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ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF HYDROCARBON WASTE

Yuldashev Narbek Khudainazarovich,
Candidate of Technical Sciences, Head of Innovation Department
development of Uzbekneftegaz JSC, E-mail: n.yuldashev@ung.uz
Khurmamatov Abdugoffor Mirzabdullaevich,
Doctor of Technical Sciences, Professor, Head of the Laboratory
IONX AN RUz, E-mail: gafuri_19805@mail.ru
Khudaynazarov Shokhrukhbek Narbek ug'li
3rd year student of the Faculty of Chemistry National
University of Uzbekistan, E-mail: narb-yuld@yandex.ru

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Abstract:

The article presents the results of determining the physicochemical properties of diluted oil sludge with various diluents. The optimal operating parameters of the bitumen production process have been determined: softening temperature according to a softening point (□method of ring and ball□); depth of needle penetration. The correspondence of the obtained bitumen to the standards has been determined. The fractional composition of the diluted oil sludge was determined.

Keywords: Oil sludge, diluent, fractional composition, sulfur, temperature, density, bitumen, gasoline, kerosene, diesel.

To protect the environment from pollution by industrial emissions, it is necessary to create technological processes that would provide not only quantitative and qualitative requirements for the target products, but also the complex use of raw materials. The intensive development of the industry is determined by the creation and implementation of resource and energy-saving technologies. Until now, there are no general principles for the development of technology, both for low-waste and non-waste industries, allowing to solve two interrelated problems: environmental and economic [1-3].

Sulfur is one of the permanent parts of crude oil. It contains sulfur mainly in the form of organic sulfur compounds, and in its derivatives (distillates), as well as in finished petroleum products, it can be found either in pure form or in the form of organic compounds and hydrogen sulfide [4-6]. Sulfur concentration in petroleum distillates obtained by direct distillation of crude oil increases from lower to higher fractions. More than 50 percent of sulfur is concentrated in fuel oil, and its content in gasoline is minimal [7].

Based on the foregoing, a series of experiments was carried out to determine sulfur in the composition of distillate fractions obtained during processing of diluted oil sludge.

Table 1.
Sulfur content in the composition of distillate fractions obtained during the processing of diluted oil sludge

Faction names	***Mixing duration,*** *min*							
	30	60	30	60	30	60	30	60
	Diluent' s name							
	Light naphtha		Heavy naphtha		Reformat		Hydrocarbon solvent	
	Sulfur content, *%*							
Petrol	0,031	0,029	0,031	0,030	0,036	0,038	0,037	0,039
Kerosene	0,034	0,030	0,032	0,031	0,041	0,040	0,040	0,038
Diesel	0,041	0,035	0,041	0,035	0,046	0,046	0,042	0,037

Table 1 shows that the amount of sulfur in gasoline, which was released during the distillation of diluted oil sludge with light naphtha mixed for 30÷60 minutes, is 0,031% and 0,029%. The solvent used was heavy naphtha, reformate, hydrocarbon solvent. In the composition of kerosene, the sulfur content is 0,034%, and in the composition of kerosene released during the distillation of diluted oil sludge with a reformate diluent there is 0,041%. When diluted oil sludge is distilled with a solvent, a hydrocarbon solvent releases a diesel fraction which contains 0,037% sulfur.

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As you know, oil sludge in Uzbekistan annually accumulates in considerable amount and this oil sludge neither utilized nor processed. This has a negative impact on the environment. Therefore, the processing of oil sludge is an important environmental and economic challenge.

To obtain construction bitumen, we carried out a series of experiments. When conducting experiments on obtaining bitumen from oil sludge, the ratio of raw materials was: oil sludge - 7 kg (70%), solvent - 3 kg (30%).

In the course of the experiments, the hydraulic resistance of the model hydrocyclone was also determined:

$$\Delta P = \frac{\xi \rho \omega^2}{2}, \qquad (1)$$

where is the coefficient of hydraulic resistance of the hydrocyclone; ξ - inlet velocity of the liquid flow, m/s; ω - density of the medium, kg/m^3.

