UDC 622.75: 629.7

TECHNOLOGY OF REGENERATION OF EMPLOYED MASTS

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Aging of the engine oil is a complex complex of physical and chemical processes, of various factors, which are closely interconnected. Engine oils can be restored by chemical, physico-chemical and physical methods. Microfiltration can enter into the process of oil regeneration as the main operation, and in combination with other operations. The combination of microfiltration with the previous operations of regeneration of oils (removal of water, fuel fractions, coarse impurities) allows you to obtain high-quality butter. Distilled waste oil is cleaned of mechanical impurities, water and fuel fractions at high-speed centrifugal cleaners. The work proceeds at a temperature not higher than 95 ° C and pressure at the inlet to the cleaner of about 10 MPa. The purified oil is heated to 60 ° C and passed through the micropores of ceramic rods. Such microfiltration through a semipermeable membrane further cleans the oil. To further improve the performance of the oil filtrate add additives or prepare their mixture with fresh oil, followed by processing in the ultrasonic field. This allows to increase the connection of the components of additives with carbohydrate elements of oils at the molecular level, that is, to stabilize the content of additives and increase the term of their service.

Key words: lubricant, oxidation, regeneration, impurities, kinematic viscosity, coagulation, adsorption, microfiltration.

Introduction. The most important requirement for motor oils is their ability to protect the parts of the cylinder-propeller group from abrasion, scuffing, dyeing. Purification of oils - the technological process of removing from oil distillates and oils of harmful impurities. Regenerated oil - technical grease obtained by purification of spent oil by physical, chemical and physical and chemical methods, with operational properties restored to the requirements of normative and technical documentation (GOST 26098-84). Temperature resistance of oil - the property of the lubricant to provide with a temperature increase a low and stable coefficient of friction in conditions of limiting lubrication. It is known that contamination of oils occurs as a result of their contact from the outside, and as a result of changes in the carbohydrate composition of oils. These processes begin already at the production of oil at refineries and continue at all stages of its transportation, storage and operation. They can be classified into two main types: manufacturing and operating (Fig. 1) [1, 2].

Problem. On the basis of the analysis of literary sources, it was established that used in operation s.-g. technics, diesel oils may contain up to 0.14% (by mass) of pollution, and autotractor oils in the same conditions - up to 0.28% (by mass). The results of the microscopic and spectral analysis of contaminants carried out on the oils DS-11 and DS-8 show that in the oil entering the refueling machines and mechanisms, there are many particles of contamination in the size of more than 50 microns. In reservoirs of oil reservoirs, the number of such contaminants can exceed 1000 per 1 cm3 (Table 1), and a significant proportion of compounds of silicon and aluminum (Table 2) indicates the high abrasiveness of the used oils [2, 4]. Along with solid contamination in motor oils, there is water in the presence of which the process of changing the properties of oils proceeds especially intensively and plays a crucial role in the stability of the oil.

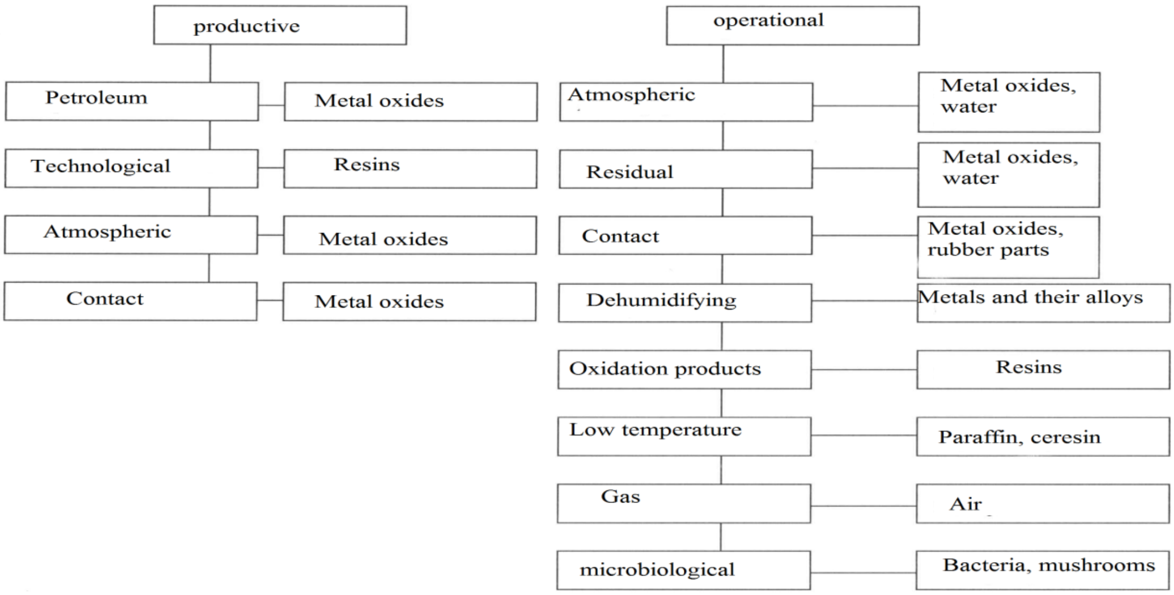

Fig.1. General classification of lubricant contamination processes.

