THE TECHNOLOGY OF PREPARATION OF THE OIL SLUDGE PIT WITH POLYMERORGANIC SCREEN FOR OIL WASTE

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ABSTRACT

In this paper described technology of preparing oil waste sludge pit, where as antifiltration screen is used polymerorganic screen based on asphalt resin paraffin deposits (ARPD) and polymer material. Processing of oil waste and reducing their formation is a significant problem from the ecological point of view and requires new ecological and technological solutions. In this research paper analyzes the results of world practical experiments on the application of waste and presents technical solutions for the use of waste that are suitable for future application. The feature of this work is obtaining waterproofing materials based on asphalt - resin - paraffin deposits and polymer, moreover the improvement of its physicochemical properties. The results of experimental laboratory testing of the effects of aggressive components of waste on the physical and mechanical properties of the material made from polymerorganic and cement mixture are presented. The composition of the material for the bottom and walls of oil sludge pits are: the Portland cement M400 and the amount of dissolved lime are respectively 4; 5; 6; 7% and soil mass 3; 4; 5%. The soil content is 60% clay, 10% sand, 22% ARPD, 6-13% polymer materials.

Keywords: asphalt - resin - paraffin deposits, polymer, waterproofing material, oil wastes, polymerorganic screen, antifiltration, technology.

INTRODUCTION

During the drilling and operation of oil and gas wells, toxic wastes that contain a large number of chemical elements and compounds are included in the closest geographical areas of the hydrosphere and the lithosphere, where the environment is isolated. Industrial oil wastes will be after oil production and processing technology, transportation, repairs and emergencies. The most affordable way to isolate these wastes is to store them directly in the oil storages outside the drilling site or outside.

Oil wastes are harmful to the environment, land, groundwater, flora and fauna. The storages for oil wastes, which are the source of the housekeeping, are primarily polluting the atmosphere. Characteristics and levels of harmful impacts of oil residues on air, soil, groundwater, flora and fauna depend on their size, shelf life, construction and relief position. As a result of tests at the Akshabulak field, pollution of the atmosphere was caused by the evaporation of hydrocarbon gases. Their size was 2-5 mg / m^3 from the opposite side to wind direction, 25-28 mg / m^3 from the wind direction.

Oil and mineral water, filtered by warehouse walls and bottoms, pollutes the land and water horizons. Therefore, the storage of oil wastes shall be resistant to the aggression impact of oil and gas wells residues and have a waterproofing anti-filtration protective screen. Therefore, modern methods of oil residue storage, sludge plants construction, operation and disposal are considered (Bartolomey, *et al.*, 2005).

In many cases the storage conditions are very low: according to normative documents of roads to have access to the landfills, the fence of the polygons has been destroyed, or at all. Antifiltration screens for waste are not provided, which is inconsistent with regulatory documents and can lead to environmental degradation. In order to avoid contamination of soil and groundwater with oil products, it is important to make a antifiltration screen on the bottom of the sludge pit, and the bottom should be waterproofing.In this regard, the construction of anti-filtration screens is necessary with the appropriate feasibility study and under conditions of their durability and resistance against the corrosive effects of waste.

EXPERIMENTAL PART

The soil filtration coefficient of the hazardous liquid II and III grade should not exceed K_f = 1x10^{-8} cm / sec or K_f = 0.0000086 (00001) m / day. The soil-bitumen screen serves as the basis for other types of screens and is a mineral natural soil, treated to a depth of 10-25 cm with liquid bitumen or oil with the addition of cement and compacted with smooth rollers.

In its pure form, concrete or reinforced concrete in screens is rarely used, since this material has a relatively high filtration coefficient (Kf = 0.01 m / day). To reduce the filtration coefficient to Kf = 0.00001m / day, the plates are coated with gunning or silicization is used.

According to filtration and strength considerations, the thickness of monolithic or precast reinforced concrete slabs is assumed to be no less than 10-15 cm, modulus of elasticity of concrete is 32500 MPa, concrete of grade not low than B30, F 100, W 8 in accordance with SNiP 2.03.01-84.

