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ТЕХНІКА  
ЕНЕРГЕТИКА  
ТРАНСПОРТ АПК



*Всеукраїнський науково-технічний журнал*

**ТЕХНІКА,  
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ЕНЕРГЕТИКА,  
ТРАНСПОРТ АПК**

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## INCREASING THE LUBRICANT RESOURCE BY DEVELOPING A DEVICE FOR ITS CLEANING

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*Agricultural production is one of the main consumers of oil products. The enterprises of the agro-industrial complex of Ukraine annually consume about 7 million tons of produced diesel fuel and about 1.0 million tons of motor oil. An average farm in the central zone consumes up to 1,200 tons of diesel fuel, 600 tons of gasoline, and 60 tons of curtain oils per year, of which at least 80% goes into the category of spent petroleum products of various groups.*

*As a result of the intensive growth of the fleet of internal combustion engines, as well as increased attention to economic and environmental factors, the task of saving and rational use of fuel and energy, raw materials and other material resources is becoming increasingly acute for the national economy.*

*It is known that one of the ways to increase the level of supply of agricultural production with motor oils is their repeated use after the restoration of some quality indicators that have deteriorated as a result of their use in the operation of auto-tractor equipment.*

*The repeated use of oils allows you to increase their service life, reduce irreversible losses and reduce the shortage of oil supplies to farms. However, the rate of use of recovered oils remains at a low level. Thus, in the country as a whole, the annual discharge of used oils amounted to 0.9 million tons, and only 0.15 million tons were regenerated, which is about 16% of the collected volume.*

*The proposed device can be used within the framework of the initiative topic "Investigation of ways to optimize the parameters of the technological process for the production of fatty acid esters for diesel biofuel" (state registration number: 0122U002187 dated 30.03.2022), and investigated under the initiative topic: "Investigation of the influence of the bioethanol component of the fuel mixture on the parameters operation of a gasoline injection engine" (state registration number: 0122U00213 dated 30.03.2022).*

**Key words:** maintenance, cleaning, oil change, energy-saving technologies, oil, fuel.

**Fig. 1. Table 2. Ref. 8.**

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### 1. Problem formulation

It has been established that partially regenerated oils, that is, only cleaning from coarsely dispersed mechanical impurities, water and fuel fractions, have low stability and cannot, without improving their quality, be used to the full extent in the engines of auto-tractor machinery. Solving the problem.

In order to improve the quality of intermediate oil purification and the possibility of its direct application, it is necessary to develop advanced technologies and technical means that would allow to bring purified oils to the level of fresh commercial lubricants, in the conditions of agricultural enterprises of various levels.

The oil's ability to reduce energy costs for friction and wear is the most important operational property.

It was established that highly dispersed oxidation products in used lubricants at a certain concentration reduce the coefficient of friction and wear, while ensuring good stability of technological properties during storage and operation.

The working hypothesis of the problem is to predict the possibility of improving the oil purification technology based on microfiltration through ceramic semipermeable membranes, which would ensure the production of oils with stable anti-wear and anti-friction properties by maintaining a rational concentration of highly dispersed oxidation products in them.

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### 2. Analysis of recent research and publications

It is known that contamination of lubricants occurs both as a result of their impact from the outside and as a result of changes in the carbohydrate composition of oils. These processes begin when oil is produced



at oil refineries and continue at all stages of its transportation, storage and operation. They can be classified into two main types: production and operational.

Studies show that used in the exploitation of - Mr. Technically, commercial diesel oils can contain up to 0.14% (by mass) of impurities, and tractor oils under the same conditions - up to 0.28% (by mass) [1].

The results of the microscopic and spectral analysis of impurities, carried out on DS-11 and DS-8 oils, show that the oil supplied for refueling machines and mechanisms contains many particles of impurities larger than 50 µm in size. In the tanks of oil storage facilities, the number of such contaminants can exceed 1000 in 1 dm<sup>3</sup> (table 1), and a significant proportion of silicon and aluminum compounds in them (table 2) indicates the high abrasiveness of the oils used.

