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Methods for Preparing Oil Sludge for Utilization

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ABSTRACT. Results of a research on preparation of oil slime for processing are given in article, for dilution of oil slime different types thinners in various ratios are chosen (light and heavy naphtha, gasoline and hydrocarbon solvent). For the purpose of purification of oil slime of mechanical impurity it is used centrifugal cleaning which flow rate is varied within 10÷20 of m/s.

KEYWORDS: Oil, oil slime, flow rate, hydroclone, mix, gasoline, centrifugal cleaning

I. INTRODUCTION

During the extraction, transportation and refining of oil, formation and accumulation of oil sludge occurs [1]. In general terms, all oil sludge can be divided into three main groups in accordance with the conditions of their formation: soil, bottom and tank type. The former are formed as a result of spills of oil products into the soil during production operations, or in emergency situations. Bottom sludge is formed due to subsidence of oil spills at the bottom of reservoirs, and tank-type sludge is formed during storage and transportation of oil products in containers of different designs [2,3,4].

The ratio of petroleum products, water and mechanical impurities (particles of sand, clay, rust, etc.) varies in a very wide range: hydrocarbons make up 5-90%, water 1-52%, solid impurities 0.8-65%. Such a significant change in the composition of oil sludge, the range of changes in their physico-chemical characteristics is also very wide. The density of oil sludge ranges from 830-1700 kg / m3, the pour point is from -3 ° C to + 50 ° C. The flash point lies in the range from 35 to 120 ° C [5,6,7].

During long-term storage, oil sludge with time is divided into several layers, with properties characteristic of each of them:

the top layer is a watered petroleum product with up to 5% fine particulate matter and belongs to the class of water-in-oil emulsions. The composition of this layer includes 70-80% oils, 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 upper layer of oil sludge is close in composition and properties to the original oil product;

the middle, relatively small volume layer is an oil-in-water emulsion. This layer contains 70-80% water and 1.5-15% mechanical impurities;

the next layer consists entirely of settled mineralized water with a density of 1.01-1.19 g / cm3;

finally, the bottom layer (bottom sludge) is usually a solid phase comprising up to 45% organics, 52-88% solids, including iron oxides. Since bottom sludge is presented in the form of a hydrated mass, the water content in it can reach up to 25%. In the process of processing sludge, various technological methods can be applied depending on their physical and mechanical characteristics. The collected oil sludge of a liquid-viscous consistency is subjected to separation into oil product, water and solid solids. This phase of refining has its purpose - the extraction of oil products with initial properties from the sludge and their use for its intended purpose. There are two main methods of phase separation of liquid-viscous oil sludge - mechanical and chemical. For deeper refining of petroleum products, they sometimes resort to complex technology. The destruction of stable water-oil emulsions by mechanical means is based on technological methods of artificially changing the concentration of the dispersed phase of the emulsion, followed by

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coalescence of small drops of this phase. To carry out the operation of interphase separation of liquid-viscous oil sludge, a large number of technological devices have been developed at present, including separators, centrifuges, and hydrocyclones of various designs [8, 9, 10].

II. SIGNIFICANCE OF THE SYSTEM

Results of a research on preparation of oil slime for processing are given in article, for dilution of oil slime different types thinners in various ratios are chosen (light and heavy naphtha, gasoline and hydrocarbon solvent).The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

Based on the foregoing, we have assembled an experimental laboratory technological line consisting of a two-stage hydrocyclone installation for cleaning oil sludge from mechanical impurities (Fig. 1). The production line consists of: a tank for supplying oil sludge 1, a tank for supplying a diluting agent 2, a collector for mixing the diluent with oil sludge 3, hydrocyclones for separating solids 4.5, silos for trapped mass 10 after cleaning the oil sludge from solids, pumps for injection of flow 12, valves for regulating the flow inside the pipes 15. Tank 3 is filled with oil sludge through pump 12, diluent is poured from tank 2 into tank 3 to dissolve the oil sludge in various proportions, then mixed for 30 ÷ 60 min. The temperature of the process is in the range of 60–70 ° C, after which, in order to clean oil sludge from mechanical impurities using pump 12, the diluted fraction was supplied in two-stage hydrocyclones 4 and 5 at a speed of 20 m / s. Formed during the process, the purified phase is discharged into the bunkers 10. Moreover, the flow rate of the feedstock is measured using a flow meter, and the hydraulic resistance of the hydrocyclone and the hydraulic pressure of the liquid in it is determined by a pressure gauge 14.

