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**Development of complex purification technology of used motor oil**

**ABSTRACT**

PhD Thesis  
with specialization in 6D072100-Chemical technology of organic  
substances

**General characteristics of thesis work.** The thesis work is concerned with development of regeneration technology of used motor oil by a method included ultrasonic treatment and subsequent adsorption purification with a vermiculite sorbent. The regularities of changes in the composition and properties of vermiculite depending on the activation method are revealed.

**Timeliness.** Motor oil can be considered as an integral part of the technique and as a structural material. At the end of the service life, significant volumes of used motor oils appear, which are currently one of the main types of industrial waste and have a negative impact on the environment (soil, water and atmosphere). Pollution of water bodies with used petroleum oils, for example, accounts for 20% of the total volume of industrial pollution and 60% of pollution by petroleum products.

Up to 50 percent of the used lubricants are irreversibly lost during the operation of equipment: it evaporates, burns out in engines, spills, rinses, etc. The remaining 50 percent undergo significant changes under the influence of operating conditions and must be removed from the equipment.

According to the Law of the Republic of Kazakhstan, approved in 2016 “On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on the Transition of the Republic of Kazakhstan to the Green Economy,” the Environmental Code of the Republic of Kazakhstan was amended to prohibit the disposal of used automobile oils at landfills .

However, at present in Kazakhstan there is no positive practice of introducing a centralized system for the collection, regeneration or disposal of used motor oils, which is organizationally and legislatively formalized and sets established common requirements for the products received. This is the main reason that the collection and disposal of used motor oil is still a serious problem. An increase in motor oil life, which is economically justified, leads to the accumulation of environmentally hazardous products in the oils, which only complicates the disposal process.

The steady trend of increasing consumption of motor oils is explained by the increase in the number of vehicles in the Republic of Kazakhstan. So, in 2003 in Kazakhstan there were 1433,2 thousand units of vehicles, in 2008 – 3080,2 thousand units, in 2012 – 4169,0 thousand units, in 2017 – 4382,6 thousand units .

The resources of used motor oils are estimated at about 48-50% of the consumption of fresh products (30% of all oil waste).

Thus, a review of literary sources and an analysis of the level of technology development indicate the high relevance of the selected topics for conducting a dissertation research aimed at developing a technology for the regeneration of used motor oil.

**Thesis work objectives.** Development of a method for the complex regeneration of used motor oils, including ultrasonic (sonochemical) treatment and adsorption post-treatment with a vermiculite sorbent of domestic origin.

**The following problems have been solved in order to fulfill objects in view:**

- determination of the composition of used motor oil and the nature of the polluting components;
- analysis of scientific and technical literature and patent sources of information on the research topic;
- determination of methodological approaches to the creation of a technology for the regeneration of used motor oil;
- determination of the effect of sonochemical treatment on unacceptable components of used motor oil;
- the implementation of a complex research of the physical-chemical properties of vermiculite of the Kulantau deposit as applied to the oxidation products of used motor oils;
- identification of patterns of changes in the composition, physical-chemical and adsorption properties of the vermiculite sorbent of the Kulantau deposit, depending on the activation method;
- development of a technology for the regeneration of used motor oils by the adsorption method;
- determination of the physical-chemical properties of the regenerated oil and the establishment of technical and economic feasibility of the process.

**Targets of research:** used motor oil received from an unspecified brand automobile service station; Mobil motor oil used to compare physical-chemical characteristics with used oil samples; vermiculite sorbent of the Kulantau deposit (Turkestan region).

**Scope of research** is possible to regenerate used motor oil through the use of two-stage technology, including ultrasonic destabilization of polluting components and subsequent adsorption purification with a vermiculite sorbent.

**Scientific novelty of the thesis work** is that for the first time:

- a method for restoring the quality of used motor oils using ultrasonic activation followed by adsorption purification with a vermiculite sorbent has been developed (Utility Model Patent for “Method for Cleaning Used Motor Oils”, No. 102759 publ. 05.05.2017, bull. No. 22);
- the optimal mode of exposure of the ultrasonic unit to the used motor oil is proposed with the aim of removing metals and aromatic hydrocarbons. The expediency of carrying out the reaction in an inert gas medium in the presence of

water in an oil emulsion up to 20% of the mass is proved and in an oxidizing environment;

- the main patterns of changes in the composition, physical-chemical and adsorption properties of the used adsorbent - Kulantau vermiculite - depending on the activation method, have been identified. It has been proven that the most effective method of vermiculite activation is its intercalation with octadecylamine;

- the design of a combined filter adsorber for cleaning used motor oils has been proposed (Utility model patent “Combined filter adsorber for cleaning used motor oils”, No. 102770 publ. 05.05.2017, bull. No. 22).

**The main provision to be defended:**