**Table 1**

**Content and granulometric composition of pollutants in diesel lubricants**

Lubricant brand	Impurity content % (by mass)	The average number of particles, by size, thousands of pieces/cubic dm							
		1-5	5-10	10-15	15-20	20-30	30-40	40-50	50...
DS-11	0,01	15,8	8,4	3,9	2,1	1,1	0,3	0,2	0,01
DS-11	0,014	17,4	12,3	2,0	1,0	0,8	0,2	0,02	0,005
DS -8	0,110	863,7	97,2	30,2	13,9	7,5	0,97	0,8	1,15
DS -11	0,112	974,5	849,2	24,5	74,2	16,3	4,1	1,7	2,9

**Table 2**

**Characteristics of the ash part of engine oil contamination**

Lubricant brand	Impurity content % (by mass)	Content in sizes 10-4 %				
		Fe	Cu	Pb	Fl	Si
DS-11	0,137	Traces	0,2...0,4	0,04	Traces	1,5...2,0
AKp -10	0,080	-	0,12	-	0,5	2,3
DS -11	0,100	-	0,7...0,9	-	Traces	1,7
DS -11	0,115	Traces	0,25	0,02	0,12	1,4...2,2
AKp -10	0,125	Traces	0,17	-	0,32	1,4...2,5
DS -11	0,103	-	0,1...0,2	-	0,13...0,3	2,4

During the operation of oils in engines, their quantitative and qualitative changes occur continuously. These changes are the result of chemical and physical processes. Along with solid impurities in motor oils, there is water, in the presence of which the process of changing the properties of oils proceeds particularly intensively and plays a decisive role in the stability of the oil.

Thus, in the presence of moisture, the concentration of impurities in the oil can decrease to 50-60% of the original [2]. The mechanism of precipitation of impurities from oil in the presence of water boils down to the fact that alkalinity carriers - carbonates - are the catalyst of this process, and with the increase of crystals, the carbonates of the corresponding metal undergo sedimentation. These processes cause turbidity of commercial lubricants and a decrease in their stability, aging of the oil, as well as its external contamination during operation.

Aging of oil in the engine is a complex complex of physical and chemical processes, various factors closely related to each other. The main ones are the following. Oil oxidation that occurs under the influence of air oxygen and high temperature. Products of oxidation and polymerization of oil hydrocarbons can be liquid, semi-liquid and solid products, part of which can be soluble in oil, and the other part will replenish the amount of insoluble impurities.

Oil contamination with insoluble impurities, which are formed from solid hydrocarbon particles (soot) due to incomplete combustion of fuel, from solid and liquid products of oil oxidation formed during interaction with impurities, from wear products and pollution coming from the surrounding environment (water, sand, dust).

Pollution due to the consumption of impurities, which is reflected in the reduction of oil alkalinity as a result of the neutralization of acidic products, as well as in the consumption of impurities for the dispersion of carbohydrate particles.

The formation of aging products in the oil creates leaks in various areas of the engine, but the most intense occurs in the area of the piston rings, where the oil film is exposed to high temperatures, air oxygen



and fuel combustion products. In this zone, the oil undergoes deep thermal destructive decomposition, which leads to an increase in the contamination of the oil with insoluble impurities. Their accumulation in oil can be considered mainly as a physical process. The main source of formation of insoluble impurities is soot, wear products, dust and others. The chemical processes of oil aging include neutralization of acidic compounds with impurities (reduction of oil alkalinity) to oil oxidation [3]. The speed of these processes depends on the concentration of reactants and changes during engine operation. The most important process is the reduction of alkalinity as a result of the neutralization of acidic compounds (sulfur fuel combustion products), which determines the intensity of wear and the amount of carbon deposits in the engine.

The essence of the neutralization process is that sulfur oxides in the presence of water give sulfuric and sulfurous acid, and also interact with oil hydrocarbons and their oxidation products, forming sulfonic acids. The content of compounds of chemical interaction (oxidation, neutralization, etc.) in the oil depends on the initial concentration of reaction products, the presence of inhibitors or neutralizing impurities, temperature and pressure. As a result of the aging process, the composition of the oil changes, because the content of useful impurities decreases, the concentration of insoluble and soluble oxidation products and negative impurities increases.