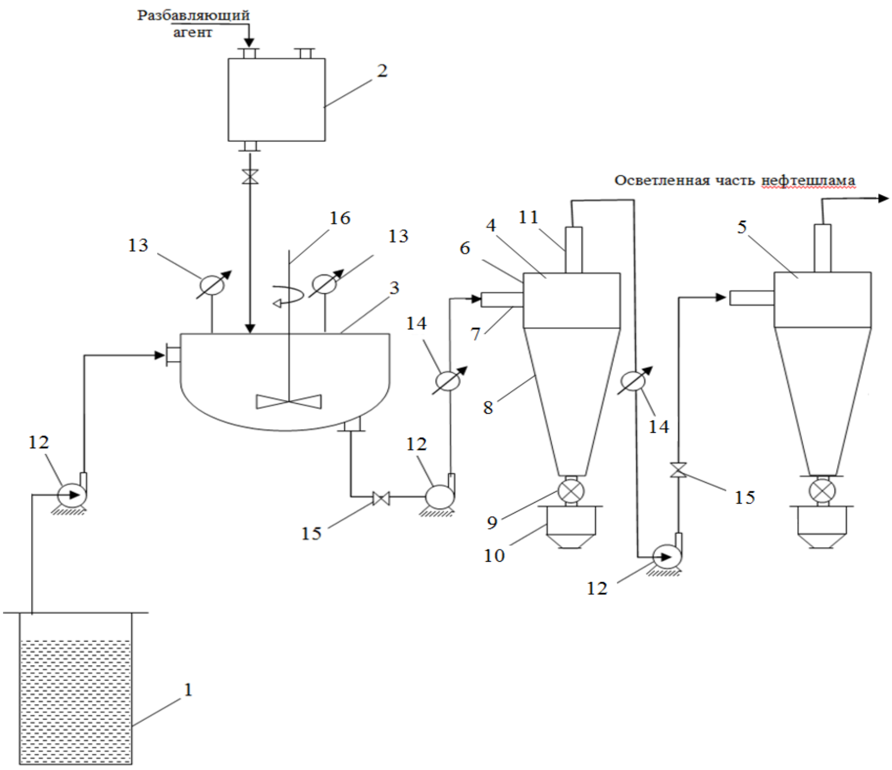

Fig. 1.Purification of oil sludge from mechanical impurities: 1- capacity for oil sludge supply; 2- capacity for supplying a diluting agent; 3.16-capacity with a stirrer; 4,5-hydrocyclones; 6- cylindrical part of the hydrocyclone; **7** - a supply pipe of a hydrocyclone; 8 - conical part; 9- lock gate; 10- hopper for trapped mass; 11 - drain pipe; 12 - pumps; 13- manometers and thermometers; 14- flowmeters; 15 - gate valves.

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The geometric dimensions of the tank with a stirrer: height - 400 mm; diameter - 300 mm; stirrer rotation frequency - 300 rpm. The dimensions of the laboratory hydrocyclone are as follows: the diameter of the cylindrical part D is 10 mm, the height of the cylindrical part is 10 mm, the height of the conical part H is 30 mm, the diameter of the inlet (supply) pipe for the suspension dвх is 15 mm, and the diameter of the drain pipe for the purified raw material dвв is 15 mm.

IV. EXPERIMENTAL RESULTS

To determine the effect of the diluted liquid flow rate on the efficiency of cleaning oil sludge from mechanical impurities, we conducted a series of experiments. The experiments were carried out in a hydrocyclone, i.e. in a centrifugal field (Fig. 1). In the course of the experiments, the flow velocity in the hydrocyclonewas varied within 10–20 m / s. The results of the experiments are shown in table 1.

