Procedia of Theoretical and Applied Sciences
Volume 2, | Sep 2022
ISSN: 2795-5621 Available: http://procedia.online/index.php/applied/index

APPLICATION OF MICROFILTRATION FOR THE REGENERATION OF USED TRANSMISSION OILS

M. J. Makhmudov, Kh. I. Shodiev
Bukhara Engineering - Tenological Institute

Annotation: The process of regeneration of used gear oils on various types of microfiltration membranes (polymer, cermet, ceramic, and carbon with pore size 03-0.1 µm) on a flow-through installation with partial retentate extraction. Before membrane separation, the oil was subjected to coagulation to destroy the colloidal system and neutralize naphthenic and naphthenoaromatic acids. Experiments on membrane separation of regenerated oils were carried out at a pressure in the pressure channel of 0.1–0.5 MPa, a temperature of 40–140 °C, and a speed of 1–3 m/s. Optimal parameters of the membrane separation process were selected . The formation of a dynamic layer from asphalt-resinous compounds of gear oils is shown. A clarified transmission ¬oil on polymeric, metal-ceramic and carbon membranes was obtained. It has been shown that the degree of selectivity for monoethanolamine and asphalt-resinous compounds of transmission oil depends on the membrane material and the size of the membranes used.

***Keywords*:** regeneration, used transmission oils, microfiltration.

Introduction. During the operation of gear oils in internal combustion engines, oxidation products are formed in them in the form of asphalt- resin compounds, deposits, varnishes and other compounds.

In order to prevent precipitation of the above compounds, detergent-dispersant additives from the class of surfactants are introduced into the oil, which keep the oxidation products of the transmission oil in a colloidal state.

A sharp decrease in the performance of gear oils occurs when the additives in the free state are practically exhausted. Under such conditions, oxidation products begin to precipitate, thereby causing engine wear. This condition of the transmission oil indicates the need for its replacement.

Waste transmission oils (hereinafter referred to as OMM) are classified as “unfilterable” [1], since during their filtration there is a very small effect of purification from oxidized compounds that are in a colloidal state due to the action of additives. It is obvious that in order to increase the cleaning effect, it is necessary to carry out, in one way or another, the "enlargement" of oxidized compounds - coagulation.

A number of works [2] are devoted to the process of OMM coagulation, in which the main attention is paid to the search for effective coagulants and determination of their doses. It was shown [3] that the greatest effect is observed when monoethanolamine (hereinafter MEA) is used as a coagulant.

The excess coagulant remaining in the oil after regeneration will interact with the newly introduced additives necessary to give the oil performance properties. In this case, the formed compounds precipitate until the coagulant is exhausted, i.e., it completely reacts with additives [4].

Thus, it can be concluded that the main problem of the OMM coagulation process is the removal of excess coagulant, which depends both on the quality of the original oil and its service life in the internal combustion engine.

Procedia of Theoretical and Applied Sciences
Volume 2, | Sep 2022
ISSN: 2795-5621 Available: http://procedia.online/index.php/applied/index

It should be noted that membrane separation methods have been little studied for the regeneration of OMM [5], and the purification of OMM from MEA has not yet been considered.

Experimental part . The purpose of this work is to study the possibility of purification of OMM from MEA and asphalt- resinous compounds, as well as to study the effect of temperature and pressure on the specific productivity and selectivity of fine-porous microfiltration membranes (see Table 1).

When studying the regeneration process, used Nordix gear oil with the characteristics shown in Table 1 was used. 2.

Table 1. Characteristics of the studied membranes and their properties

Membrane type	Properties				
	Average pore diameter, μm	Bubble point pressure, kgf / cm ^{2}	Membrane performance in distilled water at Δp = 0.5 atm, l/m ^{2} h	Thermal stability, °C, no more	Limit working pressure, atm
Polymer MFFC type	0.07	2.1	800	70-100	3-5
Metal-ceramic type TRUMEM	0.03 0.05 0.07	1.7 1.7 1.7	360 800 1000	400 400 400	- - -
Ceramic single channel	0.03	-	300	500	-
Carbon single channel	0.1	-	100	300	-

Table 2. Characteristics of OMM "Nordix"