The chemical composition of oil wastes was investigated and the physical and mechanical properties of the polymerorganic material were determined and analyzed for use of anti-filtration screen of oil waste sludge pit (Figure 1).

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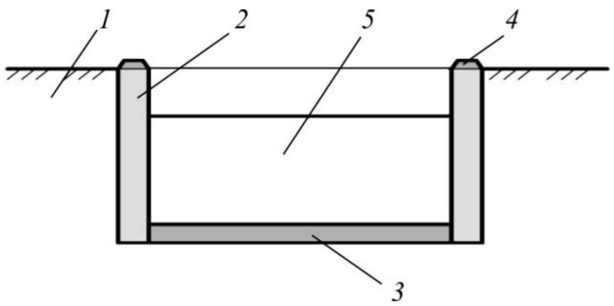

Sludge pit: 1 - ground; 2 - vertical anti-filtration curtain; 3 - horizontal anti-filtration screen; 4 - barking, 5 - drilling mud

Figure-1. Preparation of the anti-filtration screen of polymerorganic material sludge pit.

As a result of the test it is investigated the water impermeability and pressure of the polymerorganic material. Laboratory research shows that oil wastes can be used to create an anti-filtration material for suspension. A reliable and cost-effective way of building a waste sludge pit with an anti-filtration screens based on polymerorganic material was developed to ensure the environmental safety of well-disposal wastes and use of oil and gas wells.

Advantages of the polymerorganic material are: the use of oil waste sludge pit, ease of production, unlimited working time, high water resistance and compression strength, resistance to aggressive components of oil wastes (corrosion resistance), low cost of work and environmental safety of this material.

When drilling wells for the preparation of drilling fluids, chemical reagents are used, which relate to substances of the SH-1U toxicity class, which is very dangerous for the environment. When developing deposits to intensify the extraction of hydrocarbon raw materials, concentrated solutions of various acids, surfactants, inhibitors, etc. are used, during the operation of the wells, oil and condensate emissions occur. The entry of these substances into water bodies, soil, groundwater is environmentally hazardous (Tanzharikov, 2007).

The most accessible way to eliminate drilling wastes and operation of wells is their disposal. Practice the elimination of waste in specially designated areas, deep underground horizons. Burial in specially designated places provides for the use of special structures, abandoned quarries, etc. for this purpose. Such liquidation requires significant transportation costs, therefore it is considered economically impractical. Basically, they practice the collection and storage of industrial-technological semi-liquid drilling wastes directly in earth sludge pits on the site of the drilling site.

But pollutants contained in waste, due to their mobility and high penetrating ability, migrate to groundwater and pollute the environment (Tanzharikov, *et al.*, 2015).

The ground base of the sludge pit of the slurry barn must be protected by a waterproof protective anti-filtration screen that has the properties of durability and resistance to the aggressive impact of drilling waste and exploitation of oil and gas wells. Anti-filtration screen is a reliable waterproofing of the bottom and walls of sludge pits.

As waterproofing materials for anti-filtration screens, compact clay soils mineral soil treated with bitumen with the addition of cement, monolithic concrete, reinforced concrete slabs, polymer concrete, asphalt concrete, asphalt polymer concrete are used (Abilbek, *et al.*, 2017).

All listed materials require multi-layering of both the material itself and additional layers of polyethylene film, sand, gravel, silicate, bitumen or other materials to improve the anti-filtration characteristics. This requires additional costs for the material and its delivery to the site of the storage device. In the practice of foundation engineering and the installation of artificial bases, building material such as ground cement is often used, and it is also widely used as a waterproofing material.

Ground cement is a complex multiphase system containing soil, which has a polydisperse and polymineral composition; cement, which connects soil particles into a monolith; water and, if necessary, various additives (Zotcenko, 2010). Laboratory tests of soil cement showed its high water resistance, which is not less than W6 (Zotcenko, 2011).

