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Диханбаева Ф.ТАбжанова Ш.А., Сыздыкова Л.С., Рскелдиев Б.А. Сапарәлі Н., Хажимукан А.
Expansion of assortment of meat products for heroin production
Summary. The article presents recipes for new types of meatballs with increased food and biological value - meat semi-finished products with plant raw materials for gerodietic nutrition.As a result of research in order to increase the biological value of new types of cutlets, the use of wheat bread in the recipe is replaced with pumpkin powder, buckwheat and oatmeal.
Key words: geodetic nutrition, meat products, cereals, vegetable raw materials, supplements, nutritional value.

Диханбаева Ф.Т., Абжанова Ш.А. Сыздыкова Л.С. Рскелдиев Б.А. Сапарали Н. Хажимукан А.
Расширение ассортимента мясных продуктов для геродинтического производства
Резюме. В статье представлены рецептуры новых видов котлет повышенной пищевой и биологической ценностью - мясных полуфабрикатов с растительным сырьем для геродиетического питания. В результате исследования в целях повышения биологической ценности новых видов котлет использование пшеничного хлеба в рецептуре заменено тыквенным порошком, гречневой и овсяной мукой.
Ключевые слова: геодиетическое питание, мясные продукуты, крупы, растительное сырье, добавки, пищевая ценность.

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COMPUTER SIMULATION OF THE BREAKUP, DISPERSION AND EVAPORATION PROCESSES OF LIQUID HYDROCARBON FUELS' DROPLETS

Abstract. This article is devoted to the study of breakup, dispersion and evaporation of drops of two types of liquid fuels. The octane and dodecane were used as liquid fuels in the researches. There was also constructed the model of the combustion chamber in a cylinder form. During the numerical simulation has been determined optimum combustion mode for two types of liquid fuel. Optimum pressure for octane was 100 bar and for dodecane was 80 bar. Optimal injection mass for octane was 6 mg and for dodecane was 7 mg. Under these optimum values the computational experiments to study of ignition and combustion of octane and dodecane were conducted.
Keywords: combustion, numerical simulation, octane, dodecane, combustion chamber.

One of complex challenges of thermal physics is the numerical study of the combustion of liquid fuels, due to accounting of a large number of complex, interrelated processes and phenomena. Therefore, numerical simulation is becoming vitally important in the area of study of combustion processes and design of different devices, which use combustion process. Undoubtedly, in the future its role will increase. Having opportunity to optimize some experiment on the basis of its virtual prototype making wide distribution of Methods of computing hydrodynamics over the thermal physics. Obviously, in this days all problems arising in aerodynamics and hydrodynamics at the numerical solution of the equations of Navier - Stokes, will be hardly solved. Therefore, due to the dramatic popularity of numerical studies in solving scientific and technical problems, it is necessary to ensure more possibilities of scientific and practical sides of this issue. Methods of mathematical modeling can be the most successful condition to solve practical issues in each subject area.

Improved prospects of wide using of methodology and the specific physical results in considered areas and also paths of more efficient application of methods of mathematical modeling which use the modern computer technology in various subject areas are realized by high level of researches achieved [1]. It is observed that in recent years, produced 60 million cars that is approximately 165,000 cars produced per day, this is the relevance of using of liquid fuels. Nowadays car engines are significantly different from decades ago ones. The main combustion process in engines is the same, but the types of injections are substantially different. For example, modern engines with electronically controlled injection system with air compression mechanism which enhances the combustion process, use only the required amount of fuel [2-4].

Thus, problems of saving energy and improvement of an ecological condition of heat-power object in many respects depend on the organization of high-quality combustion of fuel. However, considering that all available technologies of a fuel-preparation and combustions are practically perfect, but the efficiency and

ecological purity of package boilers in many cases are not well done, consequently, there is a problem of searching of new methods in the field. Simulation of the collapse, dispersion, evaporation and combustion of liquid fuel droplets under different initial conditions is relevant to solve this problems.