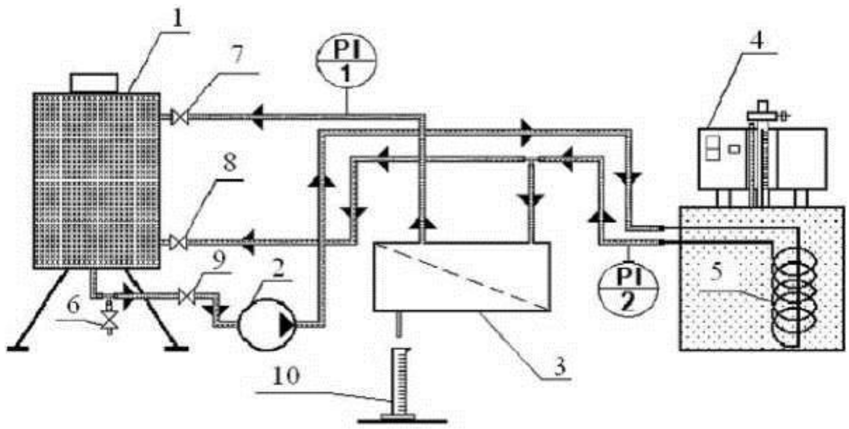
Names of indicators	OMM "Nordix"
1. Flash point in an open crucible, °C	186
2. Kinematic viscosity at 100°C, cSt	6.1
3. Acid number of oil, mg KOH/g	2.49
4. Base number of oil, mg KOH/g	0
5. Water content, % wt.	0.00430
6. The content of mechanical impurities, % wt.	2.51
7. Density at 20°C, g/ cm3	871.3
8. Color of dark oil products, units CNT	over 8.0
9. Ash content of oil with additives, % wt.	0.5695

In order to transfer OMM to the category of "filterable" it was coagulated in a laboratory reactor with a stirrer at a temperature of 80°C and a coagulant concentration of 10% by volume (a mixture of MEA : isopropanol = 2:1) for 60 minutes, followed by separation in a laboratory centrifuge for 30 minutes

Procedia of Theoretical and Applied Sciences
Volume 2, | Sep 2022
ISSN: 2795-5621 Available: http://procedia.online/index.php/applied/index

with a split factor of 10,000.

Thus, the "initial" oil was obtained, which was subsequently subjected to membrane separation on a laboratory bench, shown in Fig. one.



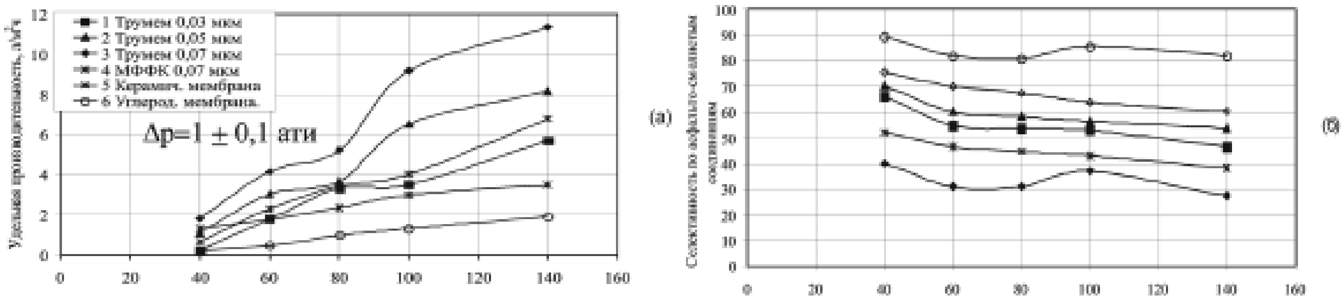
Rice. 1. Diagram of a laboratory setup for membrane separation. *1 - initial capacity; 2 - pump; 3 - flow membrane cell; 4 - thermostat; 5 - coil heat exchanger; 6, 7, 8, 9 - taps; 10 - measuring cylinder for collecting permeate*

When calculating the selectivity for asphalt-resinous OMM compounds, the optical density of OMM in the range of 500–600 nm, which is easily determined and symbatic [6] with their concentration, was used.