Table 1

The results of oil sludge treatment depending on the flow rate (initial concentration of mechanical impurity 25%)

№	Diluted oil sludge speed, m / s	Light naphtha	Hydrocarbon solvent	Heavy naphtha	Reformat	Petrol
		Residual concentration of particulate matter%				
1.	10	7,18	1,91	4,03	2,96	5,14
2.	11	7,01	1,84	3,88	2,74	4,81
3.	12	6,82	1,77	3,72	2,59	4,39
4.	13	6,56	1,48	3,48	2,37	4,23
5.	14	6,24	1,21	3,12	2,11	3,93
6.	15	5,16	0,92	2,93	1,98	3,52
7.	16	4,62	0,21	2,18	1,86	3,21
8.	17	3,91	0,19	1,92	1,72	2,95
9.	18	3,01	0,16	1,74	1,66	2,57
10.	19	2,87	0,11	1,56	1,59	2,44
11.	20	2,04	0,02	1,43	1,22	2,31

With an increase in the rate of diluted oil sludge in a hydrocyclone from 10 m / s to 20 m / s, the residual concentration of solids of mechanical impurities also varies between 7.18 ÷ 0.02%, and the type of diluent also affects the separation of solid particles from diluted oil sludge. (light naphtha, heavy naphtha, reformate, hydrocarbon solvent and asoline).

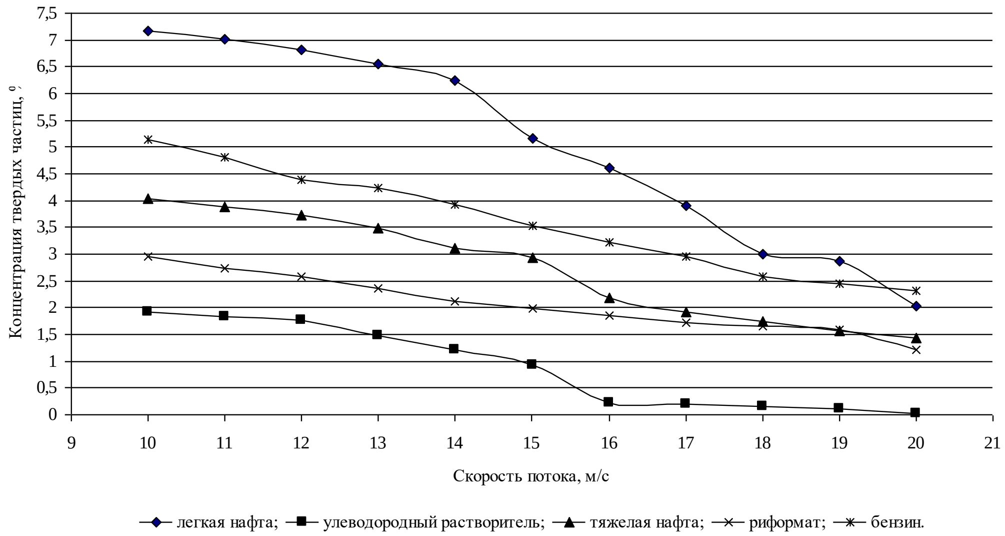

Fig.2. The change in the residual concentration of solid particles depending on the flow rate.

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It can be seen from Fig. 2 that at a speed of 10 m/s of a diluted liquid flow with light naphtha, the residual concentration of solid particles of mechanical impurities in the composition of the diluted mixture is 7.18%, and at 11 m/s this figure was 7,01 %, with a further increase in flow velocity to 20 m/s, the concentration of solid particles was 2.04%. At a speed of 10 m/s diluted with heavy naphtha, the concentration of solid particles was 4.03%, at 15 m/s diluted with this solvent, the residual concentration was 2.93%, and at 20 m/s, the concentration of solid particles was 1,43%. In the course of experiments on the purification of oil sludge from mechanical impurities, it was revealed that a hydrocarbon solvent was chosen to dilute the oil sludge in order to clean it from mechanical impurities, i.e. at a speed of 10 m/s of the liquid stream of the diluted hydrocarbon solvent, the residual concentration of solid particles was 1.91%, and with an increase in the flow rate of 11 m/s, the concentration of solid particles was 1.84%, and with a further increase in the flow rate to 20 m/s, the residual concentration of solid particles in the composition of the diluted mixture was 0.02%. This is because for the dilution of oil sludge in order to easily separate solid particles of mechanical impurities from the composition of the oil sludge, a hydrocarbon solvent is selected.

