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THE PROSPECTS OF OBTAINING PLASTIC GREASES FROM SECONDARY HYDROCARBON RAW MATERIAL

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Abstract

The paper presents the results of producing lubricating grease from industrial and household waste in the laboratory. Partially prepared diesel engine oil SAE 10W-40 was used as a dispersion environment, and high and low pressure polyethylene (household polyethylene bags used) was used as thickener. It has been established that by using selected base oil, thickener and anti-wear additive DF-11, recycling oils can be obtained, which will be classified according to DIN 51502 to K2PF-30 and K3PF-30. It is proposed to expand the raw material base for the production of recycling oils through the using of waste industrial, hydraulic, transmission oils, as well as high-boiling petroleum fractions extracted from oil sludge or acidic tar and selective waste distillate oils. On the basis of the analysis of the researching results, it was established that on the basis of exhausting motor oil and polyethylene with the addition of additives of different functional purpose, it is possible to obtain a number of antifriction plastic lubricants used in swing bearings, railway and protective greases that can be used in the range of operating temperatures, on average up to 100ºC.

***Keywords**: exhausting motor oil; thickener; plastic grease; polyethylene; additives; optical density; express analysis.*

1. Introduction

With the modern development of the techno sphere, there is a tendency to increase the volume of industrial and domestic household waste. Their accumulation has a negative impact on the environment and directly on humans. However, these wastes can be considered as an alternative source of hydrocarbon raw material for many technological processes for the production of various materials of the broad functional value. These materials can be realized in chemical industries. At the same time, waste processing improves the global environmental situation significantly and brings a significant revenue to the budget of the country developing this direction.

2. The purpose and objectives of the research

A very promising direction in the use of the secondary hydrocarbon raw material is the production of plastic greases, which in their properties are not inferior to products obtained during the oil processing. They also have a much lower cost of production.

In general, any plastic grease contains in its composition 70-90 % (mass) of the base oil (mineral or synthetic nature), 5-15 % (mass) of the thickener (metallic soaps) and 1-5 % (mass) of various additives. In addition to these constituents, 3-10 % (mass) of other components are present in oils. They are fillers that improve the performance properties of the final commercial product [1-2].

Drawing on long-term experience in the production and application of greases in various industries, it should be noted that the main components, of which today lubricants are produced, can be replaced by cheap analogs with storage of the required quality level. One of the

many-tonnage industrial wastes, which on the one hand is a rather dangerous waste, and on the other hand is a valuable resource for many manufacturing processes, is used lubrication oils [3]. These oils can be successfully used as a base oil (dispersion medium) in the technology of greases production.

Thus, for example, it has been investigated the possibility of using used motor oils after regeneration and hydrocarbon distillation from the sludge of the purification unit for the production of highly alkaline sulfonate additives as a dispersion medium of hydrocarbon and soap greases. Solid oil paraffin, petrolatum, and calcium stearate were used as a thickener [4].

Dry and calcium-rich and hydrocarbon preservative greases with enhanced protective properties are known in comparison with oils on base distillates based on the use of used motor oils as a dispersion medium. Obtained lubricants in terms of their bulk and surface properties are similar to the lubricants "EXXON Estan 1.2" and "SHELL Ossagl V (00)" [5].

In work [6], it is proposed to obtain preservative lubricants for the protection of agricultural machinery with the use of purified waste motor oils and thickeners – stillage bottoms from the production of synthetic fatty acids and metallic soaps Ca, Li. The proposed lubricants inhibit the anodic dissolution of the steel due to both the oil itself and the action of antioxidant, anticorrosive additives, and are similar in properties to commercial greases "AGIP Grease CC 2.3", "Texas Hytex EP-2".

Based on purified waste motor oils, thickener, graphite and complex antiwear additive the authors of the work [7] obtained greases in appearance and basic properties similar to general-purpose commercial lubricants.

For thickening by greasing of threaded joints, in particular for conical threaded connections of pipes and equipment used in wells, a lubricant containing the oil base and a powder filler (graphite, zinc, lead, aluminum, etc.) is used [8].

Today used polyethylene products are the most common solid domestic waste that accumulates in the countries of the European Union and is a cheap source of hydrocarbon raw materials. Taken into consideration some properties of polyethylene itself (resistance to organic and inorganic solvents, the melting point is 103-140°C), these products can be used as a thickener in the grease production.

It is shown that the addition of recycled polymers (polyethylene, polypropylene and EVA copolymer) to lithium grease improves its rheological properties significantly [9]. Based on the mixture of paraffinic mineral oils of Group I and II (kinematic viscosity at 40 °C is equal to 160 mm^2/s), they are produced by Indian Oil Corporation Ltd. (Faridabad, India) and blends of polypropylene and high-density polyethylene, greases with high rheological properties were obtained [10].

Also, in work [11] plastic greases were synthesized, they correspond to the classification DIN 51502, K5S-60 according to their properties, and contain low molecular weight polyethylene and up to 30 % (mass) oils (dewaxed oil, residual extract of selective oil purification and used oils).

In the field of railway transport, namely, for lubricating rails on the curved sections of the track, a composition consisting of low molecular weight polyethylene is used – a waste product for the production of high-density polyethylene 15-25 % (mass) of hydrolytic lignin, 10-25 % (mass) of the spent diesel oil are added to this waste [12].