Introduction of new technologies requires the considerable expenses, therefore increasing requirements are imposed to methods of projection and working off of equipment. Thus, now, the special attention gets not only creation of efficient physical and mathematical analogs, but also development of new more perfect methods of numerical realization of systems of the subtraction equations describing a convective heat-mass transfer in combustors. Mathematical modelling of combustion of liquid fuels is the complex challenge as it requires the accounting of a large number of the complex interrelated processes and the phenomena such as: multistage chain chemical reactions, transfer of an impulse, heat and weight by a convection, molecular transfer, radiation, turbulence, evaporation of drops of liquid [5].

Size of drops can reach several microns, while the sizes of fuel channels exceed them by several times under atomization of liquid fuel by pneumatic nozzle of the gas-turbine engine. Using uniform grids in describing the collapse of the liquid film on a droplets of various sizes requires correct permission net model of phase boundaries, which leads to unreasonably high computing expenses. Application of a local refinement of grids allows to manage less detailed grids and helps to approach the problem. But there is a question of influence on results of simulation of the dynamic changes of the grid model, associated with the characteristics of airborne-droplet flow instead.

The majority of currents by the nature have turbulent character, a condition of turbulence strongly influences on such parameters of a current as transfer of an impulse, temperatures and concentration of substances in the mixture during the flow motion. In this chapter, the thesis shows the mathematical model describing the burning of liquid fuels on the basis of the equations of conservation of mass (ρ), momentum $(\rho\vec{u})$, energy (E) and concentration (c) [6-8].

$$\frac{\partial\rho}{\partial t} + div(\rho\vec{u}) = S_{mass}, \tag{1}$$

where u - the velocity of the fluid. The source term S_{mass} is a local change of gas density due to evaporation or condensation.

The conservation equation of an impulse of gas has the following appearance:

$$\rho\frac{\partial\vec{u}}{\partial t} + \rho(\vec{u}\cdot grad)\vec{u} = div\vec{\vec{\xi}} + \rho\vec{g} + S_{mom}. \tag{2}$$

$S_{mom} = 0$ for a single-phase flow of gas; S_{mom} is the local rate of change in momentum in the gas phase due to the movement of droplets for two-phase.

Conservation equation of an internal energy:

$$\rho\frac{\partial E}{\partial t} = \vec{\vec{\tau}} : \vec{\vec{D}} - \rho div\vec{u} - div\vec{q} + S_{energy}, \tag{3}$$

where q – the specific heat flux, it is the Fourier law of heat transfer, $\vec{\vec{\tau}} : \vec{\vec{D}}$ is the rate of increase of the internal energy due to viscous dissipation. Source term S_{energy} denotes the contribution to the change of an internal energy due to the presence of atomized liquid or solid phase.

The conservation equation of concentration of a component:

$$\frac{\partial(\rho c_m)}{\partial t} = -\frac{\partial(\rho c_m u_i)}{\partial x_i} + \frac{\partial}{\partial x_i}\left(\rho\cdot D_{c_m}\cdot\frac{\partial c_m}{\partial x_i}\right) + S_{mass}, \tag{4}$$

where ρ_m - a mass density of a component m, ρ - full mass density.

More universal models in engineering calculations of turbulent flows are models with two differential equations. Using in technical flows model with two differential equations [9-11] is the most common. $k-\varepsilon$ is model when two equations for a kinetic energy of turbulence and dissipation rate are solved:

$$\rho\frac{\partial k}{\partial t}+\rho\frac{\partial \bar{u}_j k}{\partial x_j}=\frac{\partial}{\partial x_j}\left[\left(\mu+\frac{\mu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right]\frac{\partial \bar{u}_i}{\partial x_j}+G-\frac{2}{3}\rho k\delta_{ij}\frac{\partial \bar{u}_i}{\partial x_j}-\rho\varepsilon, \quad (5)$$