Table 1. **Contents and granulometric composition of pollution in diesel oils**

Brand	Place selection	% by weight	Average number of particles (thousand pieces / cm3) in intervals of dimensions, μm							
			1-5	5-10	10-15	15-20	20-30	30-40	40-50	50
DS-11	F / d tank	0,010	15,8	8,4	3,9	2,1	1,1	0,3	0,2	0,01
DS-11	Reservoir composition	0,014	17,4	12,3	2,0	1,0	0,8	0,2	0,02	0,005
DC-8	The same	0,110	863,7	97,2	30,1	13,9	7,5	0,97	0,8	1,15
DS-11	Barrel	0,112	974,5	849,2	24,5	74,2	16,3	4,1	1,7	2,9

Table 2. **Characteristics of the ash of contaminations in motor oils**

Oil brand	Sampling point.	Content of contaminants,% (by mass).	Contents, 10^{-4}-%.				
			Fe	Cu	Pb	Al	Si
DS-1	Reservoir composition	0,137	traces	0,2+0,4	0,04	traces	1,5+2,0
АКп-10	The same	0,080	-	0,12	-	0,5	2,3
DS-11	Tanker	0,100	-	0,7+0,9	-	traces	1,7
DS-11	Barrel	0,115	traces	0,25	0,02	0,12	1,4+2,2
АКп-10	The same	0,125	traces	0,17	-	0,32	1,4+2,5
DS-11	Distributing	0,103	-	0,1+0,2	-	0,13+0,3	2,4

Aging of the engine oil is a complex complex of physical and chemical processes, of various factors, which are closely interconnected. The main ones are the following. Oxidation of oil, which occurs under the influence of oxygen and high temperature. The products of oxidation and polymerization of hydrocarbon oils can be liquid, semi-liquid and solid products, some of which can be soluble in oil, and the other part will replenish the amount of insoluble impurities. Contamination of oil with insoluble impurities, which is formed from solid carbohydrate particles (soot) due to incomplete combustion of fuel, from solid and liquid products of oxidation of oil are formed when interacting with impurities, from products of deterioration and pollution coming from the surrounding water (water, sand, dust) . The main source of formation of insoluble impurities is soot, products of wear, dust and others. Chemical processes of oil aging include the neutralization of compounds of acidic nature with impurities (decrease of alkalinity of oil) to oxidation of oil. [2, 5]. The speed of these processes depends on the concentration of the reactants and changes in the process of engine operation. As a result of the aging process, there is a change in the composition of the oil, as the content of the impurity decreases, the concentration of insoluble and soluble oxidation products and impurities increases (Fig. 2).

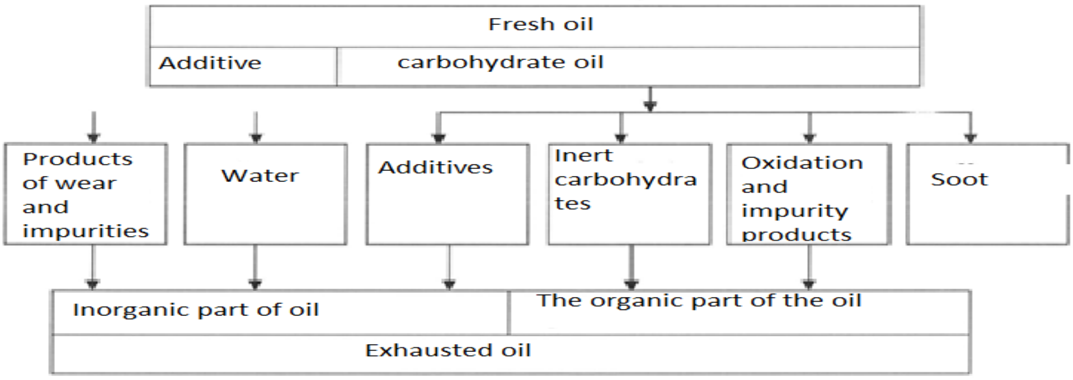

Fig. 2. Changes in the lubricant during engine operation.

Changing the composition of the oil leads to a change in its quality. Indicators characterizing negative properties (such as the content of insoluble impurities, acidity), as the aging of the oil increases. The formation of oil in products of its aging significantly affects the wear of friction surfaces of engine parts. It is known that microvision externally manifests itself as abrasion. It can be caused by various reasons. The presence of slight abrasion often does not interfere with the operation of parts, and in the initial period of operation is even necessary for the application of parts. The processes of friction and wear significantly affect the micro pollution of the oil. Studies have shown that a significant part of the power loss in the engine is due to the friction of the sealing rings on the cylinder wall. The process of oil contamination is just as intense in the same area. Friction in this site occurs in the mode of limit lubrication.