Further experiments on the purification of oil sludge from mechanical impurities with different diluent ratios of oil sludge were carried out in a centrifugal field at a liquid flow rate of 20 m/s, the concentration of solid particles of mechanical impurities in the initial and purified oil sludge were determined in a Soxhlet flask under laboratory conditions. The results of the experiments are shown in table.2.

Table 2

Results of cleaning oil sludge from solids with various solvents (initial concentration of solids 25%)

№	Ratitions of raw materials,% (solvent / oil lodge)	Light naphtha	Hydrocarbon solvent	Heavy naphtha	Reformat	Petrol
1.	30/70	4,62	0,21	2,18	1,86	3,21
2.	40/60	3,91	0,19	1,92	1,72	2,95
3.	50/50	3,01	0,16	1,74	1,66	2,57
4.	60/40	2,87	0,11	1,56	1,59	2,44
5.	70/30	2,04	0,02	1,43	1,22	2,31

From Table 2 it can be seen that with a change in the type of solvent, the concentration of solid particles of mechanical impurities in the composition of the dilute mixture also changes, i.e. When diluting a light naphtha at a ratio of 30/70, the residual concentration of solid particles is 4.62%, and at 40/60, the concentration of solid particles was 3.91%, with a 50/50 ratio, residual concentration With a change in the solvent on heavy naphtha at a ratio of 30/70, this indicator was 2.17%, with the ratio of this diluent 70/30, this figure was 1.43%. The experiments on the purification of oilshlamare also illustrated below.

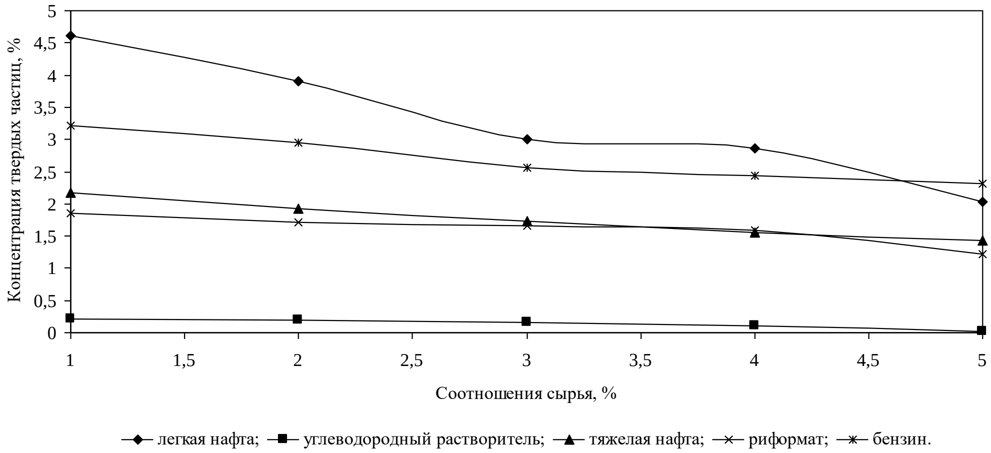

Fig.3. Changing the concentration of solid particles in the composition of the oil sludge, depending on the ratio of the solvent

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With a change in the diluent for diluting the oil sludge on a hydrocarbon solvent (Fig. 3) with a ratio of 30/70, the residual concentration of solid particles of mechanical impurities in the dilute mixture was 0.21%, With a further change in the ratio of the diluent to 70/30, the residual concentration of solid particles of mechanical impurities in the structure of the dilute oil sludge is also reduced to 0.02%.

V. CONCLUSION AND FUTURE WORK

This is due to the fact that with an increase in the diluent ratio with the oil sludge, the concentration of solid fine particles of mechanical impurities is also reduced, as well as for the purpose of light separation of solid mechanical impurities from the composition Thus, for cleaning the dilute oil sludge in the centrifugal field, the optimal liquid flow rate of 20 m/s is selected. The experiments on the preparation of the oil sludge to process indicate that a hydrocarbon solvent is chosen to dilute the oil sludge, while the residual concentration of solid particles in the composition of the dilute mixture was

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