$$\rho\frac{\partial \varepsilon}{\partial t}+\rho\frac{\partial \bar{u}_j \varepsilon}{\partial x_j}-\frac{\partial}{\partial x_j}\left[\left(\mu+\frac{\mu_t}{\sigma_\varepsilon}\right)\frac{\partial \varepsilon}{\partial x_j}\right]=c_{\varepsilon_1}\frac{\varepsilon}{k}G-\left[\left(\frac{2}{3}c_{\varepsilon_2}-c_{\varepsilon_3}\right)\rho\varepsilon\delta_{ij}\frac{\partial \bar{u}_i}{\partial x_j}\right]-c_{\varepsilon_2}\rho\frac{\varepsilon^2}{k}. \quad (6)$$

This is the standard equation of $k-\varepsilon$. Values, c_{ε_1}, c_{ε_2}, c_{ε_3}, σ_k, σ_ε, are modal constants which are determined from the experiment. Typical values of these constants are commonly used in engineering calculations and are taken from the literature [12-15].

Chemical kinetics of combustion is represented as generalized chemical reactions for the two kinds of fuel - octane and dodecane:

$$2C_8H_{18}+25O_2\rightarrow 16CO_2+18H_2O,$$

$$2C_{12}H_{26}+37O_2\rightarrow 24CO_2+26H_2O,$$

as a result there are the formation of the following combustion products: CO_2 and H_2O.

Model of the combustion chamber in the form of a cylinder which height is 15 cm, diameter is 4 cm. The general view of the combustion chamber is shown in Figure 1. The calculated area consists of 650 cells. Liquid fuel is injected through the nozzle which is located in the lower part of the combustor. The area of the nozzle is equal to $2\cdot 10^{-4}$ см^2. Temperature of walls of the combustion chamber 353 K. Initial temperature of the gas in the combustion chamber 900 K, the fuel is injected at 300 K. Initial radius of injected droplets 25 microns. The angle at which droplets are injected equal 10^0. Combustion chamber pressure is 80 bar, the liquid fuel injection velocity is 250 м/с.

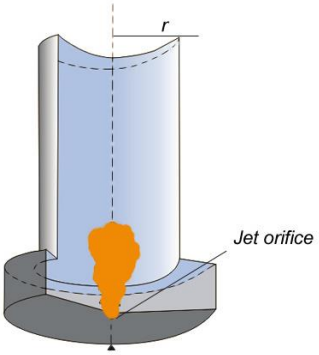


Figure 1. The general view of the combustion chamber

The optimal values of the combustion chamber pressure is 100 bar for octane and 80 bar for dodecan. Overall, it can be concluded that optimal octane mass for injection is 6 mg and 7 mg for dodecane. At this values of the injection mass of liquid fuel temperature reaches the maximum value. Further increase of the injection mass for both octane and dodecane at optimal pressures make worth the combustion process and leads to a further lowering of the temperature

