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БЕЗОПАСНАЯ ОЧИСТКА РЕЗЕРВУАРОВ ОТ НЕФТЯНЫХ ОТЛОЖЕНИЙ

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Fireproof cleaning of tanks from oil sediments

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Cleaning of tanks from sediments is dangerous and labour-consuming work. Various methods and technological schemes can be applied for it. The results of the investigations of improvement of cleaning technology of oil tanks are shown in the work. The applied technology of cleaning of oil tanks is based on the use of oil diluter containing 0,001 % mass quantity АП-ЛЗУ-1 antistatic additives. The tests showed high efficiency of developed cleaning method. For chemical-mechanized cleaning of tankers, barges, tanks and other reservoirs from various oil products residues washing agents presenting compositions of synthetical surface-active substances with electrolyte additives have been developed. The recommended method of removal of oil absorbed nonorganic sediment from oil reservoirs allows to exclude manual labour, reduce danger of formation of explosive and toxic atmosphere, create conditions providing full relaxation of statistic electricity charges in cleaning works, and also to exclude damages of the equipment which are used in mechanical cleaning. The given cleaning technology of oil tanks from bottom sediments has been recommended to industrial implementation. The suggested technology won't influence negatively on the demineralization quality if quantity of mixed solvent doesn't exceed 5–7 % the quantity of fresh oil received by the plant. The suggested method was tested in the process of cleaning of 5000 m3 (РВС-5000) capacity vertical steel tank from bottom sediments with 0,000 % mass antistatic additive oil in Dubendi transfer oil farm of main oil pipelines PA.

Keywords: tanks; vapour; oil products; bottom sediments; steaming; electrization; antistatic additives.

Очистка резервуаров от отложений – опасная и трудоемкая работа, в процессе которой используются различные методы и технологические схемы. В данной работе представлены результаты улучшения очистительной технологии резервуаров нефти. Используемая технология очистки нефтяных резервуаров основы-вается на использовании нефтяного разбавителя, состоящего из 0,001 % массовой доли антистатической составляющей АП-ЛЗУ-1. Тестирование показывает эффективность разрабатываемого метода очистки. Для химико-механической очистки резервуаров, емкостей, танкеров от различных нефтяных продуктов были рассмотрены составы синтетических поверхностно-активных веществ с электролитическими составляющими. Рекомендуемый метод очистки от нефтяных абсорбированных неорганических отложений позволяет исключить ручное вмешательство, уменьшает возможность образования вредных и токсичных для атмосферы веществ, создает условия, обеспечивающие ослабление зарядов статического электричества в очистительных работах, а также исключает повреждения оборудования, подвергаемого механической очистке. Данная очистительная технология рекомендуется к индустриальному применению, не имеет негативного влияния на качество деминерализации. Данный метод был тестирован в процессе очистки стального танкера емкостью 5000 куб. м от донных отложений с 0,001 % массовой долей антистатической составляющей нефти в терминале Дубенди ПО Магистральных нефтепроводов.

Ключевые слова: резервуар; очистка; нефтепродукты; донные отложения; пропарка; электризация; антистатические присадки.

Cleaning of tanks and reservoirs from oil contaminants and also carrying out repair works are sometimes followed by explosions and fires.

Problem of fire safety in cleaning, repair, reconstruction and dismounting of oil reservoirs is actual for all spheres of national economy consuming oil products and having reservoirs for their storage. In connection with it review of problem state on the basis of published home and foreign scientific works is given and also the results of experimental investigations carried out on this problem are shown in the article [1].

After draining oil and oil products and disconnecting tanks from the technological scheme often produce removing of combustible vapour and gases by natural or mechanical ventilation.

Natural ventilation time depends on stored oil product type, capacity and forms of the tank, meteorological conditions and in most cases it is 1–3 days [2].

More effective method of tank degassing in comparison with natural ventilation (aeration) is forced ventilation.

In spite of usability both aeration and forced ventilation, in the practice these methods are not deeply studied processes.

In most cases sediments are accumulated in the bottom, sometimes they also cover tank walls. In the presence of residue in the form of liquid or mud on the tank walls are undesirable.

Before the beginning of repair works heavy residues must be removed out of the tank or inhibited against combustion or explosion.

In using process water vapour for cleaning tanks from combustible products special precautions must be taken.

To avoid excessive pressure inside the reservoir it is necessary to provide corresponding speed of removal water vapour and evaporating volatile products out of the tank.