The purpose of research. Development of effective technologies and equipment for restoration of operational properties of waste oils for the purpose of their re-use in agricultural production.

Research results. Engine oils can be restored by chemical, physico-chemical and physical methods, the classification of which is given in Fig. 3. Chemical methods are based on the interaction of substances that pollute the engine oils and reagents introduced into these oils. As a result of the reactions occurring, compounds are formed, easily removed from the oil. Chemical methods of purification include: acid purification, alkaline purification, drying with the help of calcium compounds, dehydration and reduction by hydrides: metals. The application of chemical methods of cleaning and clarification allows the removal of asphalt-frost, acid, some heterogeneous compounds as well as water from oils.

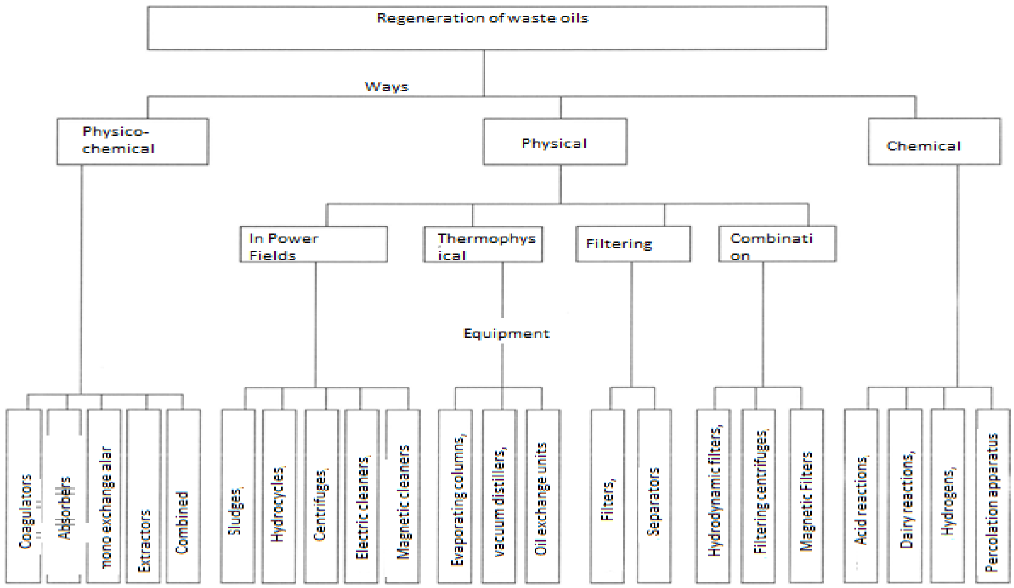

Fig. 3. Classification of regeneration of waste oils.

These methods have been widely used in industrial regeneration plants. Basic from physico-chemical methods used in practice: coagulation (inorganic and organic electrolytes, not electrolytes, solutions); adsorption (percale filtering, contact cleaning, cleaning in the moving layer, adsorbent), ion-exchange purification (static and dynamic); dissolution of impurities (deasphalting with propane, deparafinization, selective purification, water washing) [2, 4]. These methods, as well as chemical, are difficult for the practical realization of oil regeneration in the conditions of agricultural production. The physical methods of cleaning the oils include filtering and strength fields of high tension. These methods allow the removal of solid particles from the oils, microcurrents of water and partially-resinous and coke-forming substances. The main types of equipment used in the cleaning of oils in the power field: centrifugal (hydrocyclones and centrifuges); electric (high-frequency and electrostatic); magnetic (about an electromagnet and a permanent magnet), vibration (mechanical and ultrasonic), combined [2,4,5]. It is known that high-strength field strengths can be achieved on centrifugal, ultrasonic and magnetic cleaners of different design. In centrifugal cleaners solid particles of contamination are separated from the oil by the action of centrifugal forces. Depending on the speed of rotation of the rotor, the centrifuge is divided into low speed (5000-10000 rpm), high speed (10000-20000 rpm) and ultracentrifuge (rotational speed more than 20,000 rpm). The most widely used centrifuge with a hydrostatic drive. Different types of filters are also used to clean the oils. By way of separation of polluting impurities, they are divided into surface and deep. Classification of filter elements is shown in Fig. 4. Surface filters delay particles of the dispersed phase on the surface of the filter element. Such filters act as a sieve, that is, they hold only those particles whose linear dimensions are larger than the limits of the boundary channels of the filtering element.