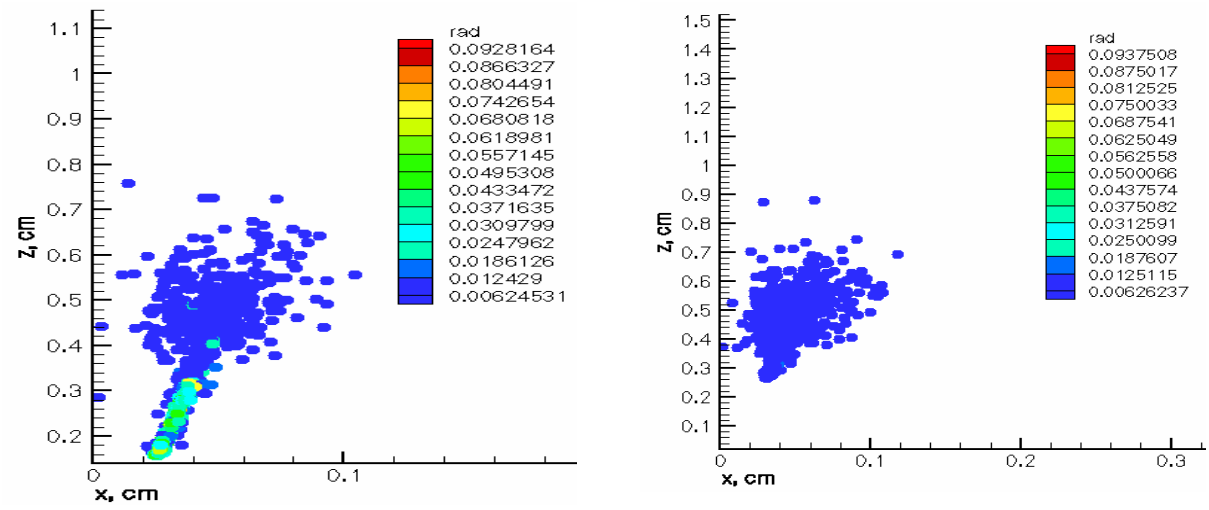
The following figures show the results of numerical simulation of combustion of octane and dodecane in the combustion chamber at the optimal pressure and mass values. Figure 2 shows the distribution of octane droplet by sizes by height of chamber at time t = 2,5 ms. At time t = 2,5 ms octane and dodecane droplets rose to the camera height equal to 0.62 cm and 0.72 cm, respectively. Analyzing the behavior of dodecane it is noticed that it drops rise to a height of 0.72 cm at time t = 2,5 ms, and the droplets sizes slightly larger droplets of octane (Figure 2 b).

Paying attention to distribution of octane and dodecane on radiuses it is possible to notice that dodecane droplets evaporate quickly and the distribution density is higher. Also the size of droplets of octane grows by time. Thus, for example, at the time of 2 ms in the lower part of the chamber located droplets with

a radius of 0.024762 mm. And at this time dodecane droplets with the same sizes completely burned out, and droplets with smaller radiuses move up by chamber height to an exit.

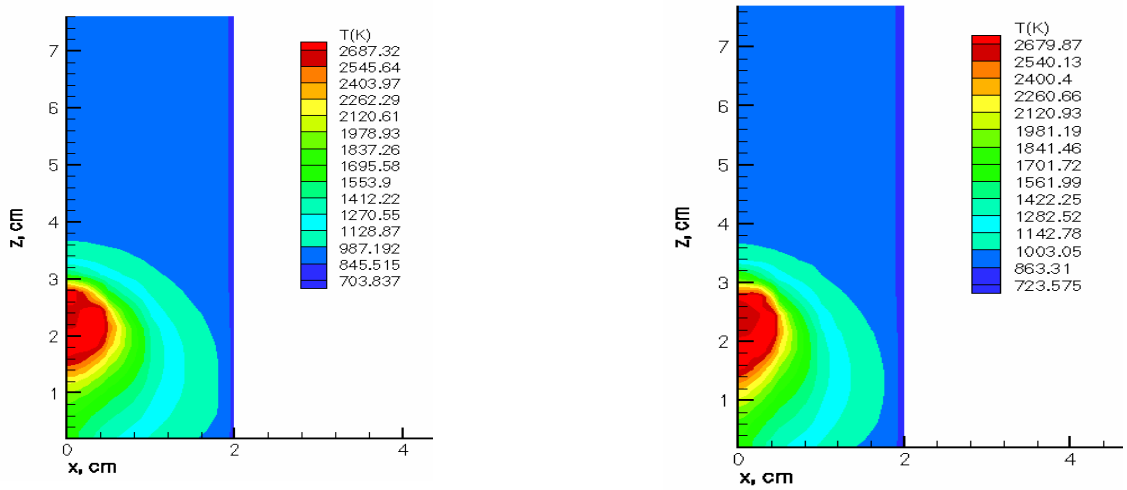
Figure 3 shows the temperature field in the combustion chamber during combustion of octane and dodecane at time t = 2,5 ms. These charts indicates that during the combustion of octane the large part of chamber warmed to 987.192 K, during the dodecane combustion chamber held longest value of the temperature equal to 1003.05 K. At time t = 2,5 ms in the core of temperature flame temperature reaches a value of 2687.32 K during the combustion of octane (Figure 3 a).