Special attention should be given to the measures against accumulation of static electricity charges, which can appear in rapid water vapour jet, especially at its impact against an obstacle.

It is necessary to mention that earthing must be used independently from the application other protection means from statistic electricity charges. At the same time it should be meant that earthing only partially provides safety of various operations connected with appearance of statistic electricity charges. It mainly prevents external charges. In practice deposits from non electricity conducting substances (sediments, film, resin) often appear on the surface and inside of metallic apparatus walls of the tanks and pipelines, in this case earthing becomes ineffective, but in its presence false thought about reliability and safety is formed, as the process of charge accumulation "flowing" out of the liquid on the equipment walls is broken down and charge dispersal process in the liquid is stopped. Thus earthing doesn't remove emergence of statistic electricity charges inside tanks. Majority of the explosions take place from the charges inside the reservoir in reliable earthing of the equipment. In connection with it earthing only partially provides safety of operations with dielectrics. That's why simultaneously with earthing it is necessary to use other means of removing statistic electricity charges.

Oil and oil products containing tanks are sometimes cleaned by washing with water and water solutions of the chemicals. The quality of cleaning especially without use of chemical washing means depends on mechanical force of jet blow and degree of water-heating [3–7]. Water channel must have necessary discharge and pressure at the sprinkle, providing efficient washing the farthest point of inside space of the reservoir, and the water must be heated. Manual and even ordinary carriage channels with 28–32 mm diameter and with carry of spray not exceeding 30 m are useless for cleaning of big tanks.

In flushing of tanks and reservoirs with high pressure water sprays, especially in collision with solid surfaces and water sprays sprin-kling formation of statistic electricity charges is possible that was proved with experimental investigations of many scientists. Investiga-tions showed conditions for statistic electricity formation are created in water flow containing alien additives or particles with small electroconductivity. Potential of electric field increases in heating water over 60 °C. Investigators from Shell Company came to such conclusions.

Thus flushing with cold water without chemicals and creating powerful compact sprays are less effective. Flushing with powerful hot water sprays with chemicals is fire explosive. If steaming or mechanized

cleaning doesn't provide removal all residues, final cleaning of the tank is realized manually. Manual cleaning can be important in the case if the tank doesn't have residues on the walls, but it is impossible to pump out all residual sludge with spades. It is very difficult and dangerous work.

In carrying out these works additional measures must be taken against people's poisoning with toxic products and also burns in the case of ignition of combustible steams over the surface of the removed sludge [8]. To exclude necessity of a worker presence inside the reservoir and mechanization of labour consuming works in cleaning reservoirs from sludge end corrosive products TB of AzSRI has de-veloped constructions of portable small hydraulic monitor and hydraulic elevator. Thick layer of deposits in the bottom of the tanks in some cases running 10–15 tons considerably complicates the work of oil gathering and goods stocks. Such deposits make difficult discharge of settled water into canalization, and sometimes it becomes practically impossible and only part of water settled in the bottom discharges data of product water content percent distorts. Deposits in the tanks are caused as a result of errors in oil quantity measurement. As a result of a big quantity of deposit accumulation in the oil tanks their useful capacity is reduced sharply.

For chemical-mechanized cleaning of tankers, barges, tanks and other reservoirs from various oil products residues washing agents presenting compositions of synthetical surface-active substances with electrolyte additives have been developed.

However in spite of high efficiency of their application for cleaning of oil reservoirs purification works in the ports of many coun-tries refuse to take flushing waters containing surface active substances in connection with the increase of requirements to environment protection. Maximum accepted concentrations of SAS (surface active substances) in the water reservoirs have been determined as 0,1–0,2 qr/m³, but working concentrations in the washing solutions are more than 1000 qr/m³. As it was above mentioned formation of high charges of statistic electricity is possible in cleaning tanks with high pressure jets.

Considering actuality of the problem of preventing statistic electricity charges accumulation and advantages of application statistic electricity charges and antistatic additives, at the Institute of Petrochemical Processes named after Y. Mamedaliev of Academy of Sciences of Azerbaijan Republic chromazote containing complex antistatic additive АП-А34-1[9] has been developed.

Mentioned additive natural oil acids are gets from chrome salts basis. Getting of these salts in their turns is performers by the following scheme:

$$RCOOH + NaOH \rightarrow RCOONa + H_2O;$$

$$3RCOONa + Cr(CH_3COO)_3 \rightarrow (RCOO)_3Cr + 3CH_3COONa.$$

Reaction is performed in hydrocarbon environment with purpose of excluding inorganic anion. In other wise case dissolution of oil products is difficulted.

