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Separation of Dispersed Water And Light Hydrocarbon Fractions From Diluted Oil Sludge

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ABSTRACT: Today, a number of works on cleaning oil sludge are carried out in the world, including such scientific research as oil refining, centrifugation and extraction. This scientific work also presents laboratory equipment and mathematical calculations for cleaning oil sludge by centrifugation.

KEYWORDS: oil sludge, mechanical impurities, mineral salts, resinous-asphaltene

I. INTRODUCTION

The production activities of oil refining and oil and gas producing enterprises inevitably have a technogenic impact on natural environment objects, therefore issues of environmental protection and rational use of natural resources are of great importance. One of the most dangerous pollutants of almost all components of the natural environment - surface and underground waters, soil and vegetation cover, atmospheric air - is oil sludge [1, 2].

At present, the restructuring of the oil refinery production structure is aimed at developing waste-free environmental technologies; priority in financing is given to projects that minimize the amount of oil waste, or reuse it profitably. Therefore, the currently known practical developments in the technology of utilization of oil sludge, both domestic and foreign firms, are mainly aimed at the separation and utilization of oil and oil products. The waste water and solid or semi-liquid mass remaining after this, saturated with chemical reagents and hydrocarbons, are practically not utilized, although in terms of toxicity it is more dangerous for the environment [3, 4].

II. SIGNIFICANCE OF THE SYSTEM

By centrifuging gasoline, diesel, kerosene and mechanical particles with different properties containing different amounts of petroleum products, the mechanism of separation of mechanical particles in the mixture was studied. It has been proven that there are mixtures of light naphtha, heavy naphtha reformate and gasoline in the composition of oil sludge. The study methodology is explained in Section III, Section IV contains the experimental results of the study and Section V discusses the future study and conclusions.

III. METHODOLOGY

Therefore, only complex processing and use of waste as secondary raw materials ensures the conservation of natural resources. At the same time, the level of environmental pollution is sharply reduced [5].

Based on the above, we have assembled an experimental laboratory setup for distilling diluted oil sludge in order to separate light fractions from its composition (Fig. 3.7). The diluted oil sludge was fed into a rectification column using a pump to separate light fractions from its composition. The laboratory rectification column consists of six valve trays, a still section 1, an air compressor 2, a gas cylinder for tar deasphalting 3, pressure gauges for determining the pressure inside the apparatus and in the still section of the rectification column 4, thermometers for determining the temperature in the rectification column 5, valves for regulating the gas flow 6,7, nozzles for the outlet of liquid fractions of the oil product 8 and for irrigation 9.

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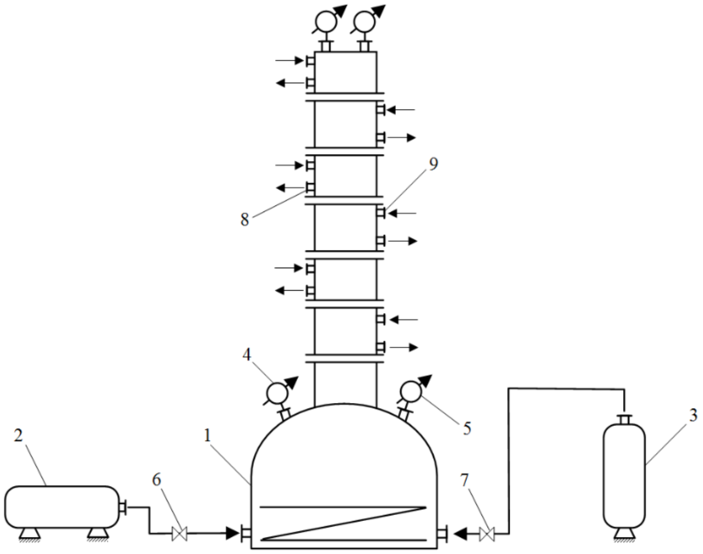

Fig.1. Laboratory distillation column for distillation of diluted oil sludge: 1-cubic part of the distillation column; 2-compressor for compressed air; 3-gas cylinder for tar deasphalting; 4-manometer for determining the pressure in the cubic part of the distillation column; 5-thermometer for determining the temperature in the cubic part of the distillation column; 6,7-valves for regulating the gas flow; 8-nozzle for the outlet of liquid fractions of the oil product; 9-nozzle for irrigation.