During the combustion of dodecane maximum temperature was 2679.87 K, and the temperature of the chamber, except for the zone of plumes reaches 1003.05 K (Figure 3 b). There is following situation for the temperature distribution of two types of fuels: the area covered by the maximum temperature during combustion of both fuels at different points of time almost the same. But during combustion of dodecane temperature of whole volume of chamber hated faster in comparison with octane. Analyzing the data obtained, we can conclude that the process of combustion of octane and dodecane occurs in the gas phase and over the whole volume of the combustion chamber there is a uniform temperature distribution.



a) octane b) dodecane

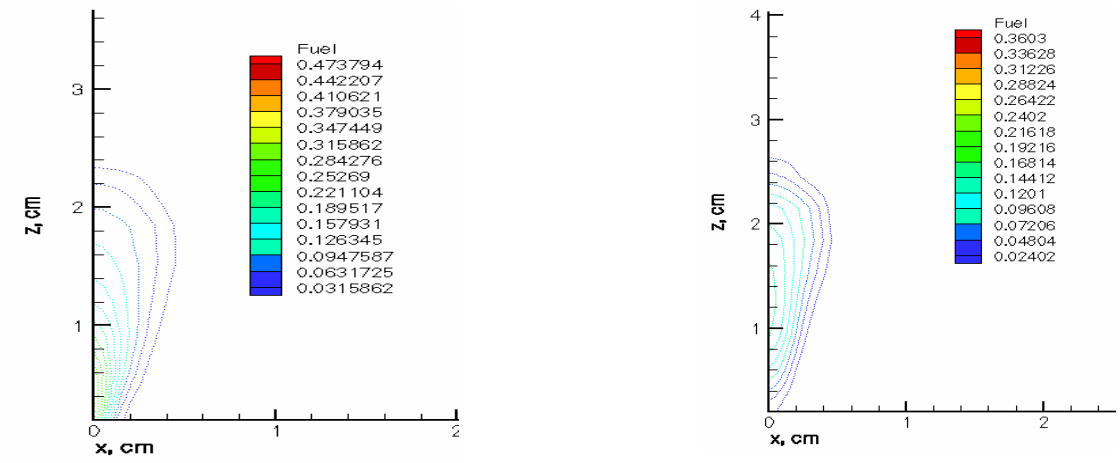
Figure 2. Distribution of droplets of octane and dodecane by radius by height of combustion chamber at time t = 2,5 ms



a) octane b) dodecane

Figure 3. Temperature profiles in the combustion chamber during the combustion of octane and of dodecane at time t = 2,5 ms