A change in oil composition leads to a change in its quality indicators. Indicators characterizing negative properties (such as the content of insoluble impurities, acidity) increase as the oil ages. Indicators that characterize the positive properties of the oil, such as alkalinity, which gives potential, etc., decrease with aging. Some indicators, for example, thermal oxidation stability, practically do not change or change very little during the aging process of the oil [2, 4].

The described changes in oil composition show only the qualitative side of the oil contamination process. However, it should be borne in mind that the sum of all types of oil contamination is only a small part, and the rest (at least 85%) of carbohydrates remains unchanged in its composition. It is this circumstance that allows us to raise the question of the possibility of effective cleaning of used oil and its further use for its intended purpose. The formation of aging products in lubricating oil significantly affects the wear of friction surfaces of engine parts. It is known that micro wear is externally manifested as abrasion. It can be caused by various reasons. The presence of minor abrasion most often does not interfere with the operation of parts, and in the initial period of operation, it is even necessary for the parts to be adjusted.

Micro-wear should be considered a normal type of wear that is inevitable in cases where liquid lubrication cannot be provided. Micro wear is manifested in the form of significant damage to friction surfaces, which irreversibly damages them and causes the part to fail. The exception is the initial stages of some types of microwear, when the damage is minor and does not develop further. Friction and wear processes have a significant impact on oil microcontamination. Studies by Maslennikov M.M. and Rappoport M.S. have shown that a significant portion of engine power loss is due to friction of the sealing rings against the cylinder walls. The process of oil contamination is also the most intense in this.

Friction in boundary lubrication is also determined by the tendency of the contacting materials to adhere to a number of actual microcontacts along the tops of individual microbumps, where the boundary lubrication layer can be destroyed. In these places, dry friction of oxide films or even juvenile surfaces can occur. The boundary layer is formed as a result of the interaction of the active elements of the lubricant with the metal of the friction surface. The active components of the lubricant are impurities introduced into it, microparticles of technological origin, oxidation products, etc.

Engine oils can be restored by chemical, physical-chemical and physical methods.

Chemical methods are based on the interaction of substances that contaminate engine oils and reagents added to these oils. As a result of the ongoing reactions, compounds are formed that can be easily removed from the oil. Chemical cleaning methods include: acid cleaning, alkaline cleaning, drying with calcium compounds, drying and reduction with metal hydrides. The use of chemical cleaning and clarification methods allows the removal of asphalt resinous, acidic, and some heterorganic compounds, as well as water from oils. These methods are widely used in industrial oil recovery plants. Chemical oil purification requires sophisticated technological equipment and chemical reagents, and therefore these methods are not widely used for the regeneration of relatively small amounts of oil in agricultural enterprises [5].

Physical and chemical methods are based mainly on the use of coagulants.

Physical methods of oil purification include filtration and high-voltage force fields. These methods allow removing solid particles, water microdroplets, and partially resinous and coke-forming substances from oils. The main types of equipment used in the purification of oils in a force field are as follows:

- centrifugal (hydrocyclones and centrifuge);
- electric (high-frequency and electrostatic);



- magnetic (permanent magnet electromagnet);
- vibration (mechanical and ultrasonic);
- combined.

It is known that high-voltage force fields can be achieved with centrifugal, ultrasonic, and magnetic cleaners of various designs [3, 7]. In centrifugal cleaners, solid particles of contaminants are separated from the oil by centrifugal forces. Depending on the rotor speed, centrifuges are divided into low-speed (5000-10000 rpm), high-speed (10000-20000 rpm) and ultracentrifuges (rotation speed over 20000 rpm). The most widely used centrifuges are hydrojet-driven centrifuges, operating on the principle of a segner wheel, where the rotor rotation is caused by jet forces and flows from the lubrication nozzles. These centrifuges are characterized by high rotational speeds and ease of maintenance.

When using a mechanical drive, higher centrifuge rotation speeds are achieved, but their design is more complex. Pneumatic and gas-driven centrifuges are still under research.