IV. EXPERIMENTAL RESULTS

We conducted a series of experiments on distillation of diluted oil sludge with various solvents (solvent ratio 30%) in laboratory conditions. The results of the studies are presented in Tables 1–4.

Table 1

Yield of light fractions from the composition of diluted oil sludge (light naphtha – 30%, oil sludge weight – 4000 ml, mixing duration – 60 min, mixture density – 900 kg/m^3)

№	Faction names	Temperature (output), ºC	Temperature (cube),ºC	Fraction yield, in %
1	Petrol	84-166	130-250	41,12
2	Kerosene	196	260	2,75
3	Diesel	204-237	298-338	2,62
4	Water	-	-	37,87
5	Remainder	-	-	10,87
6	Losses	-	-	4,75
	Sum	-	-	100

Table 2.

Yield of light fractions from the composition of diluted oil sludge (hydrocarbon solvent – 30%, oil sludge mass – 4000 ml, mixing duration – 60 min, mixture density – 905 kg/m^3)

№	Faction names	Temperature (output), ºC	Temperature (cube), ºC	Fraction yield, in %
1	Petrol	130-183	175-209	46,12
2	Kerosene	205-239	209-300	6,0
3	Diesel	260	350	3,5
4	Water	-	-	34,25
5	Remainder	-	-	6,39
6	Losses	-	-	3,74
	Sum			100

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Table 3.

Yield of light fractions from the composition of diluted oil sludge (gasoline – 30%, oil sludge mass – 4000 ml, mixing duration – 60 min, mixture density – 920 kg/m^3)

№	Faction names	Temperature (output), °C	Temperature (cube),°C	Fraction yield, in %
1	Petrol	70-170	112-270	44,5
2	Kerosene	179	330	3,5
3	Diesel	260	330	3,25
4	Water	-	-	33,5
5	Remainder	-	-	10,55
6	Losses	-	-	4,7
	Sum	-	-	100

Table 4

Yield of light fractions from the composition of diluted oil sludge (reformate – 30%, oil sludge mass – 4000 ml, mixing duration – 60 min, mixture density – 920 kg/m^3)

№	Faction names	Temperature (output), °C	Temperature (cube),°C	Fraction yield, in %
1	Petrol	105-184	170-310	38,83
2	Kerosene	210	336	3,02
3	Diesel	263	341	2,75
4	Water	-	-	42,22
5	Remainder	-	-	8,03
6	Losses	-	-	5,15
	Sum	-	-	100

From Tables 1–4 it is evident that different solvents were taken in the ratio (solvent amount 30%) for each experiment, i.e. light naphtha, hydrocarbon solvent, reformate and gasoline. To dissolve 4000 ml of oil sludge, 120 ml of light naphtha were added, while the density of the mixture was 900 kg/m3, this indicator in the hydrocarbon solvent was 905 kg/m3, and with further addition of 120 ml of reformate and gasoline, this indicator remained unchanged, i.e. - 920 kg/m3. When diluting oil sludge with light naphtha and after distillation, the water content is - 37.87%, and in the hydrocarbon solvent it was - 34.25%, in gasoline - 33.5%, reformate - 42.22%, the water content in oil sludge is on average - 37%. The yield of gasoline fractions when diluting oil sludge with light naphtha was 41.12%, and with a hydrocarbon solvent 44.5%, in gasoline 46.12%, this figure with reformate was 38.83%. This is explained by the fact that oil sludge dissolves in a hydrocarbon solvent to the maximum standards. Thus, the most suitable fraction was chosen for diluting oil sludge - a hydrocarbon solvent.

