PROFOUND THERMAL TREATMENT OF OIL WASTE IN HELIODEVICES EQUIPPED WITH CONCENTRATED ELEMENTS

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ABSTRACT

In this scientific article based on a study of the problem of utilization and processing of oily waste describes the problems of environmental safety and discusses possible ways of solving this problem. Direct on alternative methods to influence the structure of hydrocarbons a way to clean the oily waste with the use of solar energy. Established and described in detail the experimental setup for cleaning oil-contaminated waste. The results of experimental studies on the clean-up of oil waste in the solar device which equipped concentrating elements.

Keywords: oily waste; heat treatment; concentrator solar energy; solar device; hydrocarbon raw materials.

INTRODUCTION

The Republic of Kazakhstan is firmly held among the leading oil and gas producing countries in the world in terms of production and export of hydrocarbons. Large-scale exploitation of mineral resources and the increase in oil refining is accompanied by increased risk of pollution from the stage of exploration and production of oil and ending the use of petroleum products. Thus there is a formation of significant amounts of oily waste, mainly oil sludge and contaminated soils, reducing economic efficiency of oil and gas industry due to the necessity of alienation territory of enterprises under their storage, increasing environmental charges for storage of waste and pollution emissions. Currently, the implementation of disposal of oily waste has many challenges due to their complex and varied composition.

Processing and recycling of sludge - is the most important environmental and economic problem. Increased attention state and subsoil users to environmental issues and waste treatment technologies oil and gas production have aims widespread adoption of high-tech processing and neutralization of waste to man-triggered soil [1].

Graphic illustration of the potential economic and environmental effects associated with the prevention of environmental impacts can serve generalized scheme of input and output material flows various productions presented in Figure 1. Thus, for the refinery unaccounted losses, primarily determine the actual impact on the environment, up to

177 tons (at a volume of 10 million tons of refined oil), which is several times greater than declared in the state statistical reporting emissions and four orders of magnitude declared discharges of hydrocarbons. Moreover, if not the entire volume of unaccounted losses, most of it can be evaluated as direct emissions and discharges of oil and petroleum products in the environment.

Here we should pay attention to the fact that the reduction of discharges and emissions declared virtually no effect on the actual impact on the environment. Conversely, any measure and causes to reduce unaccounted losses, respectively, and reduces the actual impact on the environment.

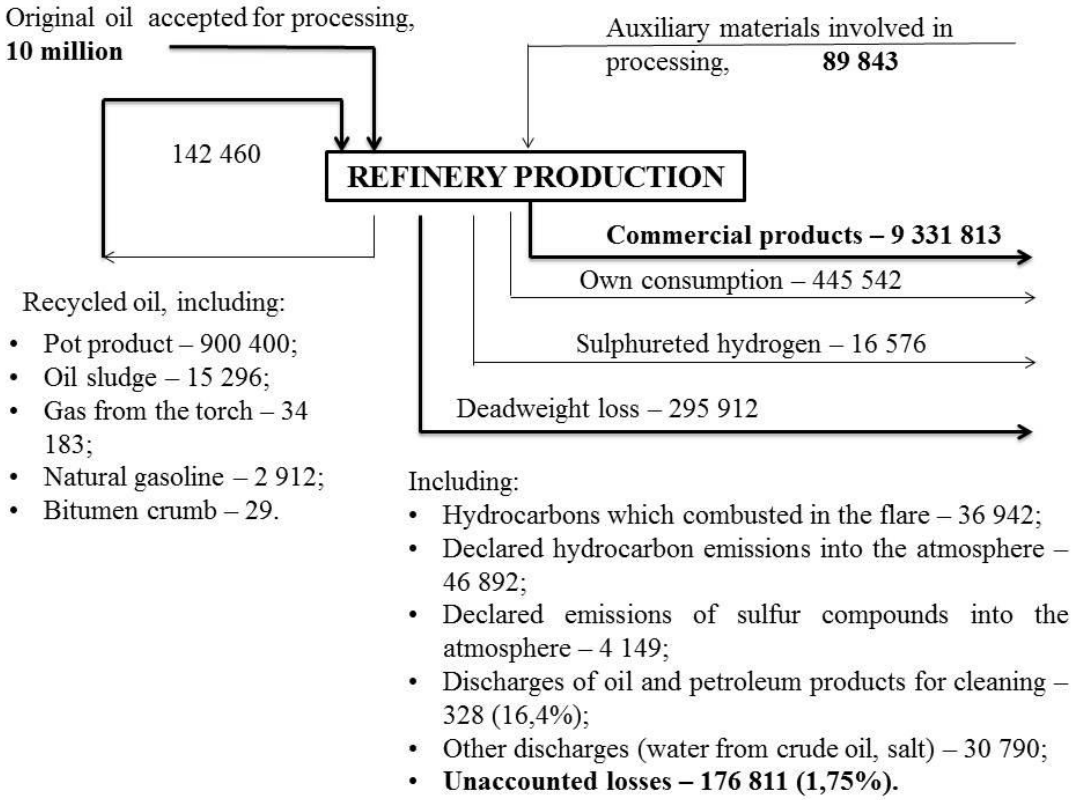

Figure 1. General scheme of input and output material courses refinery (tons/year)

Real technical, technological and organizational possibilities for this exist for almost all of the above areas to prevent impacts on the environment and are far superior to appropriate opportunities to reduce emissions and declared the discharge of pollutants. Thus reduction of unaccounted loss leads to an increase in volumes of commodity products, making such activities highly cost.

