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Development of a method for obtaining import-substituting greases based on regenerated synthetic motor oils of Uzbekistan

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Abstract. The purpose of the study is to increase the efficiency of using used engine oils as a dispersion medium for plastic lubricants. It has been established that the removal of resins, carbenes, carbides and asphaltenes from used synthetic motor oils makes it possible to obtain an oil base close to commercial base oils in terms of basic characteristics; refined oils also have a high margin of operational properties. The composition of lubricants for analogues of Lithol-24 and Solid oil-Zh based on refined used engine oils has been determined. Anticorrosive, adhesive and strength properties of lubricant compositions are considered.

1 Introduction

All available methods of production and compositions of greases involve the use of expensive and limited resources, such as petroleum base oils and additives, and their production technologies are energy-intensive and high-cost [1-5]. At the same time, untreated engine oils are a product that requires disposal, but they contain a highly contaminated oil base and a residual stock of additives that, under certain conditions, can be used in the production of secondary oils and lubricants [6-7, 10-12].

Solving the issues of resource saving and cost reduction for the production of greases, attempts have been repeatedly made to use used motor oils as a dispersion medium [1-5]. But despite this, the problems of obtaining high-quality lubricants from used oils, reducing the cost of their production through the use of spent petroleum products, thereby increasing the efficiency of the use of secondary resources are insufficiently solved in Uzbekistan.

The purified oil [6, 7] has sufficiently high performance properties to be used as a dispersion medium of greases. The color of the oil corresponds to some samples of base oils used in accordance with GOST 20799 in the preparation of greases (for example, Solidol W, Litola-24). The research was carried out to determine the regularity of changes in the physico-chemical properties of used oils when they are used as a dispersion medium

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and when preparing compositions of greases based on them [1-5, 11]. The optimal composition of lubricants based on greases was also determined, their physico-chemical and tribological properties were evaluated.

2 Materials and Methods

Used synthetic-based engine oil of the SHELL HelixHX8 5W/30 brand was used for the research. The spent and purified oil was analyzed by kinematic viscosity at 100 °C according to GOST 33, the alkaline and acid number was determined according to GOST 11362, the density at 20 °C according to GOST 3900, the flash point in an open crucible according to GOST 4333, the pour point according to GOST 20287, the residue insoluble in gasoline according to GOST 20684, the water content according to GOST 2477. Based on the established optimal characteristics of the process of obtaining a dispersion medium, its properties, it was concluded that it was advisable to use purified oil for the preparation of lubricants [6, 12-15].

The most widely used lubricants Solidol-Zh and Litol-24 manufactured by JV Chilon Lubricants LLC were used as basic guidelines for determining the compositions of lubricants Uzbekistan, having an effective viscosity at an average strain rate gradient of 10c -1, and minus 20 °C no more than 650 Pa * s, at 0 °C no more than 280 Pa * s, and at 50 °C no less than 8 Pa * s. The drop–off temperature is not lower than 185 ° C and penetration at 25 °C min -1 with stirring 60 cycles/min, within 220-250 mm-1 for Litol-24 lubricants. The viscosity is effective at 0 °C and the average gradient of the deformation rate of 10 s -1 is not more than 250 Pa * s, the drop–off temperature is not less than 80 °C, penetration at 25 ° C min -1 with stirring 60 cycles/min, within 220-250 mm-1 for Solidol-Z lubricants. The drop-off temperature of the lubricant was determined according to GOST 6793, penetration according to GOST 5346 [2-4, 11-12]. As a dispersion phase in the preparation of Solidol-W grease, cubic residues of synthetic fatty acids (KOSFA) were used in a percentage ratio of 10, 20, 30 wt. %. The mixture was heated and mixed, calcium hydroxide 20-25 wt. was added to the resulting suspension. %, heated to a temperature of 110-120 ° C and cooled with subsequent homogenization. An analogue of Litol 24 was obtained by adding lithium soap 10, 15, 20 and 25 wt.% to purified used synthetic oil. The mixture was heated to 200-220 °C for thermomechanical dispersion with stirring, cooled to a temperature of 50-60 ° C and homogenized [11-13].

After receiving the lubricants, studies were carried out to determine the anticorrosive properties in an electrochemical measuring complex according to GOST 9.080. Adhesive properties were determined on the K-2ZHV plastometer meter according to GOST 7143, as well as the strength characteristics of greases at various shear rates. The heat capacity was evaluated using the IT–S–400 meter according to GOST 23630.2. The performance characteristics of lubricants, tribological properties, were carried out on an automatic four-ball machine (HSM) MRS-10A according to GOST 9490 [11].

At the next stage of the research, the optimal compositions of lubricants were determined by mixing the dispersion medium with the dispersed phase. The used FGCS had an acid number of 70 mg KOH/g. As an agent providing the saponification process, an aqueous solution of lime (fluff) was used in a ratio of 3:1. To determine the optimal mixing concentration of the dispersion medium and the dispersed phase, the following ratios were taken: 90:10 of the dispersion medium (dm) and the dispersed phase (dp); 80:20 (dm:dp); 70:30 (dm:dp).

