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B. ABAIYLDANOV

JSC «OzenMunaiGas», Republic of Kazakhstan

PROCESSING OF OIL SLUDGE AND OIL CONTAMINATED SOIL

Abstract. In this article examines the existing modern methods for processing oil sludge and oil-contaminated soil. On the basis of comparative economic and environmental characteristics of purification processes, the preference is given to physical-chemical methods for processing oil wastes.

Keywords: oil sludge, oiled soil, processing, purification, cleaning methods, target product.

Today in the market relations, many states and large transnational oil and gas companies pay serious attention to the real needs of the world economy in energy carriers, especially in hydrocarbon resources, to develop key guidelines for their future development. Despite of the positive dynamics of oil production and the growing demand for petroleum products, Kazakhstan is one of the last places in the world in terms of the ratio of the total capacity of the refinery and the volume of production. So, in 2013, oil processing reached the level of 15.3 million tons, the processing/production ratio was only 18.7% [1]. At the same time, oil refining and petrochemicals are an attractive sector of manufacturing industry, taking into account market prospects, economic effect and competitiveness of the Republic of Kazakhstan. Priority commodity groups are defined based on the volumes of the markets of Kazakhstan and the macroregion, the technological "complexity" of product groups, as well as the possibility of their production, taking into account the requirement to reduce environmental emissions [1]. In this regard, environmental security is one of the main strategic components of the national security of the Republic of Kazakhstan and the most important aspect of state priorities. As many national and foreign researchers believe, pollution of the environment has become a serious obstacle to the socio-economic development of the country [2]. On the territory of the republic there are about 2.5 thousand enterprises that belong to the 1-2 highest risk classes among 5 existing classes [3]. According to the Environmental Code of the Republic of Kazakhstan dated January 9, 2007, the requirements to environmental standards and increasing the responsibility of industrial enterprises for the state of the environment are tightened. This is also relevant because the republic, implementing the "Strategy 2030", "The concept of transition to sustainable development for 2007-2024" aims to long-term environmental strategy - the harmonization of interaction between society and the environment, as well as the creation of an environmentally friendly safe, well-bred environment. Implementing the strategic goals of the Concept, Kazakhstan, increasing the efficiency of resource use, increasing life expectancy, providing an

increase in the index of environmental sustainability, will create an opportunity is on the level of quality of life among the most competitive and developed countries in the world [4].

The growth of oil production in Kazakhstan, the volumes of its processing and transportation is accompanied by an increase in volumes of oil pollution and other toxic waste. Every year in our country during the processing or transportation of oil, as a result of spills and accidents, about 400 thousand tons of oil waste are generated, and resources in earthen barns are estimated at 4.5 million tons [5]. According to these authors, a memorandum of cooperation was signed between the ministries of environment and oil and gas protection, NC KazMunaiGas and KMG EP, according to which 400 thousand tons of planned for disposal in the contract area of “JSC”OzenMunaiGas will be liquidated for a year until 2021, almost 1.3 million cubic meters of "historical" waste. Also, KMG is studying advanced world technologies: positive results, for example, were given by pilot-industrial tests of the hydrodynamic cleaning method. In the framework of GP FIIR, the company built the first in the region plant for the processing of oil-containing waste "Shyryn", which is included in the Map of Industrialization of Kazakhstan. At the same time, oil producing and oil refining companies can not balance all available oil sludge in the country, as only the volumes of environmental payments for them will significantly exceed profit figures. But practice shows that in many cases it is more profitable to pay environmental fees or even hide the amount of pollution. With a view to environmental safety, oil giants should seriously engage in their disposal and support of state bodies and partial or full financing of oil-slime utilization from the state budget is necessary. The state should move from point and spontaneous actions to a comprehensive and balanced program of actions, including a system of environmental monitoring and audit of accumulated damage, the amount and volume of slurry barns, the terms of mandatory recycling and fines for non-compliance with regulations.