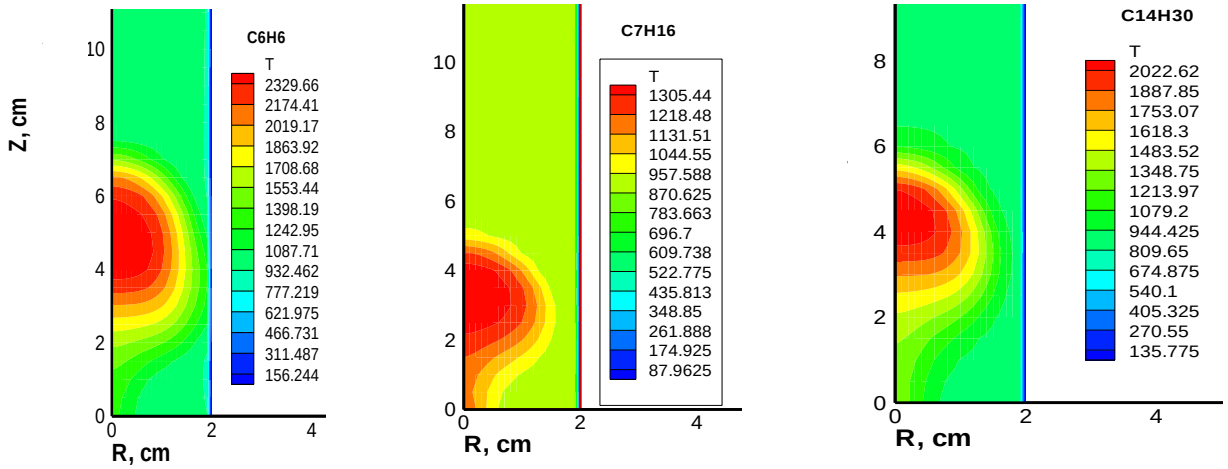
Figure 4 shows field concentration both fuels at different times of combustion. It is observed in the figures, thet the pair of octane and dodecane at time t=2,5 ms have a certain concentration. So, for the octane value of the concentration was 0.0473794 g/g, and for dodecane 0 3603 g/g. In comparison the octane and dodecane it is shown that a pair of both fuels rise to different heights. For example, at time t=2,5 ms pair octane climb chamber height of 2.3 ms, and a pair of dodecane at the same time located at a height of 2.6 cm.



a) octane b) dodecane

Figure 4. Distribution octane and dodecane vapor by height of combustion chamber at time t = 2,5 ms

The following figure 5 shows for comparison the combustion temperature distributions of gasoline, heptane and tetradecane at optimum combustion mode. Analysis of Figure 5 shows the change in temperature in the combustion chamber for the three kinds of fuels. It can be seen that the area of maximum temperature of gasoline (the core of the torch) reaches 6.5 cm in height of the combustion chamber, the rest of the chamber is heated to 1300K (Figure 5 a).



a) gasoline b) heptane c) tetradecane

Figure 5. The temperature distribution in the combustion chamber during the combustion of various kinds of liquid fuel at time of 4 ms

Results for heptane and tetradecane similar to results for gasoline in qualitative terms, differing quantitatively. Analysis of Figure 5 b shows that the maximum temperature in the combustion chamber during combustion of heptane equal to 1300 K at time 4 ms. The remainder of the chamber maintains the initial temperature of 900 K. Analysis of figure 5 c shows that the greatest value, which warms up combustion chamber by burning tetradecane, temperature is equal to 2022 K, where in the torch is a temperature higher than that of heptane (Figure 5 b). The chamber temperature at the final time 4 ms is 1200 K.

This article is devoted to the influence of various parameters on the processes of combustion of hydrocarbon liquid fuels. During the research two kind of liquid fuels were used: octane and dodecane, which are often used as a technical fuel in the aviation technical equipment and passenger cars. During the study the influence of the initial gas pressure in the combustion chamber on the combustion processes was investigated. Analysis of the numerical simulation results leads to the conclusion that the best for octane is a pressure of 100 bar and 80 bar dodecane. At these pressures, the temperature of the drops and the combustion temperature in the combustion chamber reaches the maximum values. Under these pressures intensive evaporation of the liquid fuel drops begin. Also, in the study of the influence of pressure in the combustion chamber on the processes of the atomization and dispersion of liquid fuel has been shown that for the two fuels increase in pressure causes an increase high temperatures.

The scientific importance the research is that the results obtained in this work can be applied in the construction of liquid fuel combustion theory and will contribute to a better understanding of the complex physical and chemical phenomena that occur in the combustion chambers. The practical significance of the conducted computational experiments in the work is that the results can be used in the design of a variety of internal combustion engines, which would simultaneously solve the problem of optimizing the combustion process, increase fuel efficiency and minimize emissions. The results are implemented in the educational process in the form of textbooks, manuals and virtual computer laboratory works on physics of combustion and numerical methods of thermal physics, which reflect modern approaches to organizing a special workshop intended for students in higher educational establishments specializing in the field of technical physics, thermal energy and computational fluid dynamics.