At the present day there is a widespread method of thermal decontamination of oily waste, allowing the recovery of waste without prior training and receive less environmentally hazardous product - ash , which tend to be further disposed of as Repurposed material. The purpose of heat treatment is to eliminate pollution and waste reduction to overall negative impact by reducing their size and degree of hazard reduction with simultaneous capture, concentration and destruction of hazardous materials. However, during the operation of incinerators can be possible secondary

pollution due to the formation products of incomplete combustion. In addition, this technology is energy-intensive technology, especially in the processing of sludge with high humidity [2].

In general, to the potential impacts of waste incinerators on the environment include general process emissions to air and water, including odor, technological waste residues, process noise and vibration, energy consumption and production, consumption of raw materials (reactants), and fugitive emissions mainly as a result of storage of waste [3]. Incineration processes may provide regeneration of energy, minerals and chemical components of the waste. During the combustion formed gaseous products, which their thermal energy can be used as a secondary energy source. Organic substances contained in the waste burn when the required ignition temperature by contact with oxygen.

In practice, the method of thermal decontamination of oily waste is realized in the furnaces of various designs. Special attention is devoting to the drum-type furnace. Disposal of oily waste occurs in plants with capacity up to 6000 kg/hour by burning sludge, contaminated soil, and oily wastes resulting from accidental oil spills and oil, waste oil, including vegetable origin. The facility not dispose of wastes containing oil and petroleum products in the sludge does not exceed 30%. At high oil content, it is necessary to reduce its concentration by adding to it the soil (sand). The combustion process of oily waste (loading 300-400 kg) held on the temperature 600-800°C. Temperature of the exhaust gases into the atmosphere is 100-110°C.

Emissions of gases and vapors (kg/h), released from the device, calculated by the formula [4]:

$$\mathbf{E = 0.004[(PV/1011)^{0.8} / K_d];} \quad (1)$$

where P - pressure in the apparatus (HPa); V - volume unit (m^3); K_d – coefficient of depending on the average temperature of boiling oil waste and the average temperature in the machine.

Installation of the drum type, designed for the combustion of oily waste has the following characteristics:

Table 1

Characteristics of a drum-type installation, designed for combustion of oily waste

Waste layer height, cm	0,2 – 3,0
Temperature in the equipment, ^0C	750
Pressure in the equipment, Pa	$20 \cdot 10^6$
Volume of equipment, $м^3$	0,8
Temperature of boiling of oil, t_o	>350
K_d coefficient	0,37
Emissions to the atmosphere, kg/hr	**7393**

Thermal method allows you to burn a large amount of waste oil contaminated filters, oily rags. However, this traditional method has some drawback:

- Incomplete combustion of petroleum products;
- High risk of air pollution by combustion products;

• High costs of cleaning and flue gas neutralization.

Secondary wastes which formed in this are to hazard class 4 and shall be removed at the landfills. The volume of secondary waste compared to the original reduced up to 10 times.

Given these shortcomings in the thermal treatment of oily waste, will development of new integrated methods, as well as maximum use of alternative energy sources. Increasing the share of renewable energy in the total energy mix, strengthen energy security of any country and reduce human pressure on the environment. Attractive solution is the involvement of solar energy in the processing of waste oil. We have proposed a universal commercially implemented technology in which the oily waste is deep heat treatment.

Solar device constructed from parabolic concentrator, which is virtually lossless collects all incident solar energy on him to the point of focus, where the copper tube, with the orientation of the sun [5]. Solar cell made of concentrator photovoltaic modules placed on a mechanical system provides extra warmth missing in the overcast and cold season. The device operates at 220 volts, 24 volts and 12 volts. Before the main work is necessary on the main switch, and if necessary additional capacity should include an additional switch, which energy is supplied by solar battery. Battery must charge 2-3 days for a full supply of electric current [6]. Figure 2 is a schematic diagram solar device equipped with concentrating elements.