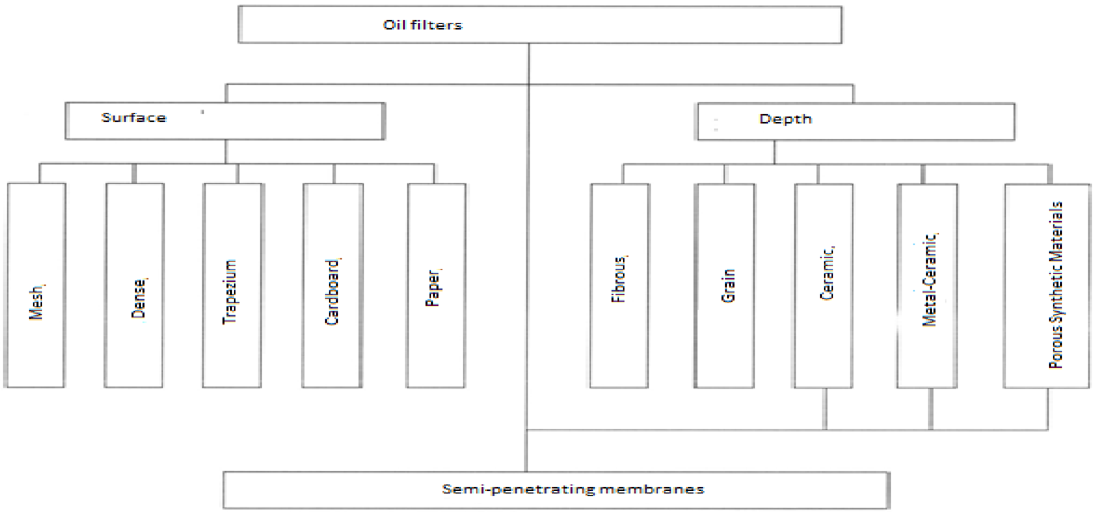

Fig. 4. Classification of filter elements.

The following types of filters are used for filtration of oil: mesh, slit, mater, cardboard, paper, ceramic. In microfiltration, the lubricant is cleared of tar substances, asphaltenes, varnishes, scum, and the like. Depending on the porous surface of the particles constantly removed from the surface by the flow of oil, created by a centrifugal pump, which is included in the circulating circuit. The efficiency of microfiltration depends on the pressure in the system and the temperature of the oil. After the microfiltration the oil enters the heating device and the reactor, which undergoes catalytic hydrogenation. In this case, cracking gas, which can be used for combustion in the tubular furnaces of the installation, is released, and heavy hydrocarbons are hydrated. The acceleration of the oil obtained in vacuum to separate it into three viscosity fractions is the last stage of the regeneration process. The oil obtained as a result of such processing, like fresh oils and can be used without restrictions. The amount of recovered oil from the raw material can exceed 70%. Microfiltration can enter into the process of oil regeneration as the main operation, and in combination with other operations. The combination of microfiltration with the previous operations of regeneration of oils (removal of water, fuel fractions, coarse impurities) allows you to obtain high-quality butter. On this basis, the scheme of the technological process of recovered waste oils, which is given in Fig. 5, was chosen. One of the operations of oil recovery in the development technology is the process of purification by the method of microfiltration. The essence of the proposed technology is as follows. Distilled waste oil is cleaned of mechanical impurities, water and fuel fractions at high-speed centrifugal cleaners. The work proceeds at a temperature not higher than 95 ° C and the pressure at the inlet to the cleaner is about 10 MPa. The purified oil is heated to 60 ° C and passed through the micropores of ceramic rods. Such microfiltration through a semipermeable membrane further cleans the oil. To further improve the performance of the oil filtrate add additives or prepare a mixture of them with fresh oil, followed by treatment in the ultrasonic field. It allows to increase the connection of components of additives with carbohydrate elements of oils at the molecular level, that is, to stabilize the content of additives and increase the term of their service. Regenerated and stabilized oils are deposited and delivered to consumers. Structurally, the microfilter unit is an independent installation with tanks, a pump station with membrane elements, an electric heating and a control board (Figure 5). The microfilter unit is a welded frame structure on which the main oil tank (4) is mounted with a capacity of 600 liters. The tank is equipped with electric heaters, temperature sensors and temperature sensors. Around the tank 12 blocks of microfilters (5), each of which has 24 ceramic rods installed. The scheme of oil flows in the elements of the block is shown in Fig. 5

