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Physico-Chemical Properties of Oil Sludge for Obtaining Road-Building Material

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Annotation: The article presents the results of the study of physico-chemical and physico-mechanical properties, and the parameters of fractional dispersal of oil sludge. The component ratios of the composition of obtaining bulk road use for the manufacture of building materials have been established

Keywords: oil sludge, fractional composition, dispersal, hydrophobic powder.

To date, practical developments are being found in the technology of oil sludge disposal, which are aimed at separating and utilizing oil and oil products from oil sludge. Having a long half-life, oil sludge accumulates in large quantities on the surface of the earth and can be the cause of environmental and man-made disasters [1-2].

The ratio of petroleum products, water and mechanical impurities (sand particles, clay, rust, etc.) varies very widely: hydrocarbons make up 5-90%, water 1-52%, solid impurities 0,8-65%. Such a significant change in the composition of oil sludge is explained by a wide range of changes in their physico-chemical characteristics. The density of oil sludge ranges from 830-1700 kg/m^3, the pour point is from -3 to +50°C. The flash point ranges from 35 to 120°C [2].

All oil sludge can be divided into three groups: ground, bottom and reservoir type.

Oil-containing waste, depending on the process of its formation, is industrial waste of the second and third class of toxicity and the main sources of entry into the environment of a wide range of hydrocarbons: liquid, solid and gaseous [3].

Advantages and disadvantages, which are shown in table 1.

Methods	**Variation of method**	**Main advantages**	**Usage restrictions**
1	**2**	**3**	**4**
1. Thermal method	1.1. Burning in open furnaces.	No large expenses are required.	Incomplete combustion of petroleum products, high risk of air pollution by combustion products.
	1.2. Combustion in furnaces of various types and designs.	It is used for many types of waste. The volume of ash formed is 10 times less than the initial product. High efficiency of neutralization.	High costs for cleaning and neutralization of flue gases.
	1.3. Drying in dryers of various designs	Volume reduction by 2-3 times. Preservation of valuable components. The	High heat consumption.

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		possibility of combining with other environmental processes.	
	1.4 Paralysis	High degree of decomposition. The possibility of using decomposition products	High material and energy costs.
	1.5. The ASTRA TASIJUK method, consisting in a combination of thermal separation, paralysis and combustion processes.	The resulting products can be reused. Solid sludge processing residues are environmentally safe.	
2. Chemical method	2.1 Solidification by dispersion with hydrophobic reagents based on quicklime or other materials.	High efficiency of the process of processing oil-containing waste into powdered hydrophobic material, which can be used in road construction.	It requires the use of special equipment, pressed lime, additional studies of the environmental impact of the hydrophobic products formed.

1	**2**	**3**	**4**
3. Biological method	3.1. Biodegradation by introducing oily waste into the arable layer of the earth.	Relatively low costs and the possibility of using existing agricultural machinery (tractors, cultivators, plows and others).	Requires significant land plots. The duration of the process, the limited use in warm seasons, the danger of soil contamination.
	3.2. Biodegradation using special strains of bacteria and biogenic additives.	The possibility of intensification of the process. Requires minor capital expenditures.	Significant preparation of land plots and special equipment is required.
4. Physical method.	4.1. Gravitational settling.	Does not require large capital and operating costs	Low separation efficiency does not completely solve the problem due to large volumes of residues.
	4.2. Separation in a centrifugal field.	The possibility of intensification of the process.	Special equipment is required (hydro cyclones, separators, centrifuges) The problem of the end is not solved due to the incompleteness of the separation of oil sludge.
5. Separation by filtration.	Relatively low costs. High degree of reliability of the method. Higher quality of target products.	The need to change and regenerate filter materials, the introduction of special structure-forming fillers.	The problem is not completely solved due to the formation of non-recyclable residues.
	4.4 Extraction	Special equipment and	The need for extract ant

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		solvents are required.	regeneration, incompleteness of extraction of petroleum products from waste.
6. Physic-chemical method	5.1. The use of specially selected surfactants (demulsifies, wetting agents and others).	The possibility of intensification of processes.	High cost of reagents. Requires the use of special dosing equipment, mixing devices. Forms solid waste.