Finely additive natural oil acid of chrome salt C16-18 is contained from olefins derivative with ratio 1:1 mol.

Antistatic additive АП-ЛЗУ-1 was tested as an addition to easily ignited liquids used as flushing liquids. Washing process of components of pumps, compressors and other oil equipment is labour-consuming and dangerous and it takes much time.

In the repairing workshops equipment are washed and components (sleeve, conductors, valve units and others) are cleaned in the open bath. The components are dipped into various oil products (petrol, kerosene diesel engine) and cleaned with tampon. In the cleaning process flushing liquid vapouring influences harmfully on respiratory organs and skins of the hand, causes dryness and eczema, pollutes working place and creates big fire danger.

In the testing process washing components were hung from the special hooks welded in the mixer. Flushing liquid was poured into the mixer (kerosene with special electrical conductivity capacity 8,1 pSm/m) into which 0,001% mass antistatic additive was injected.

Injection of antistatic additive allowed bringing special electroconductivity capacity of the fluid to 5600 pSm/m, which is considerably higher than the value (250 pSm/m) enough for providing safety in any operations with easy ignitable fluids [10–12]. High cleaning level of contaminated components was achieved due to high speeds of flushing fluid mixing.

Duration of the washing process was 10–15 minutes. Discharge liquid flowing through the filters is cleaned and can be used for components washing again. The deposit samples from various oil tanks of the Republic regions have been chosen to carry out investigations. These samples have been subjected to the analyses on the content of water, mechanical additions and organics. The results of the analyses are given in Table 1.

As it is shown from the given table the main part of the sediments (–90°) are hydrocarbons (organics), which is a valuable raw material for petro-chemical industry and is liquidated by thousands tons irrevocably at present. As a solvent of bottom sediments burning kerosene of "Azerneftyag" production association (PA) and diesel fuel containing 0,001% mass antistatic additive АП-ЛЗУ-1 are used. All equipment were earthed safely. During carrying out of the experiment 3 kg sediment was replaced into the reservoir and was con-densed in the bottom of the reservoir with special tamper. Then a solvent and antistatic additive АП-ЛЗУ-1 were put into the reservoir. The quantity of the additive was taken so that special capacity of electroconductivity of the solvent was no less 250–300 pSm/m and it would provide full fire safety of the cleaning process.

Intensive mixing of solvent with sediment was provided by circulation according to "reservoir with sediment + pump + heat exchanger + reservoir with sediment" scheme.

The investigation was carried out at 40°, 50° and 60 °C temperatures. From the experiments carried out on experimental installation we can conclude that the best time (130–145 min) of cleaning was obtained at 50–60°C temperature in 1:3 weight coorelation of sediment to solvent (Table 2). The results of the cleaning both in burning kerosene and diesel fuel containing 0,001% mass antistatic additive АП-ЛЗУ-1 are at the same level.

In increasing the temperature of cleaning process observed increase of special electro conductivity capacity of washing

Table 1. The results of analyses of deposit samples additions of various oil fields.

Sample N	Name of the product and its sampling place	Density, gr/m³	Temperature, °C	Content		
				Water, %	Mechanical additions, %	Organics, %
1	"Neft Dashlari" oil field (Dyubendi oil tank farm)	0,91	57,0	13,4	4,1	82,5
2	"Binagadi oil" OGEE Binagadi oil field	0,97	57,5	9,1	3,6	87,3
3	"Balakhani oil" OGEE Balakhani oil field	1,02	55,0	11,6	2,3	86,1
4	"Azerneftyag" refinery fuel oil	1,6	81,5	4,4	6,9	88,7
5	Baku Heydar Aliyev refinery, fuel oil	1,03	80,5	7,0	8,4	84.6

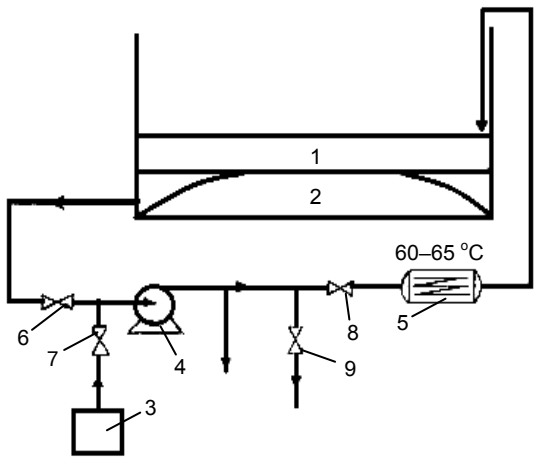

Figure 1. Scheme of reservoir cleaning from oil sediments. 1 – oil with additive; 2 – sediment; 3 – oil tank; 4 – circulating pump; 5 – heatexchanger; 6–9 – stop valve.

composition is favorable to fire safety raise.