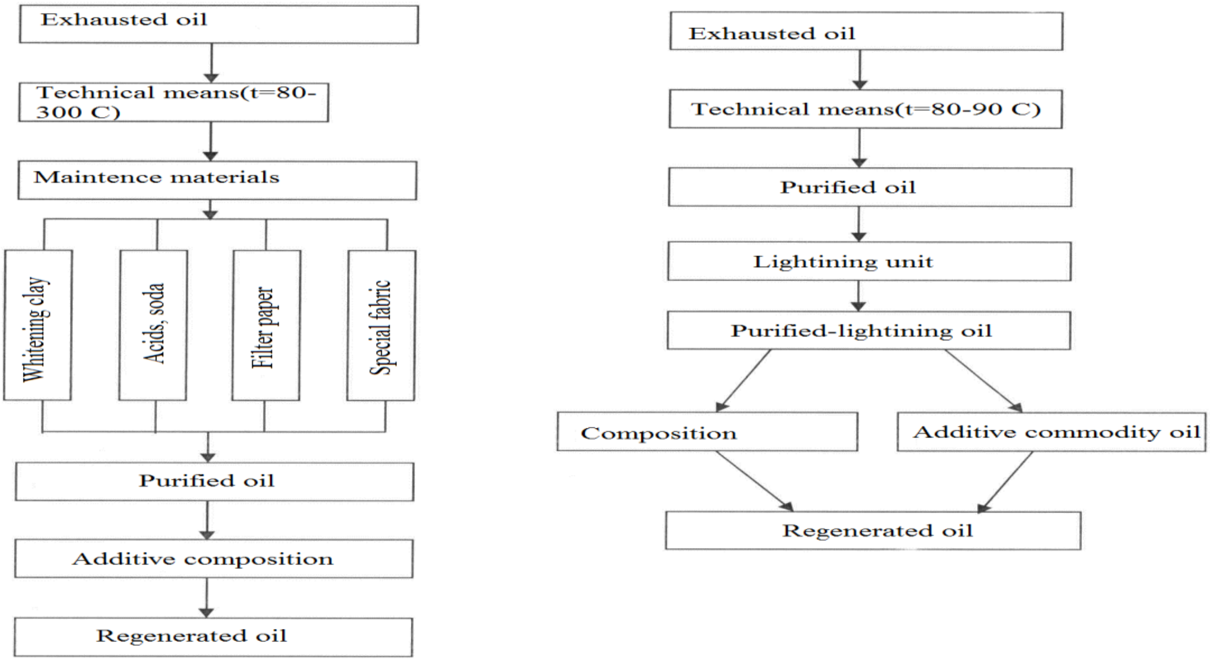

Fig. 5. Scheme of technological process of recovery of waste oils.

The oil circulation in the block of microfilters is carried out by the pump station (1). To clean the blocks of microfilters, use compressed air supplied by the compressor at a pressure of 0.4 MPa. The block consists of: control shield (4), concentrate drain pump (7), storage capacity (6), oil-wires, shut-off valves, pressure sensor. The block has a functional connection with the stabilization unit and a unit of preliminary purification of oils through a network of pipelines and shut-off valves. Install in filtration mode this way. The purified oil from the first block by the pumping station of this unit is pumped into the working capacity of the microfilter unit, which opens the shut-off valve supplying oil from the capacity of the purge, at the outlet of the pump, two shut-off valves of the oil supply lines are cut off into the working capacity of the microfiltration unit. Include pumping station unit. The filling process proceeds to reach the oil of the upper level sensor, which excludes the pumping station of the clearing unit. Close the filling lines valves. On the control panel of the microfilter unit, the heating of the oil, by setting the temperature of 70 ° C on the sensor, opens the valve of the pressure manifold of the pumping station of the microfilter unit. Upon reaching the operating temperature of 70 ° C oil, the pump station of the unit is switched on automatically. The pressure at the line at the inlet of the microfilter unit is 0.7 MPa and is supported by the through valve. The purified oil circulates in the block of microfilters, passes through the mountains of ceramic rods, on which contaminants settle, and the jet pump is fed into the storage capacity of the oil.

