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STUDY OF OIL SLUDGE OF OIL REFINERY AND THEIR PROCESSING

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Abstract

The article presents the main physical and chemical properties oil refinery production wastes, current state of them and oil sludge, types and compositions. Therefore, oil sludge formations and their compositions have been investigated. Methods of analyses and testing of oil sludge have been studied. So, physical and chemical properties of oil sludge and importance of their disposal have been shown.

Keywords: *oil, sludge, processing, composition, hydrocarbon, property, reservoir*

Introduction

Oil and gas refinery industry play main role in economy of Uzbekistan. One of them is the Bukhara Oil Refinery LLC, in 2020 produced 843,900 tons of motor gasoline, the amount of which became the highest rate in the plant's 23-year history, reports referring to the press service of Uzbekneftegaz JSC. Second is Ferghana Oil Refinery LLC is one of the largest enterprises in the Central Asian region for the processing of hydrocarbons and the production of oil products. To become a highly efficient and competitive company that takes a leading role in the oil and gas sector of the Republic of Uzbekistan is one of the most important goals of the enterprise. At the end of 2020, despite the almost complete lack of supply of the planned amount of gas condensate (light hydrocarbon raw materials), the enterprise was able to efficiently load production facilities and produce oil products necessary for the national economy and economy of the republic. Thanks to the well-coordinated work of the company's team, the refining of crude oil in absolute terms increased to the level of 900 thousand tons of oil compared to 878 thousand of crude oil in 2019. At the same time, even in the conditions of processing heavier crude oil, the refining depth indicator in 2020 remained at the level of last year's values of 87%, and the total level of fuel consumed and irrecoverable losses decreased by 2.5% compared to last year's figure (Uz Daily, 2020).

As a result of such processes, resinous compounds are formed, as well as water-oil

emulsions and mineral dispersions. Since any sludge is formed as a result of interaction with a specific environment and for a certain period of time, there are no sludges that are identical in composition and physicochemical characteristics in nature. The production activity of oil refining and oil and gas producing enterprises inevitably has a technogenic impact on natural environment objects, therefore the issues of environmental protection and rational use of natural resources are of great importance. Oil sludge is one of the most dangerous pollutants of almost all components of the natural environment, surface and ground waters, soil and vegetation cover, atmospheric air (Aliyev G. S., 2023).

Materials and methods

In the production and exploration of petroleum, wastes are generated which includes drilling fluid, petroleum wastewater, petroleum effluent treatment plant sludge and bottom tank sludge. A petroleum refinery with a production capability of 105.000 drums per day make approximately 50 tons of oily sludge per year (Sun Yuxiao, 2021). The remains found at the base of tank and other storage facilities are generally refered to as sludge. For crude oil storage vessels, this kind of sludge found at its base comprises of hydrocarbons, asphaltenes, paraffin, water, and inorganic solids such as sand, iron sulfides and iron oxides. Hydrocarbon is the principal component of petroleum sludge, which is formed when crude oil's properties are changed as a result of changes in external conditions. The formation of petroleum sludge are commonly caused by cooling below the cloud point, evaporation of light ends, mixing with incompatible materials, and the introduction of water to form emulsions. According to Resources Conservation and Recovery Act (RCRA) sludge is separated as a hazardous waste, alongside other hazardous wastes (Li G., 2013). The elemental composition of petroleum sludge is Nitrogen, Phosphorous, Potassium, Iron, Copper, Calcium, Magnesium, Cadmium, Phosphate, Chromium, Zinc, Sodium, and Lead (Gao G., 2021). With a variety of oil wastes (in a generalized form), oil sludge can be divided into four groups according to the conditions for their formation:

– Natural. Natural oil sludge is a substance that appears after oil settles to the bottom of any reservoirs and mixes it with mule and water.

– Ground. Ground oil sludge appears after the spill of oil on the ground.

– Reservoir. During storage, oil enters into a chemical reaction with the surface of the tank, thereby creating oil sludge, which is called tank sludge.

Methods for determining the total content of mechanical impurities are based on the ability of all organic components of oil to dissolve in organic solvents. The undissolved residue retained by the filter during filtration of an oil or oil product solution characterizes the content of mechanical impurities in them.

Several methods of processing oil sludge have been used with the aim of reducing toxicity, minimizing the volume of oil sludge and extracting petroleum products. Flotation, pyrolysis, combustion, biodegradation, freezing/thawing, ultrasonic treatment, electrical processing, microwave radiation and solvent extraction are among them.

Results and discussion

At consideration of the problem of residual oil waste, it is necessary to study sources of their formation, methods of utilization and processing.

Oil sludge from oil reservoirs is formed during the separation of oil and settling to the bottom of the oil sediment reservoir. Oil sludge tanks has a pasty state of aggregation. Composition and characteristics of oil deposits depend on the properties of oil.