It is common knowledge that the main sources of pollution by oil and oil products are mining enterprises, pumping and transportation systems, oil terminals and oil depots, oil products storage facilities, railway transport, river and sea oil tankers, refueling complexes and stations. In the Mangystau region, as in other regions of the country, there is still no system for preventing and eliminating the consequences of emergencies associated with oil spills and oil products, there is also no system for collecting, processing and utilizing oily waste that meets modern standards and protection requirements environment. This problem requires an immediate solution, since the accumulation of oily waste affects not only the ecological state of the natural environment, but also the sanitary well-being of the inhabitants of the region. When oil is produced, strong contamination of soil and water with drill cuttings containing hydrocarbons, and oil spills during its extraction are associated with a number of negative phenomena leading to "oiled" and degradation of the soil of huge areas. Naturally, after such an impact, the useful properties of the land are disturbed and need to restoration, that is, remediation. Reclamation is a complex of measures aimed at restoring the former

fertile qualities of the land, its biological and economic value, as well as improving the environmental conditions. The creation of a high-performance technology for processing oil-contaminated soils will solve the problem of their complete elimination with the return of land to the user, reduce environmental pollution and enable rational use of organic raw materials from waste. Accordingly, in order to carry out measures for reclamation and restoration of land, it is necessary, initially, to collect and dispose of oil-containing waste. It should be understood that the presence of oil sludge collection in barns increases the risk of animal death, pollution of groundwater, air. To improve the ecological status and return to the economic circulation of lands contaminated with oil sludge, various environmental technologies for processing and utilization are proposed [6-10].

One of the methods is using hydrocarbon oxidizing microorganisms for neutralizing the soil from oily waste (biological method). Using the oil-degrading organisms to clean the environment today is the central problem in petroleum microbiology [11]. One of the important aspects of remediation (cleaning) of contaminated soil by oil is the microorganisms (MO) of the soil. The rate of their decomposition is due to oxidation-reduction conditions, hydrothermal regime, microorganism activity and a number of other conditions [11]. In this article, the main aspects of the current state of environmental problems in the locations of enterprises of the oil and gas complex, the problems of soil contamination with oil, methods for cleaning the soil from oil and oil products contamination, using microbial biotechnologies are examined. The result of scientific works in this field have been various developments in the bioremediation of oil, including active strains - oil destructors and their consortia, on the basis of which commercial biopreparations for the liquidation of hydrocarbon contamination are produced. In [5] it is noted that despite of the efforts of scientists and oil workers, a unified method of processing for all types of oil was not found yet. It is clear that oil products should not be burned (this is harmful to the environment), and buried. On the scientific and practical side, the method of bioremediation is not bad, but the effect of bacteria takes several years and does not always give a positive result. On such costly methods as washing with ultrasound or injection into the seam, there is still no question. It is necessary to search for suitable combinations of technologies, taking into account their cost, productivity, mobility, compliance with environmental requirements and environmental safety. And in this article, a new complex is proposed that works with any oil-contaminated soil, with any oil sludge, including in the bare steppe. Own fuel is used as fuel. As a result of complex impact on oil waste, they are separated into washed sand, which can be used for pouring roads, for technical water suitable for building or dusting roads, and for a mixture of oil waste. The universal complex installation STORM-15, mentioned in the article, has much in common with the installation of oil-contaminated soil (UZG), noted in [12]. For processing and utilization of oil-contaminated soils and solid combustible oil-containing waste, incl. non-recyclable methods of washing, bioprocessing or other methods, as well as in cases where other methods are economically less advantageous, the types of oiled soil

installation are used (UZG, Patent RU 2341547, Certificate No. ROCC RU.HO01.B00158). The unit provides utilization of soils with a degree of contamination from 2% to 16%. Processing is carried out at a temperature of 500-900 °C. To reduce the emission of suspended solids into the atmospheric air, the "UZG-1M" set includes a Cyclone off-gas treatment unit and an irrigation unit, which allows to minimize the emissions of harmful substances as compared to the utilization of open burning. The cleaning factor of the cyclone at the initial stage of loading of detoxified waste into the furnace is 97.3% (dry cleaning), and in the maximum load mode "UZG-1M" the cyclone purification factor is 88.4%. However, the heat almost completely destroys the fertility of the soil being cleaned.