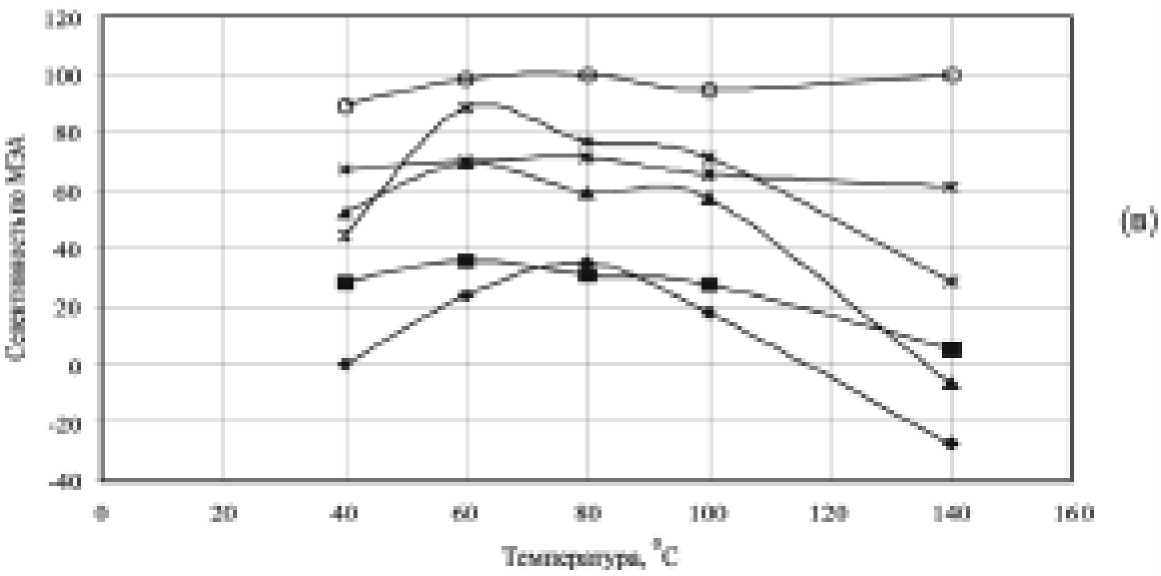
The optical density of transmission oils was determined on a KFK-2 photocolorimeter at X = 590 nm.

The concentration of MEA in oil was determined by direct titration by tensiometry using a pH-meter pH-673M.

The traditional method of increasing the specific productivity of membranes is to reduce the viscosity of the liquid by increasing the temperature rise. The upper allowable temperature limit - 140°C (see Fig. 2) is determined by the flash point of OMM, which is 160-180°C. In the temperature range of 40–140°C, the kinematic viscosity changes by a factor of approximately 40. However, the specific productivity increases by about 6 times (Fig. 2a).



Procedia of Theoretical and Applied Sciences
Volume 2, | Sep 2022
ISSN: 2795-5621 Available: http://procedia.online/index.php/applied/index



Rice. 2. Effect of temperature on specific performance and selectivity of microfiltration membranes

Conclusions

Based on the work carried out, the following conclusions can be drawn:

- A process for the regeneration of used gear oils has been proposed, which consists of two stages: coagulation and microfiltration. Recommendations on the choice of membranes and modes of their operation are given.
- The possibility of predicting the characteristics of separation based on the composition of the oil and the type of membranes is shown.

Literature

1. *Shashkin P.I., Brai I.V.* Regeneration of used petroleum oils. M.: Chemistry. 1970.
2. *Prokopiev V.N., Sinyanskaya R.I., Mishchenko E.V. and other* Method of regeneration of waste lubricating oil. Pat. 2076898 Russia, MPK ^{6} S 10 M 175/02. - 93026982/04.
3. *Mukhortov I.V., Bragina E.I.* Dependence of the properties of regenerated transmission oil on the depth of purification of raw materials // Technical operation, reliability and improvement of automobiles. Chelyabinsk. 1996, p. 88-92.
4. *Akhmetkaliev R.B.* A method for cleaning used transmission oil from suspended mechanical - impurities and water. Pat. 2015160 Russia, IPC C10 M 175/02. - 5012692/04.
5. *Lutfullina N.A., Lukashevich V.I., Lukashevich A.V.* The method of regeneration of used oils and - installation for its implementation. Pat. 2034910 Russia, MPK ^{6} S10 M 175/02. - 5040776/04.