One of the areas of application of oil sludge is road construction, where it is used as an additive to the binder components, improving the quality of asphalt concrete mix by increasing strength, reducing water absorption and reducing the cost of pavement. Another area in terms of the use of oil sludge as a raw material is the manufacture of building materials [4].
Of course, today there are many different devices and technologies of a new generation, which, firstly, allow to reduce the harmful effect on the environment, and secondly, to preserve a sufficient number of important hydrocarbon particles. Various types of centrifuges and separators reduce the harmful effects of mechanical particles, while preserving the hydrocarbon component. These disposal methods require fewer costs than simply burning oil sludge, and their level of efficiency is an order of magnitude higher [5].

The choice of the method of processing and neutralization of oil sludge mainly depends on the amount of petroleum products contained in the sludge. As the main methods of neutralization and disposal of oil waste are practically used [6].

The object of the study was the samples obtained below the following samples:

Sample No. 1 - from the treatment facilities of the sludge pit of the village "Shurtan" (the area of the sludge pit is 10x30 m, depth 3 m);

Sample No. 2 - from the oil trap of the Shirkent workshop (the area of the slurry pit is 3x4 m, the depth is 2 m);

Sample No. 3 - from the oil trap of the Kumchuk workshop (the area of the oil trap is 3x4 m, depth is 2 m).

According to the data of physic-chemical studies of the properties of oil sludge samples, in appearance it is a thick, heavy, viscous mass of dark brown color similar to heavy oil.

The analyses showed that the water content in sample No. 1 is - 7.92%, and in sample No. 2 - 10.3%, in sample No. 3 - 8.0%. The average water content in the samples ranges from 8% to 10%. The average water content in the oil sludge was 8.7%. The high water content in the samples under study required the preparation of raw materials (dehydration) for further research.

The average salt composition of water extracted from oil sludge is presented in Table 2, which confirms that the composition of oil sludge is relatively large in the amount of chlorides and sulfides.

Table 2 Average salt composition of water extracted from oil sludge samples

Name of the indicator	Meaning		
	g/cm^3	mg/l	mol/l
Anions			
Chlorides		5401,3	152,4
Sulfates		322,6	6,7
Bicarbonates		168	2,8

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Carbonates		0	0
TOTAL:			161,9
Cations			
Calcium		88	4,4
Magnesium		7,5	0,6
Sodium+potassium			156,9
TOTAL:			161,9
Dry residue		12304	
Total alkalinity			2,8
Total hardness			5,0
pH		6,8	
Density	1,005		

The analysis showed that the oil sludge contains significant amounts of chloride salts, the content of which depends on the water content. So, in the average sample, the water content was 8.7%, and the chloride salts - 5401.3 mg /l, which corresponded to 0.54%. However, it should be noted that the dependence of the amount of chloride salts on the water content is not directly proportional. The high content of chloride salts in oil sludge requires additional processing of oil sludge washing it from them [7].

The content of mechanical impurities in oil sludge depends on the selection conditions. Basically, the content of mechanical impurities is about 10% - 30%. Determination of mechanical impurities in the analyzed oil sludge samples showed that their content ranges from 11.3% - 15%. After removal of light fractions of oil sludge from the analyzed sample, the content of mechanical impurities increases to 32% -34% [8].

The density of oil sludge ranges from 830-1700 kg/m3 and differs significantly from the density of oil, and the density of the studied oil sludge at 20 oC varies from 886 to 992 kg/cm3. The kinematic viscosity of the oil sludge was at 50 0C - 3.27 cSt , and at 80 0C - 1.79 art . The conditional viscosity of the bitumen fraction increases to 7.1, which corresponds to the kinematic viscosity of 54 cSt [9].

The conducted studies have shown that the studied oil sludge samples have a solidification temperature from $7,0^0$C to $15,5^0$C, which causes its low mobility at room temperature and the flash point is 68^0C. This indicates the presence of light hydrocarbon fractions in the initial oil sludge and a significant proportion of heavy low volatile fractions in it.

The content of dissolved minerals was determined by the amount of ash formed during the combustion of oil sludge. The ash content of oil sludge depends on the quality of the feedstock and on the conditions of its processing. The high ash content in oil sludge negatively affects the quality of the roadway and its operation. Determination of ash content in oil sludge was carried out by gravimetric method after burning coke residue in a muffle furnace. The coke residue content was 45.25%. The ash content of the analyzed oil sludge was 23.62%. In appearance, the hall was a powder of brown color.

