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NEW TECHNICAL SOLUTIONS FOR THE PURIFICATION OF OIL-CONTAINING WASTEWATER

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This paper presents an analytical review of promising technical solutions for treatment of oily wastewaters of industrial enterprises (oil refineries, power plants). Construction diagrams and description of working principles of the equipment are given, and the advantages of these devices compared to traditional analogues are presented.

Keywords: *water treatment, oil products, oily wastewater.*

Rapid development in science and technology tends to disrupt the ecological balance of the environment. This problem is especially urgent in the field of oil production, refining and use of petroleum products. To solve the problem of cleaning oily wastewater of industrial enterprises (oil refineries, thermal power plants, etc.), traditional technologies are optimized, and new ones are under development.

The following are the key technologies of water treatment from petroleum products [1–3]:

1) collection of petroleum products from the water surface;

2) purification of water from petroleum products dispersed throughout the water bulk; and

3) complex purification with the use of sorbents for binding and localization of oil contamination formed on the water surface as a result of emergency oil spills.

The purpose of this work is analytical review of promising technical devices for cleaning oily industrial wastewater.

Consider the device (Fig. 1) the operation of which is based on the principle of a semi-submerged cuvette in contact with the reservoir through the bottom. At the same time, a layer of oil with a thickness of 1–20 mm or more is concentrated in its inner part. This layer of oil can then be transferred to the oil collection container in the traditional way by means of a centrifugal pump.

When the device is lowered to the surface of the water reservoir using bobbers *1*, the slit nozzles *10* of the suction head *11* are installed opposite the petroleum layer floating on the water surface. When the exhaust fan *6* is turned on, a vacuum is formed in the internal cavity of the shell *8*, so that an emulsion of effluents with dissolved petroleum products enters the cavity through the slit nozzles and the flexible pipe *2* from the water surface.

When the pump *7* is turned on (via the sensor *3*), the oil products collected in the upper part of the body are pumped into the collecting tank through the nozzle *4* attached to an additional bobber *9* floating in the internal cavity of the body, and also through the discharge tubing *5*.

The advantage of the device in question in comparison with similar devices of traditional designs [1] is a 17–24% increase in the efficiency of oily wastewater cleaning.

The device in Fig. 2 shows great promise for collecting oil products from water surface [4].

The device works as follows. From the hopper *11* through the dispenser *10*, a powder based on iron oxide Fe_2O_3 or ferrochrome slag enters the air-spray device *9*, whose head is made in the form of a truncated wedge *13*. Then, by means of

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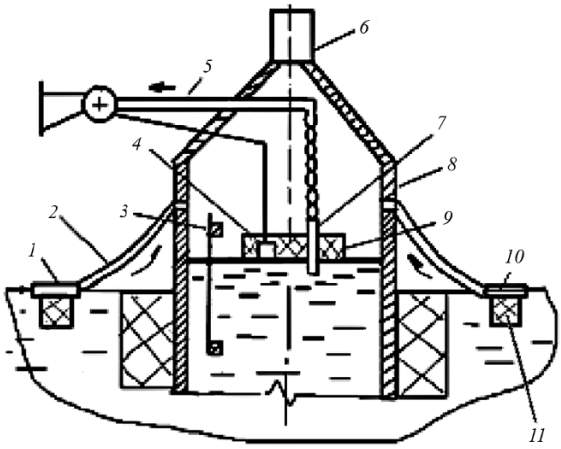

Fig. 1. Construction diagram of the device for oily wastewater cleaning.

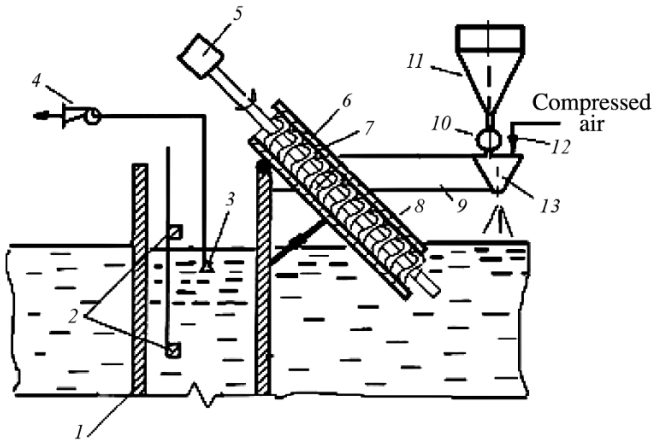

Fig. 2. Construction diagram of the device for collecting petroleum products from water surface.

the compressed air nozzle *12*, the powder is sprayed onto the surface of the oil film located outside the body *1* of the device (the body is made in the form of a cuvette open from the bottom). The atomized powder adsorbs oil products (2.6 g of petroleum products per gram of powder) to form a coagulant in the form of agglomerated particle aggregates (flakes). As a result, the water surface is cleaned of petroleum products.

When the drive *5* is turned on, petroleum products in the form of a coagulant through the worm *7* and the outer pipe *8* are transported through the oil product collection drum *6* to the main body *1*. The coagulant flocculent through the pump *4* nozzle *3* is transported from the main body to the oil tank. The control sensor *2* controls the operation of the pump (turns it on or off) when the level of the water with the coagulant in the main body *1* changes.