During centrifugal cleaning, all highly dispersed particles cannot be removed from the oil. Therefore, G.I. Bremer introduced the concept of the so-called centrifugation limit, characterized by a critical particle size below which there is practically no deposition of particles on the rotor walls.

The fineness of purification for high-speed centrifuges (for inorganic particles) reaches 1 micron. Therefore, when using high-speed centrifuges, organic contaminants remain in the oil, causing the formation of varnishes and engine carbon deposits. Ultracentrifuges remove almost all micro-impurities, but the complexity of their manufacture limits their use for massive oil cleaning. They are widely used as laboratory installations for the study of oil contamination.

Different types of filters are also used for oil purification. They are divided into surface and deep filters based on the method of separating contaminants.

Surface filters retain particles of the dispersed phase on the surface of the filter element. Such filters act as a sieve, i.e., they retain only those particles whose linear dimensions are larger than the dimensions of the boundary channels of the filter element [6].

The following types of filters are used for oil filtration: mesh, slotted, cloth, cardboard, and paper.

Strainers, which are metal mesh filters, are used as pre-filters. The fineness of purification is 20-200 microns. The disadvantage of these filters is their low fineness of cleaning.

Slot filters are used as coarse filters. The fineness of purification ranges from 20-125 microns. The fineness of cloth filters is 8-50 microns; during operation, they lose their mechanical properties under the influence of acidic substances in the lubricant. The hydraulic resistance of such filters increases as the pores become clogged.

The fineness of cardboard filters is 1-50 microns. Their disadvantage is the insufficient degree of purification and the impossibility of their regeneration, as well as low mechanical properties. Paper filters have similar disadvantages. In addition, they can operate only in a narrow temperature range.

Deep filters, having filter elements of considerable thickness, retain contaminant particles not only on the surface but also in the thickness of the filter element. This type of filter has a relatively small liquid inlet area. There are the following types of deep filters: made of fibrous and granular materials; ceramic; metal-ceramic; and porous synthetic materials.

Filters made of fibrous and granular materials are made in the form of containers made of fabric or metal filled with filter material. The fineness of these filters is low and ranges from 12-30 microns.

Ceramic filters are made of porous ceramics. The fineness of filtration depends on the grain size of the filler and ranges from 0.1-100 microns. Their disadvantage is the possibility of washing out abrasive particles of the material by the liquid flow. Metal-ceramic filters are made using powder metallurgy methods from metal, metal-ceramic and synthetic powders. Depending on the size of the powder particles and the manufacturing technology, their filtration fineness is 0.1-100 microns. These filters are characterized by high mechanical strength and heat resistance, and can be recovered by countercurrent cleaning [8].

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#### 4. Aim of the researches

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The goal is to improve the technology of cleaning used oils in the conditions of an agro-industrial complex and to develop a device for cleaning motor oils in the conditions of small agricultural enterprises. Lubrication cleaning with the use of cheap means and devices is currently an urgent issue of saving means, since hostilities are taking place in Ukraine and the place of saving is occupied by an important spectrum of the economy.





## 5. Results of the researches

The microfiltration process is the main one among the existing engine oil regeneration technologies. Thus, the French company Gothal has developed the Tejelub method of regenerating used oils. The oil is first subjected to centrifugal cleaning from coarse mechanical impurities and free water, then either heated to remove water and easily boiling fractions that got into the oil during its operation (gasoline, diesel fuel, solvents, etc.). Next, the oil is treated to remove impurities, and the substances dispersed in the oil, mainly metals, are precipitated as oil sludge and removed by repeated centrifugation. The oil is then subjected to microfiltration through porous filter elements made in the form of hollow ceramic cylinders at a temperature of over 300°C and a pressure of 2 MPa. During microfiltration, the oil is purified from resinous substances, asphaltenes, varnishes, carbon deposits, etc. The particles deposited on the porous surface are constantly removed from the surface by the oil flow created by a centrifugal pump included in the circulation circuit. Microfiltration performance depends on the system pressure and lubricant temperature. After microfiltration, the lubricating oil enters a heating device and a reactor, where it undergoes catalytic hydrogenation. This process produces cracker gas that can be used for combustion in the plant's tube furnaces, and heavy carbohydrates are hydrogenated. The last stage of the regeneration process is the distillation of the resulting lubricating oil under vacuum to separate it into three viscosity fractions. The lubricant obtained as a result of this treatment is similar to fresh lubricants and can be used without restrictions. The amount of recovered grease from the original raw material can exceed 70%.