The study showed that the total sulfur content in the initial oil sludge ranges from 0.43% to 1.04%, depending on the place of sampling. Determination of the content of hydrogen sulfide and mercaptans by titrimetric method showed that the content of mercaptans fluctuates in the range of 7% - 9% and hydrogen sulfide is absent.

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Table 3 Results of physico-chemical parameters and fractional dispersal of oil sludge

Name of the indicator	Meaning
Density at 20^0C, g/cm^3	0,918-0,992
Mass fraction of water, %	8,7
Mass fraction of sulfur, %	1,02
Hydrogen sulfide content, %	Missing
Mercaptan content, %	8,7
The content of mechanical impurities, %	11,09
The content of chloride salts, mg/l	4136,5
Flash point, ^{0}C	75
Freezing point, ^{0}C	11,5
Kinematic viscosity at 20^0C, cSt	54,0
Ash content, %	23,62
Corrosion on the copper plate	Can't stand
pH	6,54
Fractional composition (GOST 2177):	
Temperature to start distillation, ^{0}C	85
10% boils away at a temperature, ^{0}C	97
20% boils away at a temperature, ^{0}C	165
30% boils away at a temperature, ^{0}C	186
40% boils away at a temperature, ^{0}C	210
50% boils away at a temperature, ^{0}C	241
50,7% boils away at a temperature, ^{0}C	285
End boiling point, ^{0}C	285
Remains, %	47,8
Losses, %	1,5

As can be seen from the study, oil sludge is a very complex mixture of hydrocarbons of various classes and their hetero derivatives, the composition of which largely depends on the nature of the feedstock.

We know that asphaltenes, which are products of further resin compaction, play a large role in the composition of road bitumen and bitumen for construction purposes.

In the table 4 presents the physic-chemical parameters of oil sludge.

Table 4 Physic-chemical parameters of oil sludge

№	Density, g/cm^3	t^{o}C solidification	Content %				
			H_2O	S	Mechanical impurities	Asphalt-resinous substances	Paraffins
Sample 1	0,927	11,5	7-9	0,9	11,1	11,51	0,2
Sample 2	0,918-0,992	15	9,3	1,3	12,3	12,5	0,3
Sample 3	0,855 - 0,992	15,5	6,8-7	1,2	10,8	12,8	0,3

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Based on the study of the physic-chemical parameters of oil sludge, it was found that the density of the analyzed oil sludge is in the range from 0, 92 to 0,992 g /cm^3, which refers to oil sludge with an average density.

The content of asphalt-resinous substances in the analyzed oil sludge is in the range of 11,51% - 12,8%, which indicates that the production of road bitumen is not a standard.

Most oil sludge is subject to direct disposal in the manufacturing processes of road and construction materials as raw materials. Asphaltenes, paraffin's and other high-molecular compounds, which are part of oil sludge, are known to have surface-active and astringent properties. It is this feature of oil sludge that can be effectively used in their disposal. Having a high adsorption capacity, liquid-viscous oil sludge is relatively easily distributed over the surface of almost any dispersed mineral phase. At the same time, due to the physicochemical interaction of oil sludge with a mineral dispersed medium, chemisorptions absorption of pollutants, including heavy metal oxides, by the mineral matrix and their neutralization occurs. The processes of converting such colloidal-dispersed systems into road-building materials can be regulated using specially selected reagents to obtain environmentally friendly compositions with the necessary technological characteristics.

For the disposal of oil sludge containing a sufficiently high water content, quicklime was used, the effect of which is based on its ability to enter into an exothermic reaction with water.

The peculiarity of this reaction is that it proceeds with the heating of the mixture. The final stages of this reaction are accompanied by the formation of steam, and sometimes by local outbreaks. The reaction product is a brown powdery substance consisting of small granules.

The resulting product exhibits inert properties with respect to water and soil, since the particles of toxic pollutants are enclosed in calcareous capsule shells and evenly distributed in the mass of the product. The material made of such granules has a high density, water resistance and can withstand loads up to 90 Map.

When oil sludge is mixed with these components in a ratio from 1:1 to 1:10, the waste is adsorbed on the surface of Ca hydroxide. As a result, a dry hydrophobic powder is obtained, which can be used as a loose road-building material.

With natural drying of the mixture for several days, a dry, non-wet table hydrophobic powder was obtained, suitable for its further use as a loose road material or a component of the charge for the manufacture of building materials. These materials (bricks, slabs, timber, etc.) can be obtained either by pressing dry charge, or by pouring the slip into the appropriate collapsible molds.

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