One of the modern methods in processing oil sludge is the use of the ST-150 system, where it is possible to obtain commercial grade oil, industrial water and solid residue, which can later be used in the production of building materials. [13] Along with such methods, oil-containing waste is pumped in layer. The process is to collect the waste, homogenize it into a homogeneous pulp and pump it into the selected reservoir for the safe disposal of waste. However, the waste remains waste, and the cost of pumping into the reservoir is high, that this technological process is economically inexpedient and environmentally unsafe. In addition to these, there are many patented methods for processing and utilization of oil sludge such as wave combustion, vibration reduction, electromagnetic cavitation, etc., which in practice are not widely used. In all these ways, the key factor is the economic feasibility of processing oil sludge expressed in profits when implementing this process.

Oil slimes consist of three distinct fractions: **water, oil** and **solid**. With all the variety of characteristics of different oil waste in the most general form, all can be divided into the following main groups or types:

- Oiled soil - oil spilled on it and its components in the process of extraction and its purification from salts, solid hydrocarbons and mechanical impurities;
- Bottom sludge- formed on the bottom of various reservoirs after the oil spill occurred and contain a lot of water;
- Products formed as a result of stripping of reservoirs that are formed during the storage and transportation of oil in a wide variety of reservoirs (oil sludge);
- Water-oil emulsion;
- Trapping oil;
- Drilling cuttings;
- Ambar top layer.

Such wastes are generated as a result of the following activities:

- Extraction and exploitation of oil and gas fields;
- Preparation, transportation and processing of oil;
- Cleaning of tanks at refineries and filling stations;
- Wastewater treatment with oil products, etc.

However, they differ significantly in their composition and properties, depending on the quality and composition of the raw crude oil.

For the processing of oil sludge, biotechnologies, chemical-technologies, acoustic, thermal and purely fire technologies, as well as combined technologies are used. A common disadvantage of all these technologies for utilization and processing of oil sludge is their low productivity and high material, energy and financial costs. In addition, they do not allow complete refining and degassing of oil sludge and do not provide environmental safety for the environment. The problem of processing granary oil sludge in the oil-producing and oil-refining industry has not yet been completely solved. This is due to the high stability of ambar emulsions, the features of their composition and properties, constantly changing under the influence of the atmosphere and the various processes taking place in them [14]. Among the reservoir type, one can also include trapped oil. Accumulation of trapped oil takes place in closed reservoirs - reservoirs where there is no direct contact with air, there is no influence of atmospheric precipitation, storage time is limited to months and only in exceptional cases for several years, i.e. they are not subject to such long and hard aging as ambar emulsions. In this regard, possessing many characteristic common features (high content of mechanical impurities of organic and inorganic origin, paraffins with a high melting point, high viscosity and density), potting emulsions are generally less are stable than granary ones, and the values of the indicators for the parameters listed above are an order of magnitude lower. The trapping oils are stored during storage in tanks. It is noted in [12] that when storing oil sludge in tanks after the expiration of time they are stratified into four layers:

- the top layer represents the water-in-oil emulsion, where the water content does not exceed 5-8%, 70-80% oils, 6-25% asphaltenes, 7-20% ashes, 1-4% paraffins and fine impurities up to 5 %;
- the middle layer, relatively small, is an oil-in-water emulsion and contains 70-80% water, 1.5-15% mechanical impurities;
- the last layer entirely consists of mineralized water with a density of 1.01-1.19 g / cm^3;
- the bottom layer or bottom silt represents a heterophasic system consisting of 45% organic matter, 50-88% mechanical impurities and 25% water.

Spilled oil and petroleum products in the course of physico-chemical interactions with the components of the environment form oil sludge, and with soil of oil-contaminated soil. Over time, partial evaporation, oxidation and condensation occur to form resin-like compounds.

Well-known and one of the available methods is the utilization of liquid slurries with the help of sawdust. This method is effective where sawdust is available, however, the high fire hazard of recycled products requires compliance with fire safety. In turn, the slimes stored in pits and earth sediment basins are usually "weathered" and contain more solids, and their interaction with water leads to the formation of a "water-oil" emulsion, with mechanical impurities - suspensions and mineral dispersions. Effective ways of processing oil waste and rational use of natural resources are important for ensuring sustainable development of the country. The main factors on which the economic efficiency of the

