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EQUIPMENT

MAGNETIC SEPARATORS FOR CLEANING OF CUTTING-OIL FLUIDS IN APPLICATION AND UTILIZATION SYSTEMS

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A modernized unit represented as a magnetic disk separator is proposed for the removal of mechanical impurities from cutting-oil fluids.

In application and utilization systems for cutting-oil fluids (COF), significant attention is focused on restoration of their functional properties. COF application systems are divided into individual, group, and centralized systems. The first systems serve a single unit of production equipment, the second a group of machines, and the third departments, shops, or buildings [1].

Magnetic separators designed to remove ferromagnetic impurities from the fluids, are some of the basic components of all types of the systems in question. They effectively remove impurities from a directed COF flow, simultaneously entrapping mixtures with abrasive and nonmagnetic particles, which degrade the output parameters of the production processes.

To improve the degree of cleaning, increase the service life, and restore the quality of COF, we have developed a magnetic separator that differs from familiar electromagnetic separators by simplicity of use and economy during service [2, 3].

A schematic of the device for the proposed procedure for removal of ferromagnetic particles from the fluids is shown in Fig. 1, while Fig. 2 is a diagram of the position of the adaptor for cleaning slime-collecting magnetic disks (side view). Elements 2, 3, 6, 7, 9, and 10 (see Fig. 1) are fabricated from nonmagnetic materials. The base of the container for the fluid being cleaned assumes a cylindrical shape. The magnetic system is composed of hollow cylindrical magnetic disks, on the outside of which a spring-loaded squeeze roller is mounted.

Removal of ferromagnetic particles from the fluid in the device takes place in the following manner. The

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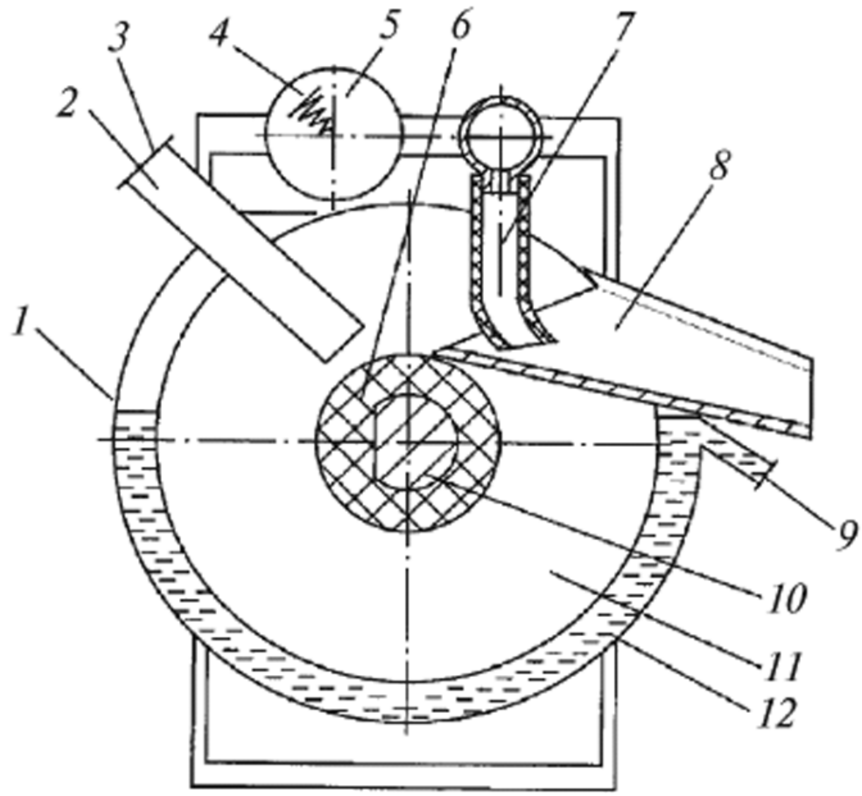

Fig. 1. Schematic diagram of device for removal of ferromagnetic particles from fluid: 1) container; 2) partition; 3, 9) delivery and discharge branch pipes, respectively; 4) spring; 5) squeeze roller; 6) partitions; 7) tubes; 8) adaptor for cleaning slime-collecting elements; 10) shaft with flat; 11) hollow cylindrical magnetic disks; 12) base of container.

fluid subject to cleaning is fed into container 1 via a delivery pipe as a thin layer along channels formed by partitions established at the same distance one from the other between cylindrical magnetic disks in the effective zone between rotating disks 11 and the base of the container. In the magnetic field, the ferromagnetic particles (slime) are attracted to the disks, and are carried away from the fluid. The slime on the disks then falls beneath a squeeze roller, which presses the COF from its layer under the force of spring 4. Removal of slime from disks 11 is accomplished by adaptor 8 during their continued rotation. The slime removed from the magnetic disks is flushed with water delivered into tubes 7 (inclined toward adaptor 8), and is directed into a hydrocyclone (not shown in the figure). Separation of the water and slime occurs in the hydrocyclone. Thereafter, the slime proceeds into a drier, and then into a container for its collection and subsequent remelting (the drier and container are not shown in the figure). The clarified water is delivered for repeated use, and the cleaned COF is removed from the container via discharge pipe 9.

The 6-m^3/h device described was tested under industrial conditions at the Volzhskie Motory Co. (Ul'yanovsk) for the cleaning of a spent 5% Avokat F-78 emulsion. A concentrate with a viscosity of 45 mm^2/sec at 50°C was used for preparation of the emulsion. The flow rate of liquid through the magnetic system was 4.5-6 m^3/h. According to the test results (Table 1), the degree of cleaning decreases from 97-99 to 94-95% when the flow rate is increased to 6.5-7 m^3/h.