The Japanese company Kawakami has developed an automatic unit for fine lubricating oil cleaning. The unit is connected to the oil system and purifies lubricating oil with a fineness of 0.02-0.1 microns using membrane filter materials. A distinctive feature of the unit is the ability to change the flow of the cleaned lubricant, which allows the filter element to be washed, thereby increasing its service life. The element is flushed for 60-90 seconds at intervals of 1-2 hours. Several types of such units are available. The performance depends on the viscosity of the oil to be cleaned and the number of filter elements in the unit. The throughput of one filter element is 10-15 liters per hour.

The main purpose of microfiltration is to remove highly dispersed oil oxidation products and other mechanical impurities with a size of 0.2 microns and above in order to increase the stability of regenerated oils. Microfiltration can be included in the technological process of oil regeneration as the main operation or in combination with other operations. The combination of microfiltration with preliminary oil regeneration operations (removal of water, fuel fractions, coarse impurities) allows to obtain high-quality lubricants.

The proposed device solves all the problems mentioned above and works as follows. The device for heating, cleaning, and distributing lubricating oil is made from components and assemblies of decommissioned machines and other materials. A standard barrel with one bottom removed is used as the tank 1 (Figure 1). The thermal insulation is made of asbestos sheet and dermatite. The cover 7 with the filler neck 14 is made at the installation site or replaced with a horizontal frame made of rolled sections. The oil pump 3 is borrowed from the SMD-14 engine, with the throttle 2 being its pressure reducing valve adjusted to the required pressure.

The coarse oil filter 10 is taken from the YAMZ engine, the jet oil centrifuge 11 is taken from the SMD-14 or A-41 engine. Liquid meter 13 is any meter selected according to the supply. If a calibrated tank is used, the meter can be replaced with a measuring ruler. The flexible high-pressure hose 4 is borrowed from the hydraulic system of T-150K tractors. The shut-off valve 9 is a cork valve from a gas pipeline valve. The guiding chute 17 for diverting oil from the centrifuge jet drive and its safety valve to the tank is made of sheet steel or aluminum. If centrifuges from engines are used, then their design usually includes a valve that works as a drain valve 12 in the device scheme when the dispensing gun valve is closed. The function of the drain pipe 16 in this case is performed by the guide chute. A remote signaling thermometer of any type of electrical contact provides semi-automatic operation of the device. It turns on the electric motor at the set temperature. When manually operating the device, it can be replaced with any thermometer.