Individual results on the yield of gasoline, kerosene and diesel fractions from diluted oil sludge when diluted in various solvents are shown in Figs. 2 and 3.

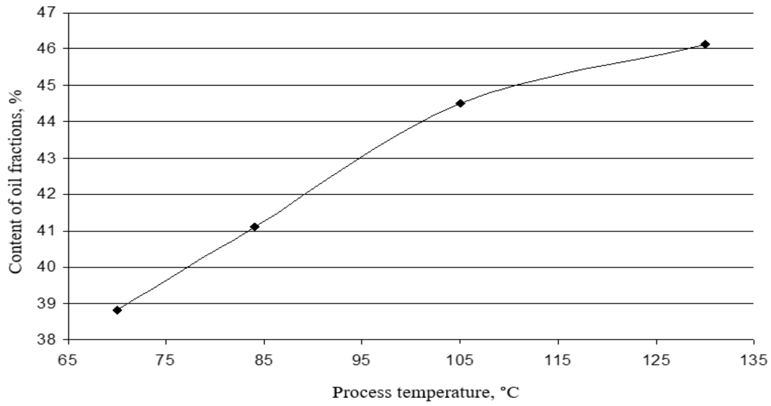

Fig. 2. Content of gasoline fractions in the composition of diluted oil sludge.

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It is evident from Fig. 2 that with an increase in the process temperature to 70 °C, the release of gasoline fractions from the composition of the diluted oil sludge during dilution of reformate is 38.8%, with an increase in temperature to 84 °C during dilution with light naphtha, the release of the gasoline fraction was 41.12%. A further increase in the process temperature to 105 °C during dilution with gasoline, the yield of the gasoline fraction is achieved up to 44.5%. The largest amount of the gasoline fraction is released at a temperature of 130 °C, when diluted with a hydrocarbon diluent, the percentage of separated gasoline fractions was 46.12. This is explained by the fact that with an increase in the process temperature, the release of light fractions also increases.

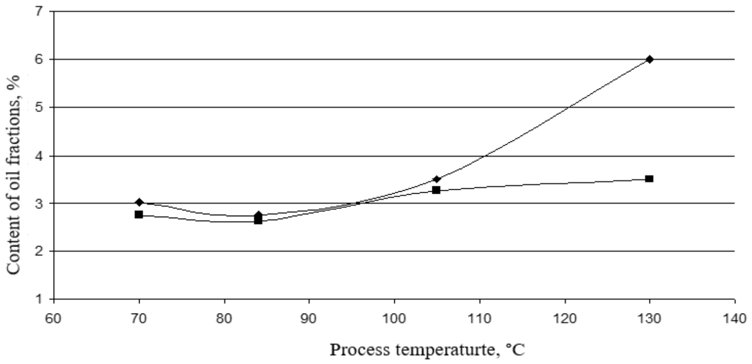

Fig. 3. Content of kerosene and diesel fractions in the composition of diluted oil sludge.

From Fig. 3 it is evident that with an increase in the process temperature to 70°C, when diluting the oil sludge with reformate, the isolated kerosene fraction was 3.02% and the diesel fraction was 2.75%, and with an increase in the temperature to 84°C when diluting with light naphtha, the isolation of the kerosene fraction was 2.75 and the diesel fraction was 2.62%.

Further increase of the process temperature to 105 °C with dilution with gasoline yielded 3.5% of the kerosene fraction and 3.25% of the diesel fraction. The largest amount of kerosene and diesel fractions was released at a temperature of 130 °C, with dilution with a hydrocarbon diluent the percentage of separated kerosene fraction was 6.0%, and the diesel fraction was 3.5%.

V. CONCLUSION AND FUTURE WORK

Thus, our experimental studies on the distillation of diluted oil sludge for the purpose of separating light fractions indicate that the average content of gasoline fractions in the oil sludge is 42.6%, the average content of kerosene fractions is 3.8%, and the diesel fraction is 3.03%. The most suitable fraction, a hydrocarbon solvent, was chosen to dilute oil sludge for the purpose of isolating valuable components from its composition.

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