3 Results and Discussion

The composition of the lubricant, consisting of a proportion of 80 to 20, allows you to obtain a drop-off temperature of the lubricant equal to 90 °C, which is an acceptable value for Solidol type lubricants. Changes in concentration in one direction or the other does not lead to a positive result.

The use of purified spent synthetic engine oil "SHELL HelixHX8 5W/30" as a dispersion medium makes it possible to obtain a lubricant with a drop-off characteristic exceeding the standard values.

Characterizing the structure of the lubricant, it should be noted that a change in the composition of 90:10 of the dispersion medium to the dispersed phase leads to its fluidity and delamination, and at a ratio of 70:30 to cracking of the lubricant.

In studies on the production of Litol-24 lubricants, lithium soap is used as the dispersed phase. One of the components of soap is 12-oxystearic acid (44.5 wt. %) and an aqueous solution of lithium hydroxide (9.3% lithium hydroxide, 27.7% water) was used as a saponification agent.

The lubricant was synthesized under the following conditions: the dispersion medium and the dispersed phase are mixed at 20 °C, then, with constant stirring, the temperature is raised to the melting point of the soap and the final treatment is carried out at this temperature for 10 minutes. Table 1 shows the values of the drop-off temperature change when mixing the dispersion medium (purified spent engine oil on a synthetic basis) and the dispersed phase.

Table 1. Change in the drop-off temperature of the lubricant composition depending on the ratio of the dispersion medium (purified waste oil SAE 10W 40 Shell) and the dispersed phase.

Indicator	**The ratio of the dispersion medium to the dispersed phase**						
Drop-off temperature	90/10	88/12	86/14	84/16	82/18	80/20	78/22
	94	115	123	134	147	161	180

Analyzing the data in Table 1, in the first approximation, it can be concluded that with an increase in the amount of the dispersion phase, the drop-off temperature of the studied compositions increases.

Comparing the obtained values of the drop-off temperature of experimental formulations with the drop-off temperature of Litol-24 lubricant, it was found that at concentrations of 82/18, 80/20 and 78/22, it approaches the values of commercial lubricants. At the same time, it was also found that an increase in the df content above the 80/20 value leads to a change in the structure of the lubricant.

To assess the effectiveness of using used oils as a dispersion medium, comparative studies of the rheological and physico-chemical properties of the compositions of lubricants prepared on the basis of used synthetic oils without their purification and after purification were carried out (Table 2).

Summarizing the results of studies on the optimization of lubricant compositions, it can be concluded that lubricants based on crude engine waste oils do not meet the requirements of regulatory documents in terms of basic physico-chemical and rheological properties, contain impurities, have a black color, low colloidal stability compared to lubricants from purified waste oils.

Table 2. Rheological and physico-chemical properties of lubricants.

Indicators	**Plastic lubricants**					
	Solidol-W (GOST 4.23-83)	An analogue based on used oil	An analogue based on purified oil	Litol-24 (GOST 4.23-83)	An analogue based on used oil	Litol based on purified oil
Drop-off temperature, ºC	75–80	70	90	185	150	180
Penetration at 25 °C, ×10-1 mm	230–290	300	240	220–250	260	230
Effective viscosity at 0 °C and 10 ° C–1, Pa •s	250	280	255	280	290	280
Impurity content (under the microscope)	absence	presence	absence	absence	presence	absence
Appearance (color)	light brown	black	light brown	yellow	black	yellow
Colloidal stability, %	13.0	8.0	13.0	12.0	10.0	13.0

Electrochemical studies to determine the anticorrosive protective properties of the obtained compositions of lubricants were carried out according to GOST 9.080. The studied greases provide a protective efficiency of steel surfaces ~ 40-55%. Solidol on a synthetic basis has a higher protective effectiveness.

As a result of the study of the heat capacity of lubricants, it was found that with an increase in the heating temperature of the commercial solidol, its heat capacity increased and by 100-110 °C reached 2300 J/(kg • K). Further, as the temperature increased, a decrease in the heat capacity of the lubricant was observed, followed by a slow increase. It was found that the heat capacity during heating of the samples in all cases increased uniformly and the maximum value was obtained in a sample of mineral–based lithols - more than 2400 J/ (kg • K).

4 Conclusion

According to the research results, the process of preparing greases based on used synthetic motor oils is justified. It has been established that the removal of resins, asphaltenes, and carbides from waste oils makes it possible to obtain a high-quality base of greases.

It is determined that mixing of purified waste oil with a dispersed phase makes it possible to obtain analogues of Solidol Zh and Litol-24 greases, which are widely used in industry. A comparative assessment of the anticorrosive, anti-wear, adhesive, strength properties of lubricants based on used oils has shown that they are not inferior in their physico-chemical properties, and in some cases surpass known analogues based on base oils.

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