The coefficient of hydraulic resistance of the model hydrocyclone was determined by the formula:

$$\xi = \frac{\Delta P}{\frac{\rho \omega^2}{2}}, \qquad (2)$$

where, ΔP - pressure loss in the hydrocyclone, Pa.

Table 2.
Influence of the diluent when cleaning oil sludge from mechanical impurities (liquid flow rate 20 m/s)

№	Solvent amount, %	Hydrocyclone cleaning degree, %	Hydrocyclone hydraulic resistance, Pa	Hydraulic resistance coefficient
1	5	79,61	1701	8,67
2	10	84,98	1651	8,42
3	15	88,19	1599	8,16
4	20	92,85	1546	7,89
5	25	95,97	1498	7,64
6	30	99,91	1450	7,40
7	35	99,91	1410	7,19
8	40	99,91	1390	7,09
9	45	99,91	1315	6,70
10	50	99,91	1278	6,52

Table 2 shows that when adding 5% of a diluent to the mixture, the degree of purification of the hydrocyclone is reached 79,61%, while the hydraulic resistance of the hydrocyclone is 1701Pa. On the basis of the studies carried out, we have determined the optimal amount of solvent for diluting oil sludge; when adding light naphtha up to 30%, the efficiency of cleaning a hydrocyclone is achieved to its maximum, i.e. this figure is 99.91%, while the hydraulic resistance of the hydrocyclone was 1450Pa, and the hydraulic resistance coefficient was 7,4. By increasing the amount of solvent in the mixture, the proportion of mechanical impurities in the oil sludge is reduced.

We carried out a series of experiments to determine the physicochemical properties (density and viscosity) of a mixture of oil sludge. The oil sludge mixture consists of sludge and diluent in a ratio of 70:30. For this, the density of the mixture was first determined using an AON-1 hydrometer and the viscosity of the mixture using a VPZh-2 viscometer. The results of the obtained experimental data are shown in table 3.

Table 3.
Change in density and viscosity of a mixture of oil sludge depending on temperature

№	Mix temperature, °C.	Density of the mixture, g/sm^3	Mixture viscosity, mm^2/s
	20	980	175·10^{-6}
	30	960	160·10^{-6}
	40	940	150·10^{-6}
	50	920	140·10^{-6}

It can be seen from table 3 that the oil sludge mixture at 20 °C has a density of 980 g/sm^3, and a viscosity of 175 mm^2/s, at 30 °C, the density decreases to 960 g/sm^3, and the viscosity of the mixture also decreases to 160 mm^2/s, with a further increase in the temperature of the oil sludge mixture at 40 °C, the density is 940 g/sm^3, and the viscosity is 150 mm^2/s. At 50 °C, the density decreases to 920 g/sm^3, and the viscosity of the mixture also decreases to 140 mm^2/s.

The widespread use of bitumen, especially in construction, is explained by the very valuable building properties of bitumen: high binding capacity, plasticity and elasticity (not only bitumen itself, but also its

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mixtures with other materials), high water-insulating capacity, etc. [8].

The most widespread are petroleum bitumen, due to the rapid development of the oil industry, which provides and soars the production of petroleum bitumen. The main properties of petroleum bitumen are characterized by the following data [9].

Since the group composition of bitumen (the content of oils, resins and asphaltenes) determines its physical and mechanical properties, it is possible to regulate these properties of bitumen within certain limits by changing its group composition. When using bitumen in road construction, as well as in the production of roofing works, this requirement is not significant, if mechanical impurities are not large, have a small specific weight and therefore can play the role of a filler [10].

The content of mechanical impurities in bitumen negatively affects the quality of bitumen, therefore, the content of mechanical impurities in the resulting bitumen should be minimal.

Based on the foregoing, we carried out experiments to determine mechanical impurities in the composition of the resulting bitumen. Experiments were carried out on Soxhlet using diluting agents light naphtha, heavy naphtha, reformate and hydrocarbon solvent.