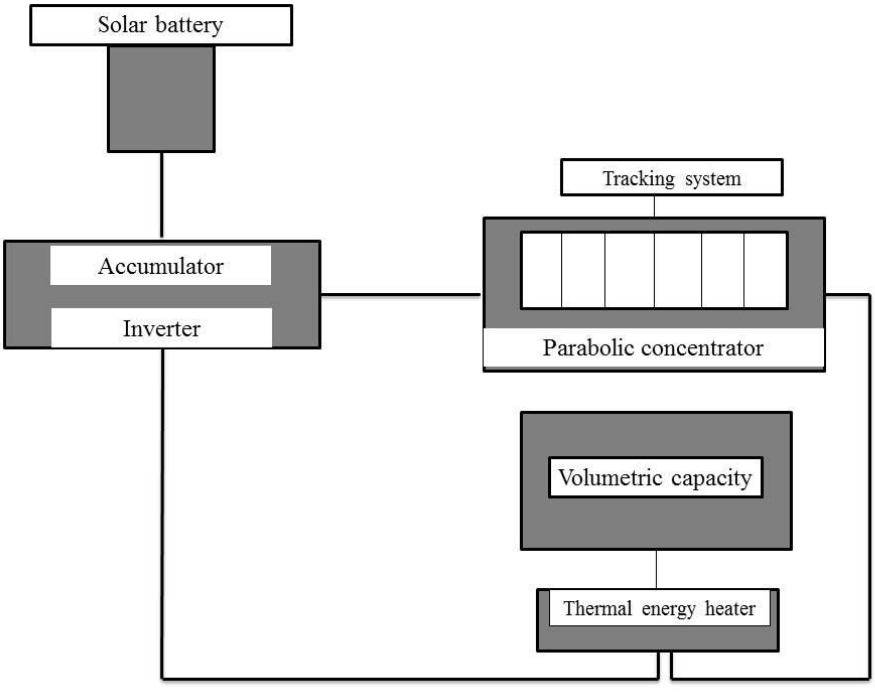

Figure 2. Schematic diagram of solar device equipped with concentrating elements

Main characteristics of solar devices equipped with concentrating the elements are listed below:

Table 2

Feature solar devices for deep thermal treatment of oily waste

Temperature in the equipment, ^{0}C	75
Pressure in the equipment, Pa	101,3
Volume of equipment, м^3	0,05
Temperature of boiling of oil, t_o	>350
K_d coefficient	1,95
Emissions to the atmosphere, kg/hr	**$2.96 \cdot 10^{-5}$**

Emissions to air (kg/h) were isolated from solar devices equipped concentrating elements are calculated according to the formula (1):

$$\mathbf{E = 0.004\ [(101{,}3 \cdot 0{,}05/1011)^{0.8}/1.95] = 2.96 \cdot 10^{-5}\ kg/h}$$

The proposed design provides the following benefits:

- The maximum focus of direct and diffuse solar radiation;
- The use of converted energy regardless of the season.

For testing generated solar devices equipped concentrating elements, experiments were conducted solar radiation. Experiments were conducted in Almaty. Solar radiation given locality composes $1{,}343 \cdot 10^{15}$ Joules per year. Figure 3 shows plots of measurements of direct solar radiation and diffusion parameters of solar radiation solar devices equipped with concentrating elements in July month to latitude 43°19 '(Almaty).

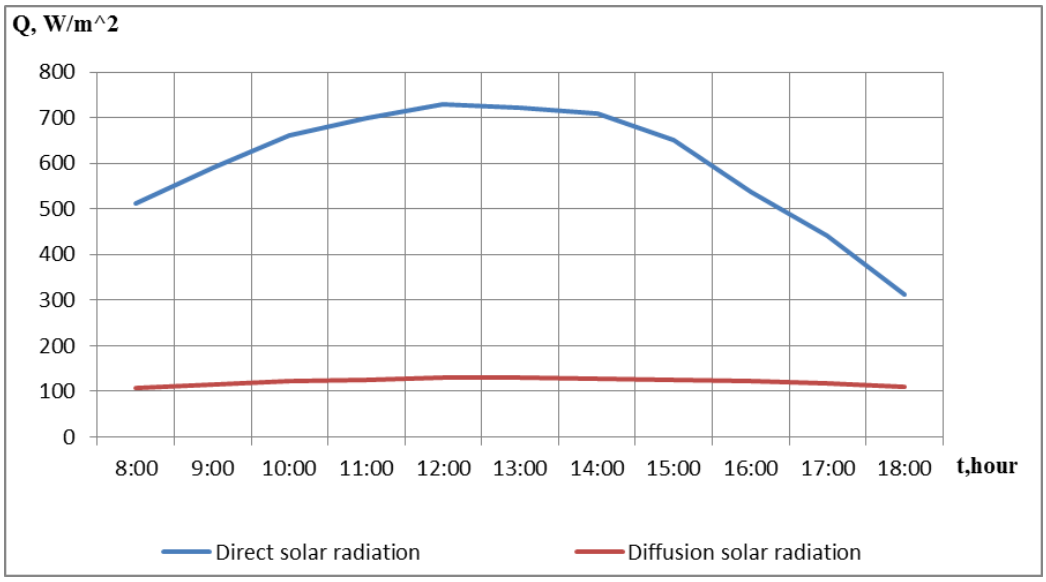

Figure 3. Graphs of direct and diffuse solar radiation during the light of a sunny day in July, the month

