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PURIFICATION AND PROCESSING OF COMPRESSOR AND AUTOMOTIVE OILS USING SORBENTS BASED ON LOCAL RAW MATERIALS

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Abstract. Currently, in many countries, the production volume of petroleum products reaches several million tons, while the specific share of lubricating oils in the total balance remains insignificant. During use, a considerable amount of used petroleum products is released into the environment, causing negative impacts and posing environmental hazards.

The worsening global ecological crisis has necessitated the development of new approaches to prevent pollution of natural ecosystems and implement closed cycles for the rational use of carbon-containing resources. One of the promising directions is the reuse of fresh and used lubricants based on oil dispersion systems.

Rational processing of used oils is important from both ecological and economic perspectives. The effectiveness of oil regeneration using bleaching clays is largely determined by the temperature regime of the process and the duration of phase contact. Practical studies show that the optimal interaction time is 25-30 minutes at a given operating temperature. The maximum temperature corresponds to that of the oil-adsorbent mixture at the outlet of the heating coil and typically ranges from 150-270 °C, depending on the viscosity and physicochemical characteristics of the initial raw material. As oil viscosity increases, a higher processing temperature is required; however, excessive heating must be avoided to prevent thermal degradation of the product.

Keywords: diesel fuel, adsorbent, clay materials, lubricating oils, toxic and carcinogenic compounds, oil waste, used fuels, operational processes.

Introduction. Most synthetic adsorbents are characterized by high cost and limited availability, making their use economically justified only when they can be regenerated and reused multiple times. However, the need for secondary processing of such materials significantly complicates the oil purification technology, as it requires additional equipment and substantial labor resources.

In this context, the use of natural adsorbents is of particular interest, as they are characterized by low cost and sufficiently high adsorption capacity for extracting energy and lubricating oils. The application of such materials allows for a reduction in processing costs and increases economic efficiency.

To date, a significant number of bleaching clay deposits are known, which can be used for the regeneration of used oils in both their natural and activated states. According to data from the last 5 years, global annual oil consumption has reached approximately 45 million tons, which is attributed to the growth of production capacities, the expansion of industrial equipment range, and the increase in production volumes of new types of oil targeted at domestic and foreign markets.

Modern technologies for the secondary processing of crude oil, applied in global practice, allow for the utilization of raw materials and waste of various origins and qualities in processing. At the same time, most of these technological processes are characterized by high

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complexity, require expensive equipment, and can be implemented primarily at specialized industrial enterprises.

Used motor oils represent valuable secondary raw materials suitable for subsequent production of lubricants. For their reuse, deep purification is necessary, ensuring a significantly lower level of contamination compared to the indicators achieved when using natural sorbents, particularly bentonite clays. After such purification, the cleaned oils can be used as a dispersion base.

The Republic of Uzbekistan possesses significant reserves of bentonite clays; however, the degree of geological exploration of these deposits currently does not exceed 20%. At present, no more than 12% of the generated used oils are collected and processed in the country, while the majority is either disposed of by incineration or illegally discharged into soil and water bodies, leading to a substantial deterioration of the ecological situation and environmental pollution.

Experimental part. In the process of obtaining essential oils, various functional additives are introduced when necessary, which allow for adjusting the product composition or significantly improving its initial physicochemical properties.

Bleaching clays are distinguished by their lowest cost and availability compared to other types of adsorbents. Natural clay materials, varying in chemical composition and consisting of aluminosilicate compounds, exhibit pronounced adsorption properties towards impurities containing aluminum oxides and alkali elements, as well as oxides of soil, alkali, and alkaline earth metals. The presence of bound and hygroscopic water in the structure of clays contributes to an increase in their adsorption activity. In this case, the adsorption characteristics of clay materials are largely determined by their level of porosity and, to a lesser extent, by their chemical nature.

Oils are classified according to their functional purpose as lubricating and non-lubricating. Lubricants used to reduce friction and wear include motor oils for internal combustion engines, aviation and automotive oils, as well as diesel fuel fractions.

The procedure for bleaching and purifying used motor oils is conducted with the selection of a temperature regime, which is determined by the vehicle's mileage and the operational characteristics of the oil. The selection of processing temperature is carried out taking into account the degree of thermal and chemical aging of the lubricant.

The color of clay soils is largely determined by their mineral and chemical composition. Clay materials used as adsorbents in motor oil purification typically have a light gray, reddish-gray, or similar color range. The degree of clay contamination during processing is assessed by the change in its color, which allows for indirect evaluation of the effectiveness of impurity component adsorption.

Figure 1 shows a diagram of using a colored clay adsorbent in the regeneration of motor oils that have been in use for approximately 5,000 km.