utilization of oily waste depends. are: oil content in oil sludge, the degree of its extraction from oil sludge, the distance of transportation of oil waste to the place of utilization, etc. The technical and economic efficiency of processing oil sludge depends significantly on the concentration of oil in them. At low concentrations of oil in oil sludge, their processing with extraction of oil becomes unprofitable. For the processing of such oil sludge, old oil sludge in barns, as well as waste oil sludge plants that are formed after the extraction of hydrocarbons from oil sludge, it is required to build additional facilities for their utilization or landfilling. This requires additional capital investment and operating costs. In [15] it is noted that the economic efficiency (***E***) from rational use consists of prevented damage (***D***) and cost Returned to the turnover of oil minus the costs of implementing the recommended activities is determined by the formula:

$$E = D + P_{ad} - E_{exp}$$

where P_{ad} - the additional income from returned oil, E_{exp} - expenses for realization of the recommended technology. In the case of complete processing of oil-bearing soils and oil sludge, the developed technology eliminates the need to construct a landfill for disposal of waste.

The presence of waste forces enterprises to incur additional costs, which certainly worsens the economic performance of production. To solve the problem, it is necessary to solve the problem of introducing non-waste technology, that is, in this case the processing of oil sludge. However, despite the efforts of scientists, a unified way of processing oil sludge has not yet been found. Incineration of oil waste violates the ecology of the air basin, dig in, means the destruction of the flora of the environment, the method of bioremediation requires appropriate climatic conditions and the action of bacteria takes several years. Washing with ultrasound or injection into the reservoir is not economically viable. Consequently, suitable combinations of technologies, given their cost, productivity, mobility, compliance with environmental requirements and safety. Based on these factors and the criteria that determine the choice of technology for processing and utilization of oil sludge, it can be concluded that the most effective is the physicochemical method. On the other hand, oil sludge is a source of valuable raw materials - and it is necessary to use them for the designated purpose as energy resources and building materials. The determining factor in making a decision on the processing of oil sludge is the composition of the waste and its physical and chemical properties. In any case, this process allows us to return to life of the earth and prevent pollutants of organic origin from entering the environment.

Slimes should not simply be disposed of, but processed into targeted products of the economy. In Europe and Russia, such technologies are already working. We must give credit, there are such examples in Kazakhstan. Small, however, in terms of the volume of the work of the enterprise, but with quite innovative cleaning methods from time to time appeared in Mangistau oblast, WKO, Kyzylorda, the construction of a mini-plant in Pavlodar is planned.

To clean the soiled soil with the preservation of fertile soil properties, the most appropriate way is to propose a patent [16]. These authors of the invention, under the supervision of First Deputy Director General of the Institute of Chemical Sciences. named after A Bekturov, Corresponding Member of NAS of the Republic of Kazakhstan U. Zh. Dzhusipbekov developed a unique new technology for cleaning oil-contaminated soil using humate-containing compounds. Depending on the characteristics of the soiled soil, the latter can be used as a road construction material, and the extracted oil for processing in an economically expedient variant (fuel, oil, complex, etc.). At the same time, humates have a positive effect on improving soil fertility - cleaned soil. Investigations of the effect of oiled soils on cleaning and impact on soil characteristics are of scientific and practical value. Today the work of cleaning oil-contaminated areas in the basin "Ozenmunaigas" continues.

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Резюме

Б. Абайылданов

МҰНАЙ ШЛАМЫН ЖӘНЕ МҰНАЙМЕН ЛАСТАНҒАН ТОПЫРАҚТЫ ӨҢДЕУ

Мақалада мұнай шламын және мұнаймен ластанған топырақты өңдеудің қазіргі заманғы әдістері қарастырылған. Тазарту процестерінің салыстырмалы экономикалық және экологиялық сипаттамалары негізінде мұнай қалдықтарын өңдеудің физика-химиялық әдістеріне артықшылық беріледі.

Түйін сөздер: мұнай шламы, майлы топырақ, өңдеу, тазалау, тазалау әдістері, мақсатты өнім.

Резюме

Б. Абайылданов

ПЕРЕРАБОТКА НЕФТЯНОГО ШЛАМА И ЗАМАЗУЧЕННОГО ГРУНТА

Рассматриваются существующие современные методы переработки нефтяного ила и загрязненной нефтью почвы. На основе сравнительных экономических и экологических характеристик процессов очистки предпочтение отдается физико-химическим методам переработки нефтяных отходов.

Ключевые слова: нефтяной шлам, замазученный грунт, обработка, очистка, способы очистки, целевой продукт.