The recommended method of removal of oil absorbed nonorganic sediment from oil reservoirs allows to exclude manual labour, reduce danger of formation of explosive and toxic atmosphere, create conditions providing full relaxation of statistic electricity charges in cleaning works, and also to exclude damages of the equipment which are used in mechanical cleaning.

Besides it using the described method of cleaning other advantages can be achieved depending on the character of technological process used in oil refinery.

Thus, if ordinary technology considers mixing of non-conditional oil products with the oil flowing to refining directed to demineralization then the solvent containing sediment would be demineralized before repeated refining. The suggested technology won't influence negatively on the demineralization quality if quantity of mixed solvent doesn't exceed 5–7% the quantity of fresh oil received by the plant. The suggested method was tested in the process of cleaning of 5000 m^3 (PBC-5000) capacity vertical steel tank from bottom sediments with 0,000 % mass antistatic additive oil in Dubendi transfer oil farm of main oil pipelines PA.

Washing of bottom sediments was carried automatically without man presence in the tank according to "tank–pump–heat exchanger–tank" scheme with following pumping mixture of bottom sediments with oil into main oil pipeline keeping quality of the oil transported on the pipeline (Fig. 1).

The tank was cleaned off the oil of "Neft Dashlari" field. The height of bottom sediments was 35 sm. Content of sediments included 78,5 % organic substances, 7,4 % water and 14,1 % mechanical additions. After pumping oil into the tank till 300 sm level 0,001% mass antistatic additive АП-ЛЗУ-1 was injected for providing fire safety of cleaning process and full relaxation of formed static electricity charges.

Special capacity electro conductivity of the oil reached 3400 pSm/m which was many times more than required rate (250 pSm/m) providing full fire explosion safety using fuel fluids.

High circulation speeds were supplied by the pumps ЦНС-30-360 and ЦНС-300-420. The pump and heatexchanger were placed on the flat ground near a cleaned tank out of dyking considering all fire prevention requirements.

By the selection of samples in every 30 minutes necessity of pumping out of the oil mixed with bottom sediments and pumping down clean oil with antistatic additive was determined for carrying out further cleaning.

Pumping out the mixture of the oil with bottom sediments to the main pipeline of Dyubendi transfer oil farm of main pipelines PA with simultaneous mixing of oil in the correlation calculated beforehand and providing conservation of oil quality in the pipeline was carried out by technological pump.

Cleaning of 130 m^3 quantity oil sediment in the tank was carried out for 12 hours without preparatory work time which was 4 hours.

The mixed oil didn't lose its trade quality.

Solution of the statical electricity charge diversion problem at above mentioned cleaning method is increases job`s safety, which is performed by service staff.

Besides it, this method of cleaning is prevents to fuel loss and pollution of environment due to utilization of reservuar.

The tests showed high efficiency of the developed cleaning method and it was recommended to wide industrial implemention. The above method uses only for cleaning of basins of oil and oil products.

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Table 2. The results of experiments of reservoir cleaning from sediments with various solvents containing antistatic additive АП- Л34-1.

Experiment #	Sediments, kg	Solvent		Temperature, °C	Special conductivity capacity, pSm/m	Charge half dispersing time, t_g, sec.	Cleaning time, min
		name	quantity, kg				
1	3	Kerosene with 0,001% mass additive	9	40	2510	0,0047	410
2	3	-//-	9	50	2630	0,0045	345
3	3	-//-	9	60	2830	0,0042	130
4	3	-//-	12	40	2500	0,0048	240
5	3	-//-	12	50	2690	0,0045	155
6	3	-//-	12	60	2740	0,0043	320
7	3	Diesel fuel with 0,001% mass additive	9	40	5430	0,0022	425
8	3	-//-	9	50	5520	0,0021	360
9	3	-//-	9	60	5810	0,0020	335
10	3	-//-	12	40	5390	0,0022	230
11	3	-//-	12	50	5480	0,0021	170
12	3	-//-	12	60	5620	0,0021	145

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