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Болегенова С., Оспанова Ш., Рахат Б., Арыстан А., Турбекова А., Тургынов М.

Сұйық көмірсутекті отындардың тамшыларының бөліну, дисперсия және булану процестерін компьютерлік модельдеу

Түйіндеме. Аталған мақала екі түрлі сұйық отындардың тамшыларының бөліну, дисперсия және булану процестерін зерттеуге арналған. Зерттеу барысында сұйық отын ретінде октан және додекан қолданылды. Сонымен қатар цилиндрлік жану камерасының моделі тұрғызылды. Сандық модельдеу барысында екі сұйық отын түрі үшін тиімді режим анықталды. Зерттеу нәтижесі бойынша октан үшін тиімді қысым 100 бар, ал додекан үшін 80 барға тең болды. Октан үшін тиімді бүрку массасы 6 мг, ал додекан үшін 7 мг құрады. Аталған тиімді режим мәндерінде октан мен додеканның тұтануы мен жануы бойынша есептеуіш тәжірибелер жүргізілді.

Түйінді сөздер: жану, сандық модельдеу, октан, додекан, жану камерасы.

Болегенова С., Оспанова Ш., Рахат Б., Арыстан А., Турбекова А., Тургынов М.

Компьютерное моделирование процессов распада, дисперсии и испарения капель жидких углеводородных топлив

Резюме. Эта статья посвящена изучению распада, дисперсии и испарения капель двух видов жидкого топлива. В исследованиях в качестве жидких топлив были использованы октан и додекан. Была также построена модель цилиндрической камеры сгорания. В ходе численного моделирования был определен оптимальный режим горения для двух видов жидкого топлива. По результатам исследовании оптимальное давление для октана составило 100 бар, а для додекана 80 бар. Оптимальная масса впрыска для октана составила 6 мг, а для додекана 7 мг. При данных значениях оптимального режима были проведены вычислительные эксперименты по изучению воспламенения и горения октана и додекана.

Ключевые слова: горение, численное моделирование, октан, додекан, камера сгорания.

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ЭЛЕКТРОМАГНИТТІК ИНДУКЦИЯ ҚҰБЫЛЫСЫН ЗЕРТТЕУ

Аннотация. Ұсынылып отырған жұмыстың негізгі мақсаты – электромагниттік индукция құбылысын жүйелі түрде зерделеу арқылы индукциялық электр қозғаушы күшінің (ЭҚК) пайда болу себептерін және пайда болған индукциялық токтың бағытының өзгеру заңдылықтарын зерттеу. Электромагниттік индукция құбылысында индукциялық токтың пайда болу себебін және оның шамасының неге тәуелді болатындығын түсіну оңай болғанымен, индукциялық токтың бағытының қалай болатындығын түсіну қиын. Сондықтан, бұл жұмыс аталған мәселені шешуге өз септігін тигізеді деп сенеміз.

Түйін сөздер: магнит өрісі, магнит ағыны, магнит ағынының өзгерісі, магнит ағынының өзгеру жылдамдығы, электромагниттік индукция, индукциялық ток, индукциялық электр қозғаушы күш.

Электромагниттік индукция құбылысы магнит өрісінің электр тогын тудыратын қасиетін сипаттайды. Индукциялық электр қозғаушы күші (ЭҚК) төмендегі екі түрлі жағдайда пайда болады. Контурды қиып өткен магнит ағыны уақыт бойынша өзгерген кезде немесе контурдағы өткізгіштің бір бөлігі магнит өрісін қиып өткен кезде өткізгіштің осы бөлігінде индукциялық электр қозғаушы күші пайда болады. Өткізгіштің бір бөлігінде пайда болған индукциялық электр қозғаушы күшінің бағыты Ленц және оң қол ережесі бойынша анықталады. Контурды қиып өтетін магнит ағыны уақыт бойынша өзгерген кезде, сол контурда пайда болатын индукциялық ЭҚК-нің бағыты Ленц ережесі бойынша анықталады.

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