Studies have shown that the degree of collection of petroleum products from the surface of water is much greater when using the device considered here than with known devices [1] and reaches 96–98%.

At oil refineries, it is customary to create two wastewater treatment systems. The first system is designed for cleaning water containing oil products and suspended substances. About 80% of the total volume of wastewater is directed to this system. The second system is designed to receive the rest of the contaminated water. Typically, the first wastewater treatment system provides oil traps and filters. In the second system, sewage treatment is carried out on local installations.

A filter for wastewater cleaning from petroleum products is of interest [5] (Fig. 3).

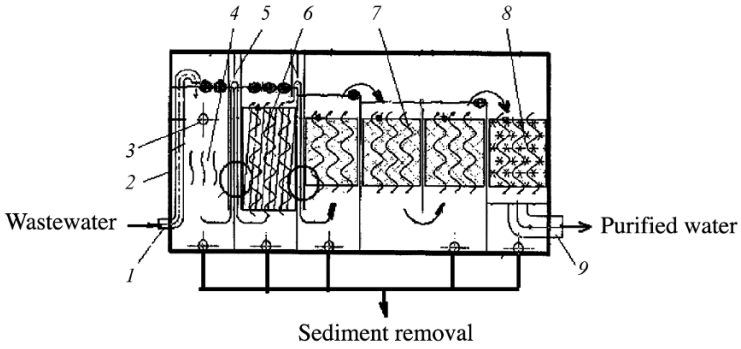

Fig. 3. Construction diagram of a filter for wastewater cleaning from oil products.

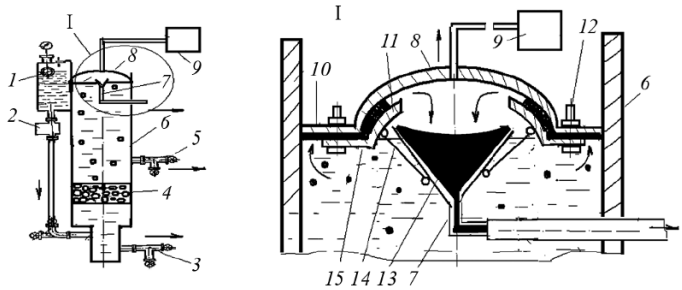

Fig. 4. Construction diagram of an installation with a coalescing filter.

Oily wastewater cleaning in this filter takes place as follows. Wastewater, in the form of an aqueous emulsion of oil products, flows through the inlet nozzle *1* of the body *2* into the receiving container *4*, from where it flows through the channel between the partitions *5* to the tank *6* with a thin-layer filter, where the water is purified from the emulsified petroleum products.

Filter material made of synthetic fibers (polyester) is used as a thin-layer filter. The cleaning time is 840 sec.

From the vessel *6*, the effluents flow into the tank *7* with sorbent fillers, where further purification from oil products takes place. Aluminum aluminosilicate with an adsorption capacity of 800 mg/g is used as an adsorbent. The time of sorption of oil by aluminum aluminosilicate is 900 sec.

Further, the effluents flow into the tank *8* with a carbon filter, where their final purification from oil products takes place.

Holes *3* are provided in the filter housing *2* for discharge of petroleum products, and outlet *9* is provided for purified water.

The advantage of the filter in comparison with other similar devices [1] is improved quality of purification. Studies have shown that the purification rate of this filter is 99.4%.

Figure 4 shows a schematic diagram of a plant with a coalescing filter for cleaning oily wastewater [6].

The installation works as follows. Effluents with emulsified petroleum products through the inlet pipe *1* enter the receiving tank, from where they are sent to the pre-treatment chamber *2* where they are magnetized (using a magnetohydrodynamic inductor) to improve their coalescing ability.

After magnetic treatment, the effluents are fed in a tangential direction to the lower part of the cylindrical body *6*, where, as a result of a cyclical process, mechanical particles in the effluent are lowered into the lower part of the body, from where they are discharged through the sludge outlet pipe *3*.

From the lower part of the body, the stream flows into the coalescing filter *4*. Oil droplets from the oil film form on the granules of the filter, which float to the upper part of the body *6* to the device for their removal. In this device, the height of the suction slot is adjusted by means of adjustment screws *12*. In this case, the annular base *10* of the casing *8* is installed relative to the annular base *15* of the bottom pan *11* in such a way that the slit height is equal to the thickness of the oil product layer.

When the exhaust *9* is turned on, a vacuum forms between the casing and the effluent surface, thereby allowing oil products to enter the cone funnel *13* through the inclined part of the suction slot. From there, oil is discharged through the flexible tubing *7*. Elastic rods *14* are in place for holding the cone funnel in an upright position.

The clarified effluent (water) is discharged through the nozzle *5* located in the middle part of the housing *6*.

In this installation, a high degree of purification from suspended solids is achieved by double deposition: first in the pre-cleaning chamber and then in the coalescing chamber.

Conclusion. The considered technical devices for cleaning industrial oily wastewater have shown high efficiency and can be recommended for broad application.

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