In Uzbekistan Oil and gas refinery plant oil sludge from fuel oil tanks is formed during the storage of fuel oil. By method of production, straight-run and destructive fuel oils are distinguished origin. Oil sludge generated during storage of straight-run fuel oil has a pasty state of aggregation. Oil sludge from treatment facilities is formed in the process of water purification from oil, oil products and mechanical impurities. These oil sludge have pasty state of aggregation and black color. Oil and oil products in contaminated water are in the form of oil floating on the surface films, emulsified oil products, settled on the bottom of heavy fractions. In the process of water purification, the oil product, together

with oil sludge, enters the metal tanks, where separation occurs at a temperature of 60––70 °C mixtures under the influence of gravity on the oil product, water and oil sludge.

According to the results of studies of many varieties of oil sludge tank type, it was found that the ratio of oil products, water in them and mechanical impurities (particles of sand, clay, rust, etc.) fluctuates over a very wide range. Hydrocarbons make up 50–90%, water 10–52% and solid impurities 28–65%. As a result, such a significant change composition of oil sludge, also determine the range of changes in their physical chemical characteristics that are very broad.

The group hydrocarbon composition of oil sludge plays an important role in their oxidation with oxygen and affects the quality of the final product for obtaining a composition having the binding property of a petroleum binder. In fig from 5 to 8 were shown the group hydrocarbon composition of oil sludge.

In order to clean oil sludge from water and bring it to a homogeneous state, their elemental and aggressive-mechanical composition was determined (Table 1).

Table 1.

Type of oil sludge	Elemental composition				Mercaptan content.%	Mech. impurities.%
	C	H	O	N		
Ground	78.0	6.9	3.5	2.7	5.5	5.0–8.0
Natural	82.0	7.2	2.0	1.2	4.0	3.5–4.0
Reservoir	85.6	8.4	1.0	0.4	0.3–0.5	0.5–0.7
Field	88.9	8.6	0.4	0.2	0.1–0.2	0.3–0.4

Densities of oil sludge range from 930––1300 kg/m^3, and pour point from –3 °C to +80 °C. The flash point lies in the range from 35 to 120 °C. When water gets into the volume of oil products stable water-oil emulsions are formed, stabilization of which are due to contained in petroleum products natural stabilizers from a number of asphaltenes, resins and paraffins. Upper oil sludge layer is a watered oil product containing up to 5% fine impurities and belonging to the class emulsions “water in oil”. The composition of this layer includes 70–80% oil, 6–25% asphaltenes, 7–20% resins, 1–4% paraffins. The water content does not exceed 5–8%. Quite often, the organic part of the freshly formed top layer oil sludge is similar in composition and properties to those stored in tanks original oil product. This situation usually occurs in consumables tanks of gas stations. Proposed technologies for processing crude oil and oil wasteusing non-standard physical, chemical, and physical influences on them. In this case, the raw material is pretreated using acoustic energy, ultrasound, high-frequency(HF) and ultrahigh frequency (UHF) electromagnetic fields, ionizing radiation, exposure to plasma-chemical and electric were used.

Conclusion

In general, on the basis of investigations and experiment results the oil sludge volume and their compositions is important to develop and obtain new materials based on them for variety industry especially for energy supply sector. As the dependency on petroleum products is increasing, which in turn unavoidably lead to increase in the generation of petroleum sludge, it will be indispensable to increase the measures by which the generators to be obliged to treat the sludge without violating the environment and health safety.

References

Uz Daily. Ferghana Oil Refinery sums up the results of the outgoing 2020. URL: http://www.uzdaily.uz

Aliyev, G. S. Analysis of Physico-Chemical Methods for Investigation of Oil Sludge. Journal of Survey in Fisheries Sciences 2023; 10(2S); 826–830.

Johnson O., Affam A. Petroleum sludge treatment and disposal: A review. Environmental Engineering Research.– 24 (2), 2019. Doi: https://doi.org/10.4491/eer.2018.134
Sun Yuxiao., Yi Liu. Physical pretreatment of petroleum refinery wastewater instead of chemicals addition for collaborative removal of oil and suspended solids. Journal of Cleaner Production., Elsevier.– Vol. 278. 2021.– P 12–38.
Gao, G., Yu, T., Liu, T., Sun, X., Chong, F., Zhangx, Qu, C. Research progress on hydrothermal oxidationtechnology to treat oily sludge. IOP Conf. Series: Earthand Environmental Science.– 804, 2021. Doi:10.1088/1755–1315/804/4/04200
Li, J., Song, X., Hu, G. Ultrasonic desorptionof petroleum hydrocarbons from crude oil contaminatedsoils. J. Environ. Sci. Health A.– 8, 2013.– 11 p.

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