsorbent of the ASKG brand is 75 A on the average radius. The adsorption temperature is 25 ° C.

After a single adsorption cleaning, the color of the miscella is 20 red units in terms of oil. After the second adsorption treatment, the color of the oil (13.5 cm thick) was 20 red units. The yield of refined oil is 75%. The results of a study on the alkaline neutralization of cottonseed oil have shown that the effective replacement of scarce and expensive sodium hydroxide with a solution of sodium aluminate. In order to replace part of the sodium hydroxide with a solution of sodium aluminate and obtain a high-quality product, cottonseed oil was gradually refined with solutions of sodium aluminate and sodium hydroxide.

They conducted a study to accelerate the technological process by reducing the duration of processing of cottonseed oil, increasing the yield and quality of refined oil [1]. This issue is solved by treating solutions of aluminate and sodium hydroxide used in the technology of two-stage purification of cottonseed oil in an electromagnetic field with a strength of 0.4-2.8 A / m. When refining raw cottonseed oil with an alkaline solution treated with an electromagnetic field, it was found that the quality of refined oil, its nutritional value increases, and the consumption of alkaline solution decreases.

They studied the effect of temperature on the absorption of pigment and phospholipids in the process of adsorption purification of mistletoe soybean oil [2]. Refining was carried out before distillation of mistella, i.e. at 16% mistella. From the analysis of the results obtained, it is known that the absorption of carotenoids and chlorophylls in the adsorbent obeys Freundlich's law. It was found that the level of absorption of pigments increased from 20°C to 45°C, and a further increase in temperature did not have a positive effect on the absorption of carotenoids and chlorophylls. The degree of absorption of phospholipids increases with a temperature from 20°C to 70 °C, and the most intense level of absorption is observed at a temperature of 40°C. Losses of phosphorus-containing substances when taking adsorbent in relation to the mass of 1% oil, 10% at 38°C. Of these, 15% is phosphatidylcholine and 20% is phosphatidylethanolamine.

When studying the mycelium of koya oil, the formation of tocoreds (pigments that give a pure color) in the oil is observed. They said that when soybean oil is obtained by tocopherol extraction, the concentration of tocopherols in soybean oil decreases, and the amount of oxidized tocopherols increases with increasing moisture content of soybean seeds [3]. Oxidized tocopherols are substances that do not have activated vitamin properties, which include dimers (5–g-tocopherocone-g-tocopherol) and tocoreds (2, 7, 8- trimethyl- 2 chromane 15,6 - quinone). Of these, the tocored is a transparent red substance that has a sufficient effect on the color of soybean oil. With an increase in the amount of adsorbent, a significant decrease in the total amount of tocopherols is observed. they said that the concentration of γ-tocopherols decreased the most. Due to the very low absorption of g-tocoreds, the color of soybean oil micelles remained red even after adsorption purification. Mistella obtained from soybean seeds with a moisture content of 8-11% was purified by adsorption refining.

Scientists have established the reducing effect of the sorbent in the processing of soybean oil [4]. Their equilibrium between the other pigments in the solvent to some extent obeys the formula of the Freundlich isotherm.

$$a = KCH \qquad (1)$$

The adsorption unit can be determined from the following inequality.

$$a = \frac{co - c}{м} \qquad (2)$$

The 1st and 2nd inequalities can be applied to individual pigments and their mixtures.

In the analysis of inequality 1, the sorption volume of the sorbent decreases when the concentration of one standard is reduced to a smaller unit. It follows that if the process is carried out in stages, then the sorption volume of the sorbent can be increased.

With step-by-step bleaching, good utilization of the sorbent and the possibility of reuse of the used soil is achieved.

Soybean oil was bleached from 55 mg of iodine to 12 mg of iodine with Czech bleaching clay at the Khabarovsk Creamery. The sorbent yield was calculated by the inequality $\alpha = 7{,}74\sigma0{,}52$.This is the color of the oil 100 g was calculated in milligrams of iodine per oil.

## RESULTS AND DISCUSSION

The results of the study show that it is preferable to use a two-stage bleaching method.

They were engaged in the process of adsorption of neutralized micelles of cottonseed oil. They recommended replacing the AKG grade silica gel, which is considered rare, used in the purification of cotton oil by mistella, with a rare KSKG grade silica gel, which is used in the purification of transformer oil. They crushed silica gel of the KSKG brand and carried out adsorption purification of cotton oil micelles. To determine them, silica gel in 0.5-1.0 mm is used. It was shown that cottonseed oil has the greatest bleaching ability when it was finely ground and purified from the mistella of cottonseed oil. During the regeneration of the used silica gels ASKG and KSKG by oxidation, their bleaching ability is practically preserved.

The processes of removing residual soapstock from the miscella formed during alkaline purification of the miscella from cottonseed oil have been studied. As a result of the experiments carried out, it was found that it is impossible to completely remove the soapstock residues contained in the neutralized mistella cottonseed oil by washing with water. They say that the residual amounts of soapstock in the neutralized mistella from cottonseed oil can be completely removed using 1.25% by weight of oil in mistella, bleaching earth. To completely remove the soapstock from it, you can use an aqueous solution of 1% citric acid, which is neutralized by mistella. To do this, the amount of citric acid should be 200-250% compared to the theoretical one, the mixing time is 20 minutes, the temperature is 50-60$^0$C.

The following authors investigated the mistella purification process of vegetable oils with a high content of free fatty acids using isopropyl alcohol and, having recorded the technology of this process and the technological equipment used, found that there is a feature of selective dissolution of isopropyl alcohol.

## CONCLUSION

Therefore, it is important to create efficient and easy-to-use methods for processing crude oil. Currently, the processing methods used in industry show a decrease in efficiency (up to 80-85%) in the purification of oils obtained from low-quality oilseeds. The main reason for this is the use of high-concentration alkali in large quantities (up to 18 kg/t) to obtain a density-structured soapstock. If we develop technologies that improve the adsorption of gossypol derivatives on soapstock particles that easily separate soapstock, losses can be significantly reduced.

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