The data obtained indicates that the solar device with virtually no loss focuses solar radiation, which in turn affects the oily waste hydrocarbons. Further experiments were carried out at the main supply of solar energy coming from the parabolic concentrator

without the use of solar panels and additional supply from the solar panel. Dynamics of change of temperature of oily waste in solar device equipped concentrating elements with and without the use of solar panels is shown in Figure 4.

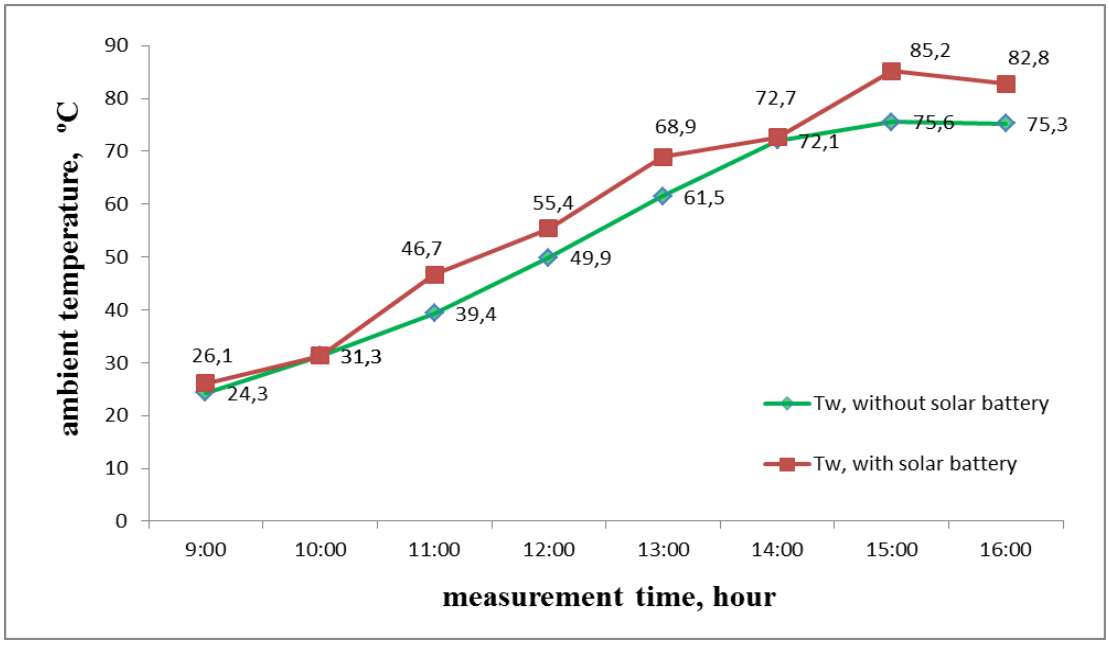

Figure 4. Change in temperature of oily waste using solar energy

According to laboratory studies of the influence of the thermal effects of solar energy on the properties of hydrocarbons in the developed device found that the content of solid residues does not exceed 6,65 – 6,79%. Also after cleaning molecular weight hydrocarbons close in magnitude to the bitumen. Component composition of oily waste after pre-treatment using solar energy is shown in the Table 3.

Table 3

Chemical composition of waste oil before and after deep thermal treatment of using solar energy

Indicator	**The index value to deep thermal treatment**	**Value of the index after a deep thermal treatment**
Density at 20 ° C, kg/m^3	942	850,7
Solids content, % wt.	76,8	6,79
Organic part of the masses, %	85,21	8,0
Water, wt. %	15,2	8,0

Designed effective way to clean contaminated soils, soil and sludge using solar energy using parabolic concentrator combined solar panel and prevents heat loss by heating during the daylight hours, as well as provides the desired temperature in the medium and high levels of achievement in obtaining productive oil.

Practically possible and more convenient use of solar energy in the processing of waste oil solves a number of problems:

• This method eliminates the need for traditional types of energy and at the same time-consuming process, which includes a three-step process that requires a significant investment of time and materials;

• The maximum solar energy used in the purification of oil waste, which increases the efficiency of the device used.

• Provides the desired temperature in the medium and high levels of achievement in obtaining productive hydrocarbons.

Therefore, at the present stage of solar energy is a promising source of energy. Solar energy is practically eternal potential and a huge source of energy without making any pollution to the environment. Nowadays, the using of an impending ecological disaster it can help avoids significant troubles in terms of environmental protection.

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