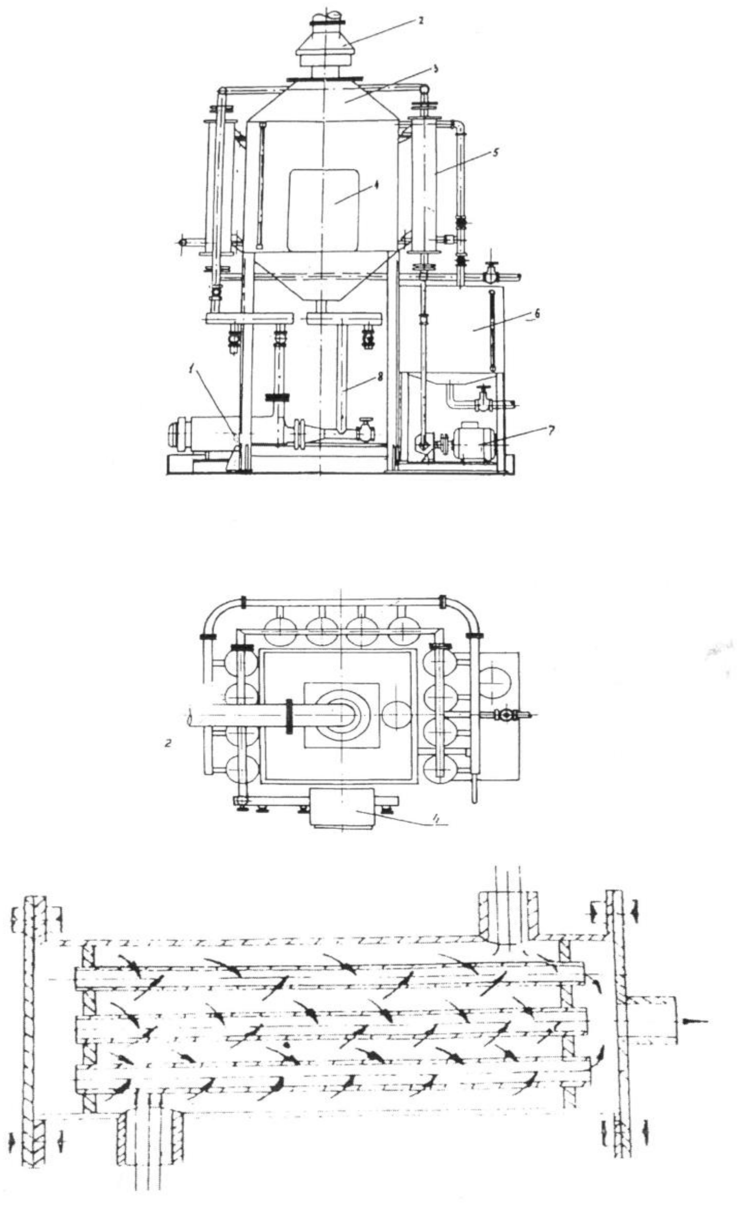

Fig. 5. General view of installation and block of microfilter.

Filtration subtlety in the block of microfilters up to 0.5 · -10-6 m. The process continues to reduce the productivity of the rods [5, 6]. In purge mode, the installation works in the following way. Open the shut-off valves of the purge line of the block of microfilters, include a compressor station in operation and 0.4 MPa of air is fed in a microfilter under pressure. Passing through the pores of the ceramic rods, antistrum compressed air frees the surface of the rods from contamination, bringing them into a container for collecting concentrate. At the end of the purge, the compressor is switched off and shut-off valves on the cleaning line are closed. Similarly, the elements of the block are cleaned if, instead of compressed air, a diesel fuel or washing liquid is used. However, this reduces the productivity of the plant and increases the operation of the unit.

Table 3. **Basic technical data of the installation.**

Number of microfilters, pcs	288
Working surface of microfilters, m^2	8
The type of filter element is tubular	Tubular
Material of the ceramic filter element	Ceramics
Average pore diameter of the microfilter, m	$1*10^{-6}$
Porosity of microfilter element,%	
The size of the ceramic rods, mm: length External diameter Internal diameter	800 12 6
The diameter of the oil at the entrance to the element, MPa	0,5
Operating temperature	80
Selectivity,%	46
Productivity, l / hour	20-30
Capacity for refined oils, l	600
Capacity for collecting concentrate, l	200
Nutrition Network, V	220/380
Installation capacity, kw	18,5

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Table 4. **Characteristics of microfilters.**

Name	Dimensions of rods			Size of pores, μm	Poris-dough,%
	length	diameter	The thickness of the wall		
Carbon steel rods	800	6,0	2,0	0,6	44,1
Non-wrought carbon brushes	800	6,0	2,0	1,0	38,0
Ceramic rods	800	6,0	3,0	1,0	60,0

The oil filtrate, obtained from non-liberated carbonaceous rods, is cloudy, has a dark red color, which characterizes it as ultramicroheterogenic organosol with a particle radius of 3 microns and below. The filtrate obtained through the ceramic rods, transparent, has a dark red color, which characterizes it as a colloid-dispersed organosol with a particle radius of 1 μm or lower. In addition, a comparative estimation of the optical density of the filtrate compared with the fresh marketable oil of M-10M2 was performed on the photocamometer FEK-56DO. The optical density of the first filtrate is lower than the centrifuged oil purified twice with a wavelength of 500 nm; the second filtrate is 1.5 times, the third - 1.2 times at the same wavelength. This allows us to conclude that the oil filtrate reduces the amount of pollutants from 3 microns and below. Analysis of the dependence of the productivity of microfiltrations on pressure based on the rheological properties of colloidal systems allows us to conclude that in the chosen filtration regime, a turbulent flow of liquid occurs in the capillaries of the microfilter. As the turbulent filtration regime is not optimal, additional tests are needed to find optimal filtration regimes based on a more in-depth study of rheological and other properties of colloidal oil systems. The hydraulic characteristics of the filtering of commercial and waste oil M-10M2 through the ceramic filter are obtained. Characteristics suggest that the most significant influence on the rate of filtration is the temperature regime and the pressure drop on the surface of the microfilter. Under the influence of temperature and pressure, the viscosity of the oil varies, and the effect of these factors on the process is uneven. Increased pressure leads to deformation of the layer of sediment on the surface of the microfiltration, the transition of the flow of filtrate through the capillaries from the laminar regime to turbulent, ie, increases the resistance of the filtration [2, 5]. For the treatment of oil filtration regimes, a series of experimental studies was conducted on a microfilter block. The productivity of microfilters (membranes) made from ceramics, with microfiltration of oil M10M2, purified centrifugation at the oil-treatment plant SUOM-1H was determined. During the block performance, the supply performance remained virtually unchanged. According to the results of the experiment, the graphical dependence of the variation of the unit's productivity on pressure and temperature was constructed (Fig. 6). The analysis of the graph shows that at a temperature of up to 95 ° C and at a pressure variation from 2 to 10 kg / cm2, there is an experimental point A in which the block achieves the highest productivity. At oil temperatures above 95 ° C, productivity increases with pressure. It was established that at temperatures above