Ground cement can be used as a reliable waterproofing material for sludge pit. Preparation of oily ground cement mixture was as follows. As the following additives: Portlandcement M400 and dissolved lime were 4; 5; 6; 7% and soil mass 3; 4; 5 %. The content of soil is 40-60% clays, 10% sand, 22% ARPD, 6-13% of polymeric materials. But for this it is necessary to investigate its resistance to drill cuttings and reagents for intensification of hydrocarbon production. The high water resistance of the oily ground cement, which is achieved in the usual technological cycle without special additives, opens up wide possibilities for the use of oily ground cement in the construction of waterproof curtains, in particular the anti-filtration screen of the sludge pit.

Cement and water in the required amount were mixed manually until a uniform state, the so-called cement milk, was obtained. The amount of cement (20%) was determined as a fraction of the weight of the dry soil. Then, the oily soil was added to the solution with a disturbed structure of a predetermined humidity. The resulting mixture was stirred until homogeneous for 5 minutes. For laboratory tests, samples of cylindrical shape were made with dimensions h = 15.0 cm, d = 15.0 cm in an amount of 120 pcs. On the second day after the formation, the samples were removed from the molds and stored until the test in water for 28 days (time to recruit strength). This method of manufacturing samples meets the technology of building a slurry barn - toxic substances enter the finished barn.

When coating the oil ground cement mixture, the horizontally waterproof screen is blocked using a single layer at the bottom. Conducted laboratory studies of the impact of aggressive components of drill cuttings on oily ground cement showed that over time the strength of oily ground cement has increased and, accordingly, its water

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permeability has increased (from W4 to W6), which indicates the stability of the oily ground cement to the drill cuttings.

This proves the possibility of its use for the construction of an anti-filtration screen of slurry barns. The oily ground-cement anti-filtration screen of the slurry barn provides effective protection of the environment and groundwater from toxic drilling waste and exploitation of oil and gas wells.

Advantages of oily ground cement are: high water resistance, simplicity and speed of production, virtually unlimited service life, resistance to aggressive components of drill cuttings (corrosion resistance), low cost of work, environmental safety.

It should be remembered that the selection of the sludge pit method does not take place for a decade, but for a long period of time. These basins have three main layers: the middle layer (water phase) and the lower layer (bottom sediments). Structure of such layers for a long time, it is due to the fact that open sludge pits. Depending on the theoretical literature (Uliya, *et al*., 2016; Bisenov, *et al.*, 2016), the strength of the oil field can be increased from 2 to 4 times by introducing compounds of polymerorganic binder.

The mixing temperature of component mixtures is broadly influenced by the physical and mechanical properties of the polymer materials. In this study, it was found that the effective mixing temperature of the polymeric materials and ARPD mixtures was 90-130 ^{0}C. At high temperatures, the burning of the organic part of the ARPD and the reduction of the physical and mechanical properties of polymeric materials. At low temperatures, the non-stratospheric distribution of the organic partition ARPD on the mixture, i.e. completely moistened with mineral materials, which also promotes to the decreasing of properties of polymeric materials (Shomantayev, *et al*., 2016).

The content of ARPD in the composition of the oily ground cement was changed from 20.0 ... 40.00% by weight, which in terms of the polymer material is 4 ...10%. The experiments showed that when the polymer content in the mixture is increased to 6%, the mechanical strength of all the samples is increased.

The effect of moisture on polymeric materials is enhanced by increasing the number of pores existing among themselves. Both the water saturation and the residual porosity decrease substantially when the content of the polymer material is increased from 4 to 5%. At the same time, the water saturation decreases from 11.5 to 8.6%, and the residual porosity from 9.1 to 7.0%.