The concentration of mechanical impurities prior to and after passage of the fluid through the magnetic

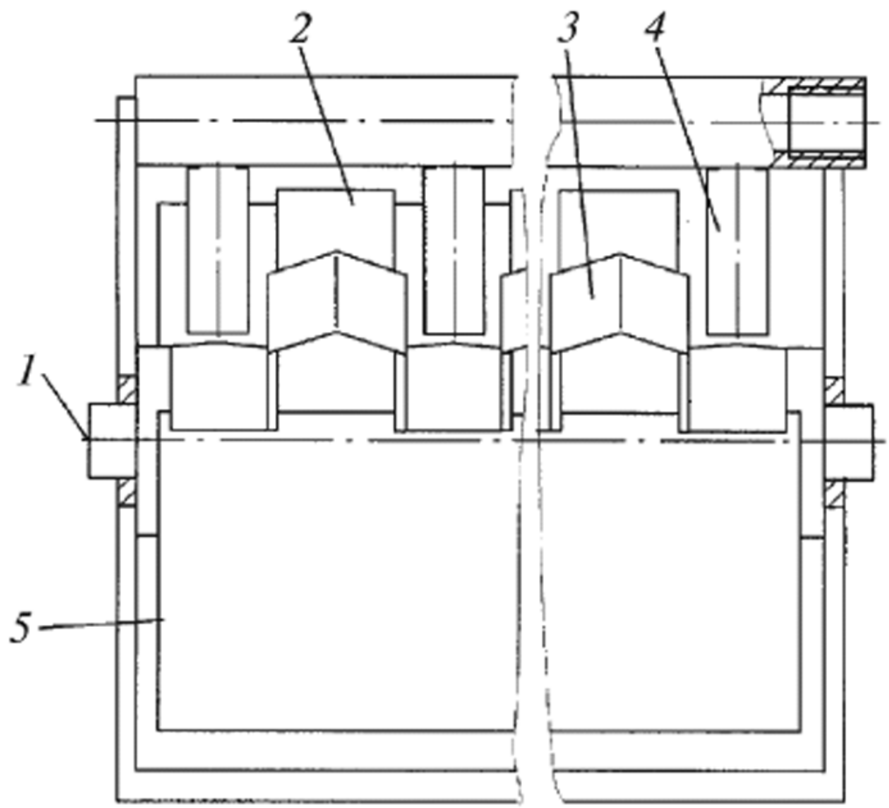

Fig. 2. Diagram showing position of adaptor for cleaning of slime-containing cylindrical magnetic disks (side view): 1) shaft with flat; 2) hollow cylindrical magnetic disk; 3) adaptor for cleaning slime-collecting elements; 4) tubes; 5) base of container.

system was determined by the procedure described in GOST 6370–83. The degree of cleaning ε (in %) was calculated from the formula:

$$\varepsilon = \left(1 - \frac{C_c}{C_u}\right) \cdot 100$$

where C_c and C_u are the concentrations of mechanical impurities in the cleaned and uncleaned COF, respectively.

According to GOST R 50558–93, the concentration of mechanical impurities in the effective COF should not exceed 0.04-0.05 g/liter. This cleanness was achieved during the tests. It must be pointed out that during the cleaning of COF (for example, oily) with a viscosity of 40 mm^2/sec at 50°C at a flow rate exceeding the output of the device, the degree of cleaning is diminished to 93-95%. The type of COF (oil, water, synthetic) has no effect on the degree of cleaning when its optimal flow rate is maintained through the device.

Use of devices with different outputs is possible for the removal of mechanical impurities from fluids. Technical data on devices providing for maximum degree of cleaning – 95-99% are presented in Table 2. The effective area of the magnetic system is calculated with consideration of the bushings employed, the diameters of which fall within the range from 60 to 120 mm, depending of the clearance dimensions and output of the device.

The technico-economic effect derived from use of the devices for removing metal-containing impurities

Table 1

Concentration of mechanical impurities, g/liter		Degree of cleaning, %
prior to cleaning C_u	after cleaning C_c	
1.40	0.025	98
1.42	0.028	98
1.35	0.019	99
1.41	0.022	97
1.37	0.020	99
1.38	0.025	98

Table 2

Technical data	Device with output of, m^3/h							
	6	12	30	60	120	180	240	300
Installed power, kW	0.2	0.3	0.5	0.75	1.0	1.0	1.5	1.5
Clearance dimensions, m								
length	0.51	0.51	0.55	0.60	0.65	0.75	0.75	1.00
width	0.55	0.75	0.80	0.80	0.85	0.85	0.85	0.85
height	0.62	0.62	1.00	1.00	1.10	1.10	1.50	1.50
Effective area of magnetic system, m^2	10.2	19.8	24.8	26.6	33.0	38.2	38.2	49.4

from fluids consists in extension of service life, and restoration of the quality of COF, lubricating oils, and other special technical fluids.

The method proposed for the removal of ferromagnetic particles from a fluid, and the device used to accomplish it can be assumed to be primarily the development, refinement, and modernization of application systems for COF and unit-modular devices with their continued implementation at machine-building establishments.

REFERENCES

1. A. N. Litvinenko, Chemotology of Petroleum Products for Alternative Fuels and Process Fluids [in Russian], Ul'yanovsk (2006).
2. Patent No. 74309 (Russia).
3. Invention Claim No. 2008107286 from 26 February 2008 (Russia)