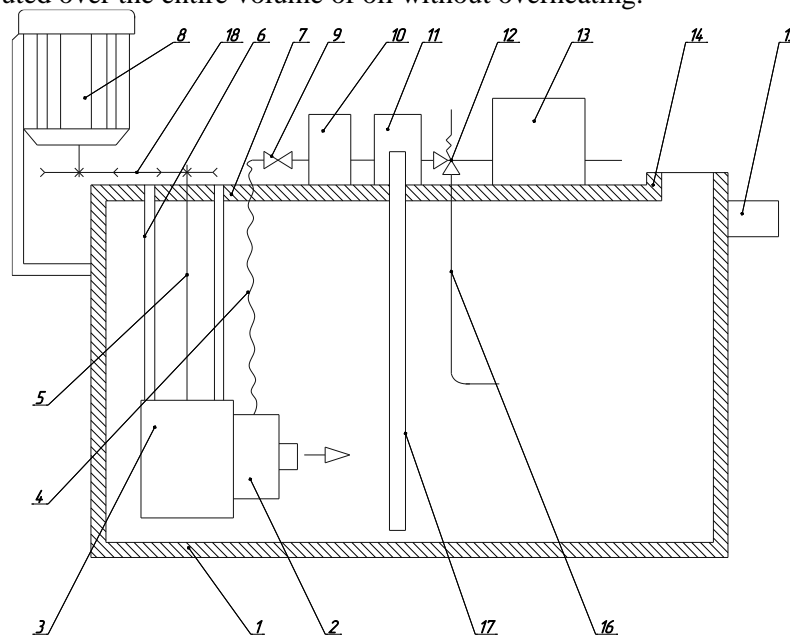
Filters 10 and 11 are bolted to plates 13 (Figure 1) made of sheet steel with a thickness of 8...12 mm through sealing gaskets. Holes are drilled in the plates against the inlet and outlet channels of the filters and fittings for hydraulic system hoses are welded or screwed in. A window equal in size to the drain window of the centrifuge jet drive is cut out in the plate for the centrifuge and closed with a guide chute 14. The plate is bolted to a horizontal frame 12 made of 32x32 mm angles, The coarse filter plate and the frame 6 of the pumping station are also attached to the same frame. The vertical shaft 8 has an elastic 9 in the upper part and a spline 4 in the lower part with connecting couplings. The oil is taken by the pump 3 through the oil intake 1 with a grid. It is connected to the pump 3 by nozzle 2. The purified oil is dispensed through a dispensing sleeve with a gun. It is similar to the dispensing devices of fuel dispensers.



The device works as follows. After turning on the electric motor with the lock valve closed, the entire flow of lubricating oil pumped by the oil pump passes through the throttle 15, causing the lubricant to heat up. If it is not necessary to clean it, then when the temperature reaches 20...30 °C (depending on the type of lubricant and the conditions for filling the machine units), the lock valve is turned to the "open" position and the lubricant is distributed to consumers using the dispensing gun valve. At the same time, the lubricant passes through a coarse filter and is cleaned of large mechanical impurities. The jet oil centrifuge 11, although the oil flow passes through it, does not purify the oil, since its temperature is insufficient for centrifugal cleaning. If the viscosity meets the conditions for refueling the machine and if fine purification is not advisable, the oil is not preheated. When the dispensing gun valve is closed and the pump is running, the oil is drained through the drain valve back into the tank. If it is necessary to carry out fine cleaning of fresh or used oil, it is heated to 60...70 °C.

Effective oil purification, especially with a centrifuge, requires proper oil preparation. Relatively stable atomic and molecular bonds between small impurity particles and liquid molecules do not allow achieving the desired degree of purity, since the density of contaminated and clean oils is almost the same. Therefore, contaminant particles cannot be separated by centrifugal cleaning. For this purpose, throttling is used. At the end of the throttled jet, these bonds are broken in the liquid column due to a sharp change in pressure and oil velocity, which makes it possible to increase the efficiency of subsequent centrifugal cleaning.

The end of the throttled jet in the fluid column further reduces throttling noise, and also allows the jet heat to be evenly distributed over the entire volume of oil without overheating.



**Fig. 1. Diagram of the proposed device for lubricant cleaning:**

**1 – Tank; 2 – Throttle; 3 – Pump; 4 – Flexible hose; 5 – Vertical shaft; 6 – Frame; 7 – Cover; 8 – Electric motor; 9 – Shut-off valve; 10 – Filter; 11 – Centrifuge; 12 – Drain valve; 13 – Counter; 14 – Filling neck; 15 – Electro contact thermometer; 16 – Drainage pipeline; 17 – Guide chute; 18 – V-belt transmission of the shaft drive.**

Oil dehydration occurs as a result of part of the water being retained in a bound state in the sediment deposited on the walls of the centrifuge rotor. Most of the moisture evaporates when it leaves the centrifuge nozzles, as the pressure in the outlet jet drops sharply and becomes less than atmospheric pressure. The water contained in the oil boils and evaporates at a temperature of 60...70 °C, at which the oil is purified. Therefore, the drain cavity of the centrifuge drive is connected to the atmosphere, and the oil supplied to the centrifuge drive is drained back into the tank through a chute. It is lowered to the bottom of the tank and is designed to prevent excessive saturation of the oil with air. The oil that has undergone fine cleaning is discharged to the tank for re-cleaning through the drain pipe. At the same time, the valve of the dispensing gun is closed. The pump takes oil from the lower, most contaminated layers that have not yet passed through the filters or have passed through them fewer times. Oil temperature control and semi-automatic operation of the device are provided by an electrical contact thermometer, which automatically shuts off the engine when the oil reaches the set temperature.