The water saturation is determined by the formulas:

$$W_v = \frac{m_3 - m_0}{m_1 - m_2} * 100$$

Where

m_0 is the mass of a dry sample in air, kg;

m_1 is the mass of a sample aged for 30 minutes in water and suspended in air, kg;

m_2 - mass of the same sample, weighed on water, kg;

m_3 is the mass of a water-saturated sample suspended in air, kg.

The strength characteristics of the mixture, with an increase in the polymer material from 4 to 5%, the temperature of 20 ^{0}C increase from 1 MPa to 1.5 MPa. The ultimate strength is determined by the formula:

$$R = \frac{P}{F}$$

Where P - destructive load, H;

F is the initial cross-sectional area of the sample, m^2.

RESULTS AND DISCUSSIONS

The strength characteristics of the mixture, with an increase in the polymer material from 4 to 5%, the temperature of 20 ^{0}C increase from 1 MPa to 1.5 MPa. The curves of the mechanical strength of water-saturated samples have the same character and at a temperature of 50 ° C, depending on the content of the organic part of the ARPD in the mixture (Figure-2).

Comparison of the curves shows that the mechanical strength of water-saturated samples at a temperature of 20 ° C is approximately 2 times higher than the strength of water-saturated samples at the same temperature and approximately 4, 5 times higher than the strength of the samples at a temperature of 50 ° C.

The low strength of the samples at a temperature of 50 ^{0}C is related to the physical properties of the organic part of the ARPD polymer material, as the viscosity of the organic binder decreases with increasing temperature, which leads to a decrease in the strength of the samples. However, an increase in the content of ARPD in a mixture of 40.00% leads to a violation of the optimal granulometry of the composition of the mixture and, as a consequence, to a decrease in the quality of oily ground cement.

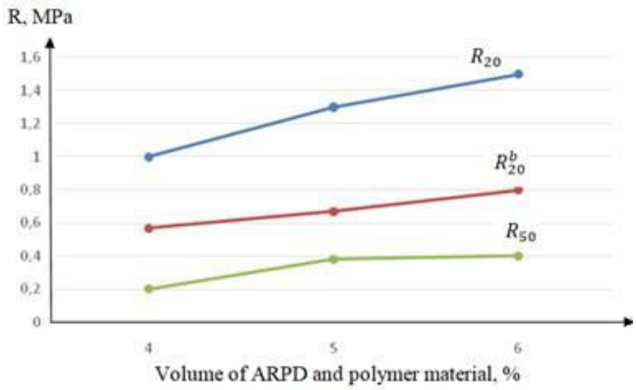

Figure-2. Graphics of strength changes depending on the size of the ARPD and the polymer material mixture.

The temperature of the finished mixture was 100-130 ^{0}C. The content of the polymer additive in the mixture was changed from 1% to 6% of the weight of the mineral part of the mixture, with ARPD content from 20 to 35.7%.

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As studies have shown, the addition of polymeric material contributes to a decrease in water saturation, residual porosity, and increase in strength properties (Figures 3, 4). The introduction of a polymer in an amount of 3-5% makes it possible to obtain a polymerorganic material with following physical and mechanical properties.

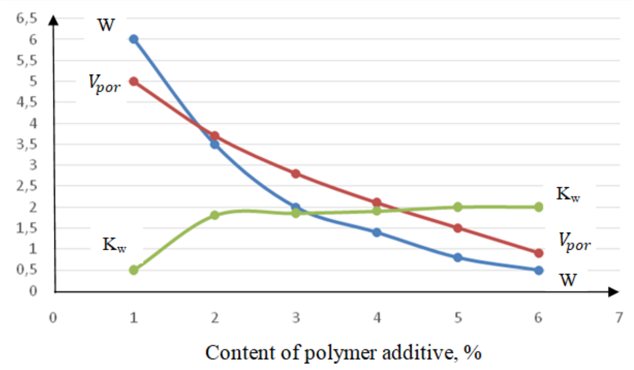

Figure-3. The change in water saturation (W), Residual porosity (V_{por}), water resistance coefficient (K_w) of the mixture from the amount of added polymer additive.

