Journal of Fundamental and Applied Research **Vol. 3**, Issue 3 (2023) **20230014**

Received: 21 July 2023 / Accepted: 13 September 2023
Published online: 14 September 2023
© 2023 The Author(s)

RESULTS OF PRELIMINARY ANALYSES TO DETERMINE PROPERTIES AND FRACTIONAL COMPOSITION OF OIL SLUDGE

Abdugoffor M. Khurmamatov,[1,*] Muslimbek V. Jurakulov,[1,†] and Asan A. Sultanov[2]

[1] *Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan, 100170 Tashkent, Uzbekistan*
[2] *Karakalpak State University, 1 Ch. Abdirov ave, Nukus, Uzbekistan*

Abstract. In the article physicochemical characteristics and fractional composition of oil sludge are studied. Therefore, we have carried out laboratory experiments to determine the physical and chemical properties of feedstock. As raw materials for obtaining anti-corrosion coatings 2 samples of oil sludge were selected, which were brought from Bukhara oil refinery (sample 1) and from Fergana oil refinery (sample 2). On the basis of oil sludge analysis it was established that there is a significant amount of oil products in them, which are mainly heavy fractions of oil. Based on the results of the study of group composition and physico-chemical characteristics, we selected oil sludge from Bukhara refinery as a promising raw material for anticorrosion coatings. The obtained data are of practical interest for utilisation of oil sludge as a raw material for obtaining anticorrosion coatings.

Keywords: anticorrosion coating, oil products, oil sludge, mechanical impurities, colloidal system

I. INTRODUCTION

The oil industry occupies one of the first places among the leading industries in terms of environmental impact due to the formation of a large amount of heterogeneous waste. One of them is oil sludge - a colloidal system of high molecular weight oil compounds, mineral particles of different composition and formation water. It is the largest tonnage waste of oil production and refining industry, characterised by the complexity of its chemical composition and in the process of constant transformation [1, 2]. At petrochemical production facilities there are inevitably accumulations of oil sludge wastes. In particular, there is a problem of utilisation of oil sludge generated during construction of oil and gas wells, during field operation of fields, treatment of waste water containing oil products, as well as during cleaning of tanks and other equipment. As a rule, sludges are heavy oil residues containing on average (by weight) 10 - 56 percent of oil products, 30 - 85 percent of water, 1,3 - 46 percent of solid impurities (clay, sand, mechanical impurities). Accumulation of oil sludge is carried out on specially allocated sites or in bunkers, the waste is not sorted by its physical and chemical composition. Natural accumulation of moisture due to atmospheric precipitation, development of microorganisms, oxidative processes take place in sludge reservoirs, but due to the presence of a large amount of salts and oil products with a general lack of oxygen the process of self-regeneration of such wastes can last for tens of years. At the same time, physical and chemical compositions of sludge change in time, and also sludge from oil product storage tanks and sludge from treatment facilities differ in their morphology [3]. In a simplified model, oil sludge is a multicomponent physicochemical systems (mixtures) consisting of oil products, water and mineral additives (sand, clay, metal oxides). Oil sludge is formed in the course of production activities during extraction, transport and processing of crude oil. There cannot be oil sludge of the same nature, as they are based on different conditions of formation and different storage conditions [4]. The presence of open pits with a huge amount of accumulated liquid and paste-like oil sludge leads to constant pollution of the environment - soil, surface and ground waters, as well as atmospheric air with hydrocarbons, hydrogen sulphide and other emissions due to evaporation of light fractions. Oil-containing wastes stored in storages fall into water bodies mainly as a result of erosion of the pits' cover by flood waters, washing off by rain and melt waters. Pollution of soil with oil and oil products causes significant changes in morphological properties of soil. As a result of blockage of its capillaries aeration is strongly disturbed, anaerobic conditions are created, redox potential is disturbed [5]. Therefore, depending on the composition of oil sludge, different

* gafuri_1980@mail.ru
† Corresponding Author: mus94lim95mus94lim95@gmail.com

processes can occur, i.e. it can affect the behaviour of oil sludge when the latter is used as an additive mixture in obtaining anti-corrosion coating. Although many methods are known for the use of oil sludge in the production of anticorrosive coating, but the study of its influence on the properties of anticorrosive coating remains relevant due to the difference in their nature [6]. In this regard, the purpose of this work is to select a suitable oil sludge for the production of anti-corrosion coatings.