To determine the amount of mechanical impurities in the bitumen composition, the method according to (GOST-state standard - SS) SS6370-83 was used, according to which the paper filter was dried to constant weight at 105 °C. A batch of bitumen was preheated in a water bath to 40 °C, since the analyzed bitumen was highly viscous. Next, a sample of bitumen weighing 1 g was diluted with gasoline weighing 25g. The hot solution of the sample was filtered through a dried paper filter placed in a glass funnel. After filtration, the filter was transferred to a weighing bottle and dried in a thermostat for 1 hour. After drying, the beaker was cooled in a desiccator for 30 minutes, then weighed on an analytical balance.

Below are the physical and chemical properties of the bitumen obtained by us in laboratory conditions. The samples were analyzed in accordance with SS22245-90, with instruments and measuring instruments that passed the State inspection.

Table 4
Results in comparison of the obtained bitumen with various SSs

The name of indicators	**SS 22245 -90 BN 60/90**	**Norm for TS05767930 * -263:2017**	**Indicators of the obtained bitumen from oil sludge**
Softening temperature according to softening point, ° C.	Not less 45	Within 38-50	57
Depth of needle penetration, 0.1 mm, at 25 ° C	60-90	140-220	200
Depth of needle penetration 0.1, at 0 ° C	No less 10	-	140
Elongation, cm, at 25 ° C	No less 70	-	72
Brittleness temperature , 0 ° C	Not higher - 6	-	-5
Flash point, in an open crucible ° C.	240	250	245

** - Technical Standard*

From table 4 it can be seen that the bitumen obtained by us has a softening temperature according to ring and ball method of 57 °C, the penetration depth of the needle is 0,1 mm, at 25 °C it is 200 °C, the penetration depth of the needle is 0,1, at 0 °C - 140, the brittleness temperature is -15, flash point 170 °C.

Table 5/
The content of mechanical impurities in the composition of the resulting bitumen

Light naphtha	Heavy naphtha	Reformat	Hydrocarbon solvent
0,012	0,013	0,015	0,011

Table 5 shows that bitumen diluted with light naphtha contains 0,012% mechanical impurities. Soluble bitumen with a diluent, heavy naphtha, contains 0,013% mechanical impurities, and also,

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when reformate was used as a solvent, the amount of mechanical impurities in the bitumen composition was 0,015%. The minimum amount of mechanical impurities in bitumen diluted with a hydrocarbon solvent is 0,011%.

Also, experiments were carried out to determine the fractional composition of diluted oil sludge. The results of the studies of the fractional composition of the distillate obtained during the disposal of oil sludge are shown in table 6.

Table 6.
Fractional composition of the obtained distillate at disposal of oil sludge

Density of oil sludge at 20 C, g / cm3	1,2
Water content in oil sludge,%	35
The content of the fur. impurities,%	19
Fractional composition of oil sludge	
Oil sludge distillation start temperature	93
at 95^0 C% vol.	1
- 105 -	4
- 110 -	11
- 120 -	13
- 130 -	15
- 140 -	20
- 170 -	25
- 180 -	35
- 200 -	45
- 210 -	60
- 230 -	75
- 240 -	86,0

Table 6 shows that the density of oil sludge at a temperature of 20 °C is 1,2 g/cm^3, the water content in the oil sludge is 35%, the content of mechanical impurities in the oil sludge is 19%. The initial distillation temperature of oil sludge is 93 °C, at 95 °C - 1% was distilled, and at 105 °C - 4%, at 110 °C - 11%, at 120 °C - 13%, at 130 °C - 15% and the experiment continued in this form up to 240 °C, while - 86% of the total amount of oil sludge was distilled.

Thus, the optimal operating parameters of the bitumen production process have been determined: softening temperature according to ring and ball method - 57 °C; penetration depth of the needle 0,1 mm at 25 °C; The speed of the liquid flow in the hydrocyclone is 20 m/s, the hydraulic resistance of the hydrocyclone is 1450Pa. The bitumen obtained by us meets the requirements of SS 22245-90 oil road bitumen - BND 60/90. The composition of the diluted oil sludge contains distillates of oil products, this is due to the fact that as a result of the processing of oil sludge, the volume of the processed product increases.

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