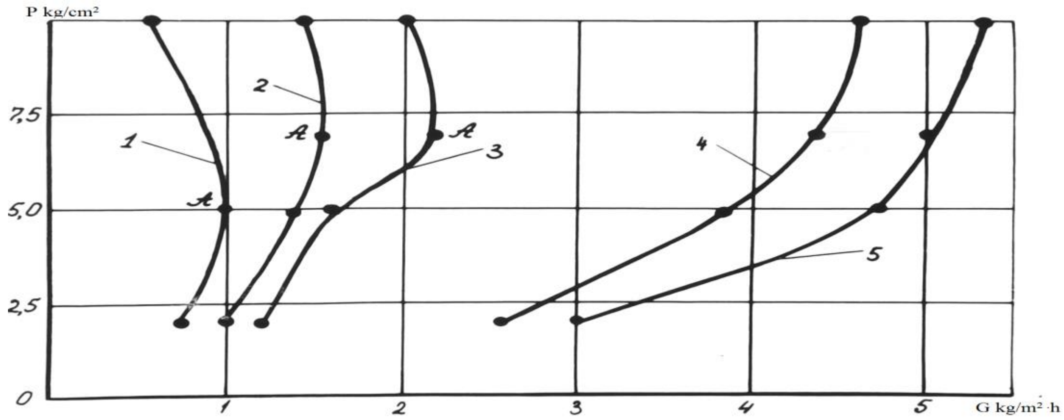

Fig. 6. Dependence of membrane performance on pressure and temperature.

95 ° C the oil filtrate permeates sharply. This is due to a decrease in the viscosity of the oil and its contact with electric heaters, which at these temperatures contribute to the preservation of highly dispersed soot particles in it. At low oil temperatures, the selectivity of the microfilter unit increases, that is, on the surface of the microfilter, particles of the micro-admixture are most effectively retained. Table 5.6 shows the results of physico-chemical analysis of oils at different filtration regimes, which also confirm that, at low filtration temperatures, the concentration of mechanical impurities in oil is reduced. Data analysis table. 5 shows that the process of filtration of purified oil reduces the content of mechanical impurities by 6.5 times compared with purification centrifugal apparatus and 2.5 times improve the light penetration. The content of detergents in the filtrate decreased by 3% compared to the refined oil and by 12% compared to the spent fuel. The content of mechanical impurities in the product oil is almost 10 times the permissible values, the viscosity is 2% lower than the standard. The filtrate contains 2 times less mechanical impurities and a 10% reduced viscosity due to the destruction of polymers in the process of operation in the engine. In general, the filtrate is close to the relevant requirements of the standard, and when introduced into it, the composition of the additive will conform to the standard. [5,7,8]. According to the content of pollutants and products of engine wear (Fe; Al; Cr; Cu; Si), the filtrate is comparable to commercial oil. The results of the comparative analysis allow to confirm the significant efficiency of the process of microfiltration of oil with ceramic filters and the possibility of bringing the waste oils to a level of fresh commodity.

Table 5. **Physico-chemical parameters of oil filter** M1OG 2

Type of oil	Contents fur. impurities,%	Cinematic viscosity. at 100 oz, mm2 / s	Moon number, mg KIN / g
Output M1OG2	0,0164	10,52	2,68
M1OG2 filtrate at T = 40^{oc}	0,0051	9,64	2,25
M1OG2 filtrate at T = 60 ° C	0,0073	9,81	2,28

M1OH2 filtrate at T = 95 ° C	0,0094	9,98	2,27
M1OH2 filtrate at T = 120 oz	0,0127	10,23	2,25
M1OH2 filtrate at T = 120 oz	0,0158	10,75	2,26

