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STABILIZATION OF ENERGY OILS WITH ANTIOXIDANT ADDITIVES

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Abstract: The article examines the deterioration of physicochemical and operational properties of energy (transformer and turbine) oils during long-term use, their restoration through adsorption method using Navbahor bentonite, and stabilization with antioxidant (anti-oxidation) additives. The optimal conditions for the adsorption regeneration process based on Navbahor bentonite were determined experimentally. The application and efficacy of a modern antioxidant—ionol—are substantiated to enhance the stability of regenerated oils. According to the obtained results, it has been established that regenerated turbine and transformer oils with the addition of 0.5% ionol fully comply with current standard requirements.

Keywords: energy oils, transformer oil, turbine oil, regeneration, adsorption, Navbahor bentonite, antioxidant, ionol, aging, physicochemical properties, operational properties.

Introduction. During prolonged operation, petroleum oils undergo aging and changes in their physicochemical and performance properties. At present, the main direction in the utilization of used petroleum oils, in terms of volume, is their use as a component of boiler fuel or even their direct combustion (disposal). However, the use of simple, economical, and easily applicable regeneration methods, such as adsorption, makes it possible to obtain sufficiently purified regenerated oils, which can be stabilized by the addition of antioxidant additives.

Due to the depletion and the need to conserve petroleum resources, technologies using synthetic and natural sorbents will dominate in this field. Among the natural sorbents, bentonite clays are the most suitable, one of the most important deposits of which — the Navbahor deposit — is located in Uzbekistan.

In the Republic, there are practically no enterprises for the regeneration of used petroleum oils, particularly energy oils; therefore, the development of technological foundations for the regeneration of used oils is an urgent problem.

To improve the quality of regenerated oils and stabilize them, antioxidant additives — or antioxidants, as they are commonly called — are introduced. They are added to oils used at moderate temperatures, since under conditions of thermal decomposition of hydrocarbons, antioxidant additives become ineffective. Transformer and turbine oils, which belong to the group of energy oils, operate under such moderate conditions. [1]

This work presents the results of regenerating used petroleum oils — turbine and transformer oils — with the natural sorbent Navbahor bentonite and restoring their physicochemical and performance characteristics through the introduction of antioxidant additives. It should be noted that the used turbine oil from the hydroelectric power plant was highly water-contaminated — about 10%. The water was settled and separated from the oil. Final drying was carried out using calcined synthetic zeolite CaA.

Based on a large number of experimental studies, the possibility of regenerating used transformer and turbine oils using Navbahor bentonite [2] has been demonstrated, and the optimal purification conditions have been determined: solid-to-liquid ratio, sorbent grain size, its activation, solvents, desorbents, temperature, etc. The main parameters of the adsorption–desorption processes of oils have been worked out, forming the basis of the conceptual technological schemes of adsorption regeneration. [3,4]

The most promising antioxidant additive at present is Ionol. Ionol (DBK, dibutyl para-cresol), or as it is known abroad — Parabor, Kerabit, Tokanol-O, etc. — is a crystalline substance produced by alkylating phenol with isobutylene in the ortho-position on an organoaluminum catalyst.

Ionol is an effective inhibitor of oxidation of oils and fuels; it dissolves well in them even at room temperature. At optimal concentration, Ionol effectively slows the aging of energy oils — turbine and transformer oils — as well as the aging of operating and regenerated oils.

In the CIS countries, Ionol is permitted for use in automotive fuels, aviation gasoline, hydrogenated jet fuels, and oils.

The antioxidant additive Ionol must meet the requirements shown in the table:

№	Indicator	Standard	Test method
1	color and appearance	colorless crystals	organoleptic
2	odor	absent	same
3	melting point	70 ± 0.1 °C	GOST 9884-61
4	ash content	absent	

According to current understanding [5,6], the oxidation of hydrocarbons in petroleum oils is inhibited by the following mechanism: at the first stage, Ionol reacts with peroxide compounds of oxidized hydrocarbons to form a stable phenoxyl radical, incapable of continuing the chain oxidation of hydrocarbons. At the same time, one molecule of Ionol is capable of terminating at least two oxidation chains.

Studies in [5,6] have shown that for certain commercial samples of transformer oils, a concentration of 0.4% Ionol is critical, and further addition does not enhance its inhibitory effect. Therefore, 0.5% Ionol was introduced into regenerated energy oils to restore their physicochemical and performance characteristics. [7,8]

Tests of the energy oils obtained by this method showed that they met the generally accepted standards for transformer and turbine oils.

It is known that during the stabilization of regenerated oils with antioxidant additives, the sensitivity of oils to additives depends mainly on the nature of the additive rather than on the depth or method of oil recovery. This is especially evident in the example of Ionol, which is an effective inhibitor for regenerated oil regardless of the depth of purification.

In terms of production volume and application, petroleum oils occupy a leading position among lubricants. The production of petroleum oils continues to grow, which in turn increases the volume of used oils. [9]

The term regeneration refers to restoring the quality of used lubricants to the level of commercial, fresh oils. In this case, the properties of used products are fully restored and they can be reused.

When processing mixtures of various used petroleum oils collected centrally from industrial enterprises, the term secondary processing is used. From such feedstock, base oils of various compositions and purposes can be obtained.

In our country, according to GOST 21046-86, similar concepts are used — regeneration of used oil and regeneration of a group of used oils.

Thus, based on literature sources and our own experimental data, the following can be stated: in the complex of technological processes of regenerating used petroleum oils, the following sequence must be observed — physical methods (settling, filtration, evaporation, etc. to remove free water and solid contaminants), physicochemical methods (coagulation, adsorption) — to remove oxidation products.

The conceptual technological scheme of the regeneration process should be as follows: used oil → removal of mechanical impurities → dehydration → removal of oxidation products → regenerated oil → additives → restored oil.

Conclusion.

The conducted research has demonstrated that the adsorption regeneration of transformer and turbine oils using Navbahor bentonite provides an effective purification method. Under optimal conditions, it has been confirmed that the physicochemical and operational properties of the regenerated oils comply with regulatory requirements.

The addition of 0.5% Ionol antioxidant to the regenerated oils significantly enhanced their oxidation stability. These results offer opportunities to extend the service life of energy oils, improve recycling technologies, and develop import-substituting technologies based on local sorbents in the country.

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