After the oil has passed through the filters three to four times, it is distributed to consumers or pumped into a storage tank.

The centrifugal purification method does not (like all other known methods) remove the smallest carbon particles from the used oil. They give the used oil its characteristic black color, but do not affect its performance. Therefore, the color of the purified used oil is not a criterion for its purity. Its analysis in the laboratory showed that even after passing through the filters twice, it is free of water and abrasive impurities.

The introduction of the device into production will help reduce the cost of purchasing oil for its replacement.

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## 5. Conclusions

According to the technical maintenance and requirements of the manufacturing plants, the oil must be replaced after a certain number of hours of operation of the machine. In engines, this is due to partial production of additives and pollution, and in hydraulic systems and transmissions only pollution and watering, but not due to loss of lubricating properties. Therefore, it is very important to collect and regenerate used oil. However, for separate collection by groups and delivery of oil to enterprises. Large repair companies require significant resources. In addition, in the process of collection, accumulation and transportation, intensive aging of the oil occurs.

The problem at small agricultural enterprises is the lack of devices for cleaning a small amount of grease, which is collected from several energy sources. When a large amount of lubricant is collected in large containers to be sent to repair facilities for cleaning, the lubricant ages and loses its qualities.

To solve this problem, we have proposed the design of a device for cleaning grease at small agricultural enterprises.

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### ЗБІЛЬШЕННЯ РЕСУРСУ МАСТИЛА ШЛЯХОМ РОЗРОБКИ ПРИСТРОЮ ДЛЯ ЙОГО ОЧИЩЕННЯ

Сільськогосподарське виробництво - один з основних споживачів нафтопродуктів. Підприємства агропромислового комплексу України щорічно споживають близько 7 млн.т вироблюваного дизельного палива й близько 1,0 млн.т моторного масла. Середнє по величині господарство центральної зони витрачає за рік до 1200 т дизельного палива, 600 т бензину, 60 т шторних масел, з яких не менше 80% переходить у категорію відпрацьованих нафтопродуктів різних груп.

У результаті інтенсивного зростання парку двигунів внутрішнього згорання, а також підвищеної уваги до факторів економічного й екологічного характеру перед народним господарством усе гостріше стає завдання заощадження й раціонального використання паливно-енергетичних, сировинних і інших матеріальних ресурсів.

Відомо, що одним зі шляхів підвищення рівня забезпеченості сільськогосподарського виробництва моторними маслами є їхнє повторне використання після відновлення деяких якісних показників, що погіршилися в результаті їхнього застосування при експлуатації автотракторної техніки .

Повторне застосування масел дозволяє збільшити термін їхньої служби, скоротити безповоротні втрати й зменшити дефіцит поставок масла в господарства. Однак темпи використання відновлених масел залишаються на низькому рівні. Так, у цілому по країні щорічний злив відпрацьованих масел склав 0,9 млн.т, а регенерувалося всього лише 0,15 млн.т, що становить біля 16% від зібраного обсягу.

Запропонований пристрій можна використати в межах ініціативної тематики «Дослідження шляхів оптимізації показників технологічного процесу виготовлення ефірів жирних кислот для дизельного біопалива» (державний реєстраційний номер: 0122U002187 від 30.03.2022), та дослідити по ініціативній тематичі: «Дослідження впливу біоетанолової складової паливної суміші на параметри роботи бензинового інжекторного двигуна» (державний реєстраційний номер: 0122U00213 від 30.03.2022).

**Ключові слова:** технічне обслуговування, очищення, заміна мастила, енергоощадні технології, мастило, паливо.

**Рис. 1. Табл. 2. Літ. 8**

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