Table 6. **Physico-chemical parameters of oils** M1OG

Type of oil	Commodity butter	Kinematic viscosity, cSt	Flame temperature, oz	Alkaline number, mg CIN / g	Water content, %	Content density,%
Fresh oil	0,220	10,82	204	5,66	0,07	65
Exhausted oil	0,410	10,56	179	1,63	0,24	23
Purified oil SUOM-1M	0,014	10,23	181	1,61	Сліди	29
Oil filtrate, keram. Filter	0,007	9,32	176	0,44	Сліди	58
Commodity oil	0,042	10,25	189	4,90	0,08	32

Conclusions. Microfiltration can enter into the process of oil regeneration as the main operation, and in combination with other operations. The combination of microfiltration with the previous operations of regeneration of oils (removal of water, fuel fractions, coarse impurities) allows you to obtain high-quality butter. Distilled waste oil is cleaned of mechanical impurities, water and fuel fractions at high-speed centrifugal cleaners. The work proceeds at a temperature not higher than 95 ° C and pressure at the inlet to the cleaner of about 10 MPa. The purified oil is heated to 60 ° C and passed through the micropores of ceramic rods. Such microfiltration through a semipermeable membrane further cleans the oil. To further improve the performance of the oil filtrate add additives or prepare their mixture with fresh oil, followed by treatment in the ultrasonic field. It allows to increase the connection of components of additives with carbohydrate elements of oils at the molecular level, that is, to stabilize the content of additives and increase the term of their service. Analysis of the dependence of the productivity of microfilters on pressure based on the rheological properties of colloidal systems allows us to conclude that in the chosen filtration mode there is a turbulent flow of liquid in the capillaries of the microfilter. Under the influence of temperature and pressure, the viscosity of the oil varies, and the effect of these factors on the process is uneven. The increase in pressure leads to the deformation of the layer of sediment on the surface of the microfiltration, the transition of the filtrate stream through the capillaries from the laminar regime to the turbulent, that is, the increased resistance to filtration. The filtrate contains 2 times less mechanical impurities and a 10% reduced viscosity due to the destruction of polymers in the process of operation in the engine. In general, the filtrate is close to the relevant requirements of the standard, and when introduced into it, the composition of the additive will conform to the standard.

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ТЕХНОЛОГИЯ РЕГЕНЕРАЦИИ ОТРАБОТАННЫХ МАСЕЛ

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Ключевые слова: масло, окисление, регенерация , примесь , кинематическая вязкость, коагуляция, адсорбция, микрофильтрация.

Резюме

Старение масла в двигателе - это сложный комплекс физических и химических процессов, различных факторов, тесно связанных между собой. Моторные масла можно восстанавливать химическими, физико-химическими и физическими методами. Микрофильтрация может входить в технологический процесс регенерации масла как основная операция, так и в сочетании с другими операциями. Сочетание микрофильтрации с предыдущими операциями регенерации масел (удаление воды, топливных фракций, грубодисперсных примесей) позволяет получить высококачественные масло. Отстоявшееся отработанное масло очищается от механических примесей, воды и топливных фракций на высокоскоростных центробежных очистителях. Работа протекает при температуре не выше 95°С и давлении на входе в очиститель около 10 МПа. Очищенное масло подогревается до 60°С и пропускается через микропоры керамических стержней. Такая микрофильтрация через полупроницаемые мембраны дополнительно очищает масло. Для дальнейшего улучшения эксплуатационных качеств в фильтрат масла вводятся присадки или готовится их смесь со свежим товарным маслом, с последующей обработкой в

ультразвуковом поле. Это позволяет увеличить связь компо-нентов присадок с углеродными элементами масел на молекулярном уровне, то есть стабилизировать содержание присадок и увеличить срок их службы.

TECHNOLOGY OF REGENERATION OF EMPLOYED MASTS

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Key words: lubricant, oxidation, regeneration, impurities, kinematic viscosity, coagulation, adsorption, microfiltration.

Summary

Aging of the engine oil is a complex complex of physical and chemical processes, of various factors, which are closely interconnected. Engine oils can be restored by chemical, physico-chemical and physical methods. Microfiltration can enter into the process of oil regeneration as the main operation, and in combination with other operations. The combination of microfiltration with the previous operations of regeneration of oils (removal of water, fuel fractions, coarse impurities) allows you to obtain high-quality butter. Distilled waste oil is cleaned of mechanical impurities, water and fuel fractions at high-speed centrifugal cleaners. The work proceeds at a temperature not higher than 95 ° C and pressure at the inlet to the cleaner of about 10 MPa. The purified oil is heated to 60 ° C and passed through the micropores of ceramic rods. Such microfiltration through a semipermeable membrane further cleans the oil. To further improve the performance of the oil filtrate add additives or prepare their mixture with fresh oil, followed by processing in the ultrasonic field. This allows to increase the connection of the components of additives with carbohydrate elements of oils at the molecular level, that is, to stabilize the content of additives and increase the term of their service.