3. Results and discussion

Having analyzed the information given above, it is possible to propose a conditional technological classification of plastic greases according to the main components from which it was obtained, namely, base oil and thickener:

Group I plastic greases – classic greases obtained from distillate petroleum or synthetic oils, which as a thickener contain metallic soaps, solid hydrocarbons, and inorganic substances;

Group II plastic greases – combined greases in which the base oil and thickener can be partially replaced by industrial waste, by-products, and substances found in other industries;

Group III plastic greases – recycling greases, in which the base oil and thickener can be completely replaced with industrial and household waste.

The share of recycling greases in the total volume of production and consumption of lubricants is very small, but at the moment the certain conditions have already been created under which this direction is a priority in scientific research of the countries of the European Union.

Considering this, it is possible to propose a scheme for the grease production (Fig. 1), in which the base oil is the partially prepared semisynthetic motor oil SAE10W-40 API SL/CF, and the thickener is high pressure polyethylene or low pressure polyethylene, or their mixture.

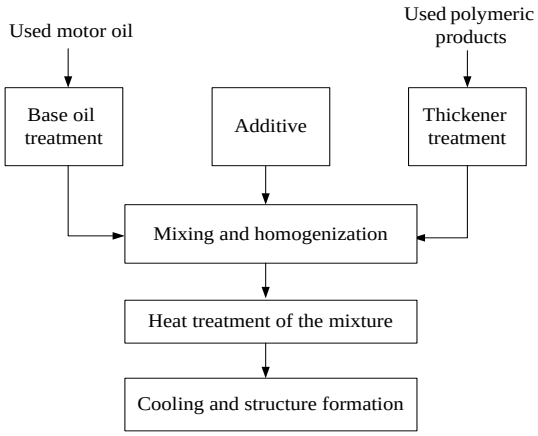

Fig. 1. The structural scheme for obtaining recycling grease

First, the dispersion medium – used motor oil SAE10W-40 API SL/CF, undergoes a preparatory stage, including the removal of water and mechanical impurities from its composition by settling and centrifuging the oil. At this stage, also used polyethylene products – packaging film, bags, etc., are crushed.

Further, the prepared components (base, thickener, and complex additive) are fed into mixing and homogenization, where the thermal dissolution of the thickener with a certain concentration of polyethylene occurs at a temperature of at least 110 °C. Then the reaction mixture undergoes heat treatment at a higher temperature. The final stage in the scheme is cooling and forming the final structure of the grease with the properties given in Table. 1.

Table 1 Quality indicators of obtained plastic greases

Indicator name	Numerical values of indicators for grease compositions	
Thickener mark	Polyethylene of high pressure	Polyethylene of low pressure
Concentration of thickener, % (mass)	7	5
External view	Homogeneous ointment, black	Homogeneous ointment, black
Penetration at 25 ºC, mm·10^{-10}	273	235
Droplet temperature, ºC	95	110
Corrosion effect on metals (carbon steel)	Withstands, no traces of corrosion	Withstands, no traces of corrosion
Evaporation at 120 ºC	0,72	0,43
Content, % (mass):		
free alkalis	0,04	0,04
water	not available	not available
mechanical impurities	0,10	0,10
water-soluble acids and alkalis	not available	not available
Colloidal stability, %	6,34	3,67

It should be noted that in the grease production with the use of polyethylene as a thickener, unlike lubricants where metal soaps are used [13], it is not necessary to conduct a deep preparation (cleaning) of the dispersion medium. It is enough to remove only water and mechanical impurities.

Polar tar-asphaltene substances, which are the products of oxidation of hydrocarbon crude, they also have a positive effect on the properties of the grease, since they cause high adhesion to metal surfaces. Another oxidation product is carboxylic acids. They are corrosion inhibitors [14], and these acids improve the volumetric properties of lubricants [15]. Also, the grease has good low-temperature properties due to the depressant additives that make up the base oil.

The results of the laboratory tests show that a lubricant thickened with 7 % by weight of high pressure polyethylene and 4.0 % of an antiwear additive according to DIN 51502 refers to K2PF-30, and a lubricant with 5 % by weight of low pressure polyethylene and 4.0 % of an antiwear additive can be attributed to K3PF-30.

Also, compared «EXXON Estan 1.2» this lubricant has a higher value of the dropping point (at 15°C), which extends the upper temperature limits of its application. Also, the greases obtained have a lower value of colloidal stability (by 3.66-9.33 % of the removed oil) than "EXXON Estan 1.2". According to other indicators, the obtained greases have values close to those of "EXXON Estan 1.2".

The adhesive properties of the obtained lubricants were tested by applying the grease to a degreased metal plate, followed by testing it in a laboratory centrifuge for discharge at 3000 rpm. within 3 minutes. The undertaken study has shown that the grease layer is completely preserved on the metal plates. Hence the lubricants withstand the tests.

It is possible to expand the raw material base for the production of recycled oils of thickened high pressure polyethylene and low pressure polyethylene by using other raw materials (used industrial, hydraulic, transmission oils, as well as high boiling petroleum fractions isolated from oil sludge or acid sludge, and wastes of selective purification of distillate oils), but, this requires additional research.

4. Conclusion

The development and introduction of recycling grease production technologies in the industry will allow reducing the harmful impact on the environment from the accumulation of industrial and domestic waste, using them as raw materials in manufacturing processes aimed at obtaining fuels and lubricants.

It is possible to get a number of antifriction plastic greases on the basis of large-tonnage waste, used motor oil and used polyethylene products, which are a valuable source of secondary hydrocarbon raw materials, including the additives of various functional purposes. These lubricants are used in rolling bearings, as rail and protective lubricants, which can be used in the range of operating temperatures to an average of 100°C. Due to the low cost and simplification of the raw material preparation technology, the obtained greases will be much cheaper compared to analogues made from oil according to the classical technology.

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