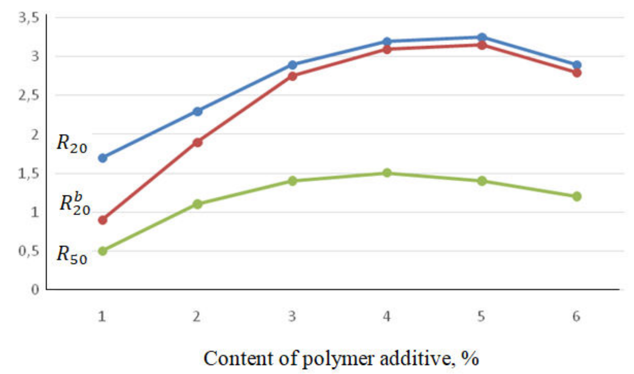

Figure-4. Change in mechanical strength of the oily ground cement mixture from the added polymer additive.

The effect of the molding temperature on the physico-mechanical characteristics of the polymer organic material was studied. It has been established that polymerorganic material with satisfactory physicomechanical indexes is obtained when the samples are formed in the temperature range 70-130^{0}C (Figure-5, Table-1).

Hydrotechnical properties of the polymerorganic material were carried out on felling, which was taken from the anti-filtration coating at various intervals of time in water.

Samples of cuttings were tested to determine the volumetric weight / density /, water saturation and swelling during vacuum metering, according to GOST 12801-84.

The swelling of the samples from the polymerorganic material is determined by the following expression:

$$H_v = \frac{V_k - V_н}{V_н} * 100$$

Here
V_N - the volume of the sample before saturation, m^3;
V_k - after saturation of the sample, m^3

With a long stay in water, the physical and mechanical properties of the material stabilize, meeting regulatory requirements.

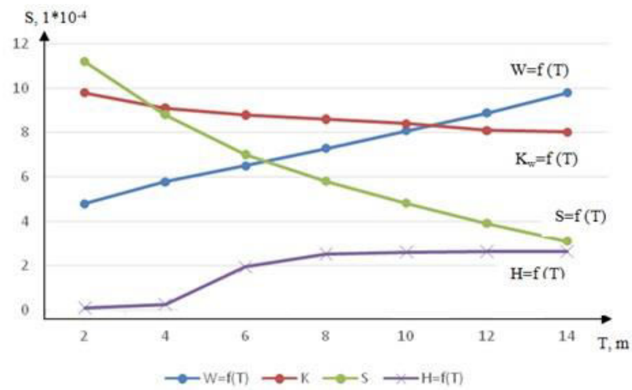

Figure-5. Dependence of water losses on the filtration (S) of the water saturation coefficient (W), water resistance (K), and swelling (H) on the long stay of polymerorganic material in water.

Table-1. Physical and mechanical properties of polymerorganic material.

Sample №	Duration of stay in water T, month	Swelling, H %	Water saturation W,%	Strength, MPa		Coefficient of water resistance K_w
				20	50	
1	1	0,01	1,1	3,0	2,95	0,98
2	4	0,15	1,51	2,90	2,70	0,93
3	6	0,45	1,63	2,75	2,40	0,87
4	9	0,625	1,8	2,60	2,20	0,84
5	12	0,64	2,2	2,55	2,20	0,83

Forming the samples at a temperature of less than 70 ^{0}C makes the compaction process difficult due to the cooling of the mixture, which causes a poor quality of the polymerorganic mixture, namely, the water saturation is increased to 2.1 MPa, at 50 ^{0}C-1.0MPa, the coefficient of water resistance is -0.8. It has been established that samples from mixtures of high temperature (145 ^{0}C) also have low physicomechanical properties. Therefore, packing and sealing of polymerorganic material must be carried out at the optimum temperature of 70-130 ^{0}C. This provides the required complex of structural and mechanical properties, the necessary density, and strength and water resistance.

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