II. METHODS AND MATERIALS

For obtaining anticorrosion coatings, the composition of the feedstock is very important. Therefore, we conducted laboratory experiments to determine the physicochemical properties of the feedstock. As raw materials for obtaining anti-corrosion coatings we selected 2 samples of oil sludge, which were brought from Bukhara (sample 1) and from Fergana oil refinery (sample 2). A series of experiments were conducted to determine the amount of water using the method of Dean and Stark. The experiment lasted for 45 minutes. The condensed solvent and water were continuously separated from each other in the trap until the increase in water volume ceased, with the water remaining in the graduated compartment of the trap and the solvent returned to the distillation vessel. The sample was thoroughly mixed by shaking in the vial for 5 min. High viscosity products were preheated to 40-50°C. From the stirred sample, a 100g sample was taken into a clean dry sample. The pre-weighed glass flask was then poured 100ml of solvent into the flask and the contents were stirred. A few glass capillaries or a few pieces of pumice or porcelain were thrown into the flask for uniform boiling. The flask was attached to the outlet tube of the receiver-trap by means of a slurry, and the refrigerator was attached to the upper part of the receiver-trap on the slurry, the receiver-trap and the refrigerator should be clean and dry. To avoid condensation of water vapour and air, the upper end of the refrigerator should be covered with cotton wool. The contents of the flask were heated with an electric cooker. The distillation was carried out in such a way that 2-4 drops per second fell from the refrigerator tube into the receiver - trap. Heating was stopped when the volume of water in the receiver-trap stopped increasing and the upper layer of the solvent became completely transparent. After the test product had cooled to room temperature, the instrument was disassembled. If the amount of water in the receiver - trap is not more than 0.3 ml and the solvent is cloudy, then the receiver is placed for 20-30 minutes in hot water to clarify and again cooled to room temperature. After cooling, the volume of water in the receiver - trap was determined with an accuracy of one upper division [7]. Mass fraction of water V weight , percent, was calculated according to the formula [8]:

$$V_w = \frac{100 \cdot V}{G}$$

where V_w is the volume of water collected in the receiver - trap, ml; G is the sample of oil sludge taken for testing, g.

In the receiver - trap amount of water 0.1 ml and less is considered as traces. Discrepancies between two parallel determinations of water content should not exceed one upper division of the water-occupied part of the receiver - trap. It can be seen that in the experiment conducted by the method of Dean and Stark, it is found that the amount of water in sample 2 is less, i.e., 24.2 percent, and the amount of water in sample 1 is greater than in sample 1, i.e., 32.3. percent.

Mechanical impurities in the composition of oil sludge negatively affects the quality of the obtained product. We have carried out a series of experiments to determine the content of mechanical impurities in the composition of oil sludge after dilution with oil fractions with stirring for 30÷60 minutes [9]. The mass fraction of mechanical impurities, percent, was calculated by the formula:

$$M = \frac{m_1 - m_2}{m_3}$$

where m_1 - mass of the cup with filter after filtering, g; m_2 - mass of the cup with clean filter, g; m_3 - mass of the oil sample. The content of mechanical impurities was calculated as the arithmetic mean of the results of two parallel determinations. If mechanical impurities contained no more than 0.05 percent, then this case is considered as the absence of mechanical impurities. First of all, the initial content of mechanical impurities in the composition of oil sludge was determined. The paper filter was dried, to constant weight at 105°C. The oil sludge suspension was preheated on a water bath to 40°C, because the analysed oil sludge was highly viscous. Next, a 2 g weight of oil sludge was diluted with 25 g weight of petrol. The hot solution of the suspension was filtered through a dried paper filter placed in a glass funnel. After filtering, the filter was transferred to a beaker and dried in the thermostat for 1 hour. After drying, the beaker was cooled in the desiccator for 30 minutes [10]. The content of the mass fraction of mechanical impurities in the oil sludge was determined by extraction of the sludge in a Soxhlet apparatus. The Soxhlet extractor was fitted with a round bottom flask containing the extraction solvent and was provided with a reflux condenser. In the centre of the apparatus was a reservoir in which was placed a sleeve made of paper and filled with the solid sample from which the extraction was made. The solvent was heated to boiling point, vaporised and, passing through the side outlet, entered the return refrigerator where it condensed and flowed into the sleeve. While the sleeve was filled with solvent, the extraction of the target substance into this solvent took place [GOST 6370-83]. As soon as the liquid level in the sleeve reached the upper level of

 Copyright © 2023

Oil Sludge Indicator	Sample 1	Sample 2
Water Content (% wt)	32.3	24.2
Content of Mechanical Impurities (% wt)	36.99	44.6
Chloride Salt Content (mg/L)	1744.7	6328.9
Paraffin Content (% wt)	16.0	4.3
Resin Content (% wt)	10.9	15.6
Asphaltenes Content (% wt)	0.7	1.4

TABLE I. Physico-chemical Characteristics of Investigated Oil Sludge

Fractions	Boiling point at residual pressure (rise), °C	Boiling point at atmospheric pressure, °C (conversion)	Mass fraction, % wt.
Sample 1			
Water	-	98-99	30.3
1st fraction	75-85	200-215	8.7
2nd fraction	140-195	280-350	14.6
Residue	>320	>450	33.8
Losses	12.6	-	-
Sample 2			
Water	-	98-99	21.9
1st fraction	90-145	195-255	21.5
2nd fraction	145-195	255-320	38.2
Residue	>320	>450	6.1
Losses	12.3	-	-

TABLE II. Fractional Composition of Investigated Oil Sludge Samples

the siphon, the sleeve was emptied: the solution of the substance was poured into the original flask, and the cycle was repeated again. Thus, the device allows for multiple extraction by reusing a relatively small volume of solvent, with the extracted substance accumulating in the main flask. The extraction efficiency is further increased by the fact that the sleeve is directly above the flask and is heated by the vapour of the boiling solvent. It can be seen that despite the small amount of water in sample 2, the amount of mechanical impurities is high, i.e. 44.6 percent, in sample 1 this index is less than in sample 2, i.e. 36.99 percent.

A. Results and discussions

According to the mass analysis results, the amount of mechanical impurities, water and chloride salts in sample 1 is 36.99 percent by mass, 32.3 percent by mass and 1744.7 mg/dm3 in sample 2 and 24.2 percent by mass, 44.6. wt. percent and 6328.9 mg/dm3 in sample 2 respectively. Presence of salts in oil sludge compositions causes especially heavy and various complications during processing. Clogging of equipment occurs, salts are deposited mainly in hot equipment. Salts dissolved in water are released during evaporation of water. Part of the crystallised salts adheres to these surfaces, settling on it in the form of a strong crust. The results of physicochemical characteristics of the investigated oil sludge are given in Table 1.

As can be seen from Table 1, the amount of water and amount of paraffin in sample 2 is less than sample 1 by 8.1 percent and 11.7 percent respectively, and the amount of tar and mechanical impurities in sample 1 is less than sample 2 by 4.7 percent and 7.61 percent respectively. It can also be noted that the asphaltene content in sample 1 is 2 times less as compared to sample 2. The study was carried out for both significantly watered oil sludge sample and sample with insignificant moisture content. In oil sludge of sample 1 the content of chloride salts and tar respectively 3.6 and 1.43 times less than sample 2, and paraffins 3.72 times more. The composition of oil sludge of sample 2 revealed 1.4-15.6 percent of heavy fraction of oil products, mechanical impurities 44.6 percent, and 24.2 percent of water, toxic chemical elements nickel and vanadium. Presence in oil sludge of considerable quantity of resins and heavy fractions makes oil sludge a potentially perspective raw material for production of anticorrosive coatings. As it is known the use of oil sludge as a raw material in the production of anticorrosive coatings requires preliminary analysis and preparation of oil sludge for processing. The results of fractional compositions of the investigated oil sludge are given in Table 2.

As can be seen from Table 2, the products separated in the 1st and 2nd fractions in sample 1 are much less, but as the amount of residue in sample 1 is 33.8 According to the results of the analysis it can be seen that the oil sludge of Bukhara oil refinery belongs to high paraffinic, the more paraffin in oil sludge, the less resins and asphaltenes in its composition. Therefore, according to the results of the analysis it can be seen that the physical and chemical properties of oil sludge of Bukhara oil refinery fully meets the requirements relative to the raw materials and they can be used in obtaining anti-corrosion coating.

Copyright © 2023

III. CONCLUSIONS

On the basis of oil sludge analysis it was established that there is a considerable amount of oil products in them, which are mainly heavy fractions of oil. As can be seen from 2 samples tested by us, in sample 1 and sample 2, respectively, water content, percent wt 32.3, 24.2, mechanical impurities, percent wt 36.99, 44.6 paraffin content, percent wt 16.0, 4.3. According to the results of these experiments, the most suitable in terms of the content of various impurities is the oil sludge sample of Bukhara oil refinery also it has less water content and mechanical impurities.

REFERENCES

[1] Chernykh O.V., Purygin P.P. Investigation of the possibility of obtaining road bitumen by oxidation of oil sludge. Proceedings of the Samara Scientific Center of the Russian Academy of Sciences. 2009. Vol. 11, No. 1. P. 233-236.
[2] Dzhanalieva N.S. The impact of oil pollution on natural geosystems. Spirit time. 2020. №4 (28). P. 23-28.
[3] Minakov V. V., Krivenko S. M. New technologies of purification from oil pollution. Oil and gas technologies. 2002. No. 3. pp. 4-7.
[4] Minnigalimov R.Z., Nafikova R.A. Improvement of oil sludge processing technology. Oil industry. 2008. No. 4. pp.54-67.
[5] Kurochkin, A.K. et al. Oil sludge is a resource raw material for the production of light motor fuels and road bitumen. The sphere of oil and gas. 2010. No.4. pp.72-75.
[6] E.I. Imanbayev, A.K. Serikbayeva, A.Ch. Busurmanova, etc. On the issue of the use of oil sludge in the modification of bitumen. International Scientific and Practical Conference "Science and Education: theory and practice", 17.12.2020, Neftekamsk, Republic of Bashkortostan.
[7] Imran Hafeez, Mumtaz Ahmed Kamal, Muhammad Reza Ahadi, Qamar Shahzad, Nadia Bashir. Performance Prediction of Hot Mix Asphalt from Asphalt Binders. Pak. J. Engg. & Appl. Sci. Vol. 11, July., 2012 P. 104-113
[8] Khurmamatov A.M., Yusupova N.K., Khametov Z.M. Results of the study of hydrodynamics of bitumen production processes. Scientific and Technical Journal of FerPI-Fergana, 2021. No. 1. Volume 24.special issue -pp. 184-188.
[9] Khurmamatov A.M., Yusupova N. K., Boymirzaev T. T. Intensification of the Bitumen Production Process. IJIAET. International Journal of Innovative Analyses and Emerging Technology. Indonesia. e-ISSN: 2792-4025 — http://openaccessjournals.eu Volume: 1 Issue: 5. –P. 65-69.
[10] Edwards Y., Tasdemir Y., Isacsson U. Effects of commercial waxes on asphalt concrete mixtures performance at low and medium temperatures. Cold Regions Sciense and Technology Volume 45, 2006. P. 31-41.

 Copyright © 2023