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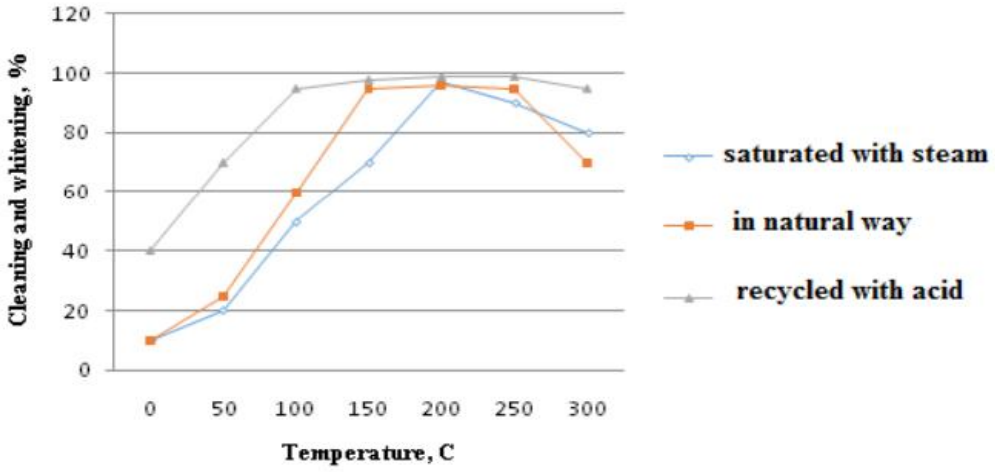


Fig. 1. Temperature dependence of using 20 g of bentonite to purify 100 g of used motor oils

When the sorbent is insufficiently ground, the clay material tends to settle to the bottom of the mixing device, resulting in incomplete utilization. Increasing the fineness of grinding leads to an increase in the specific surface area and, consequently, an increase in the adsorption activity of clay. At the same time, excessive grinding of the adsorbent negatively affects the filtration stage: the oil flow rate through the filter medium decreases, and fine clay particles can penetrate the filter cloth along with the product being cleaned. Furthermore, the use of processed clay is accompanied by an increase in oil retention in the solid phase, which leads to additional product losses.

The effectiveness of oil regeneration using bleaching clays is largely determined by the temperature regime and the duration of contact between the adsorbent and the oil phase. Practice shows that the optimal interaction time is typically 20-25 minutes at a given operating temperature. The maximum temperature corresponds to the temperature of the oil and clay mixture at the outlet of the heating coil and usually ranges from 150 to 270 °C. The specific value is selected taking into account the viscosity and physicochemical characteristics of the initial raw material: as the oil viscosity increases, a higher processing temperature is required. However, excessive heating is unacceptable, as it can lead to thermal degradation of the oil.

The consumption of regenerating clays during the processing of petroleum products varies between 3-25% and depends on the requirements for the adsorbent quality, the properties of the initial oil, and the characteristics of the final product. As a rule, for distilled oils, the amount of unactivated bleaching clay is 3-10% by weight, while for residual fractions, this figure reaches 15-25%, depending on the degree of purification.

Before use, the clay adsorbent undergoes activation, which is carried out by thermal treatment in drying units. As shown in Figure 2, activation contributes to increased cleaning efficiency and ensures a higher level of impurity removal.

Conclusion. One of the key factors determining the effectiveness of waste oil treatment is the duration and intensity of its contact with the adsorbent. Without mixing, the adsorption process is limited to the near-surface layers of the liquid, while the transfer of contaminants from the deeper layers to the adsorbent surface occurs extremely slowly. For this reason, contact cleaning of used oils is typically carried out under intensive mixing conditions at speeds of

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approximately 1000-1400 rpm, which ensures uniform interaction between phases.

Despite the variety of existing methods for waste utilization and regeneration, the process efficiency is largely determined by the properties of the adsorbent used. Active clay materials play an important role in cleaning oil waste; however, the degree of adsorption of contaminants can vary significantly depending on their nature and processing conditions.

The technology for processing used oils includes several sequential stages, the main ones being sedimentation, distillation, bleaching, and purification using activated clay. In this case, the sedimentation and distillation processes are relatively simple to implement, while acid treatment and adsorption purification with activated clays require more complex technological control.

The consumption of bleaching clay during the treatment of acidic oils is determined by the quality of the initial raw material and the degree of phase separation: as the yield of refined oil decreases and its separation worsens, the need to increase the amount of adsorbent to achieve the required regeneration level grows. At the final stage, the resulting mixture of oil and bleaching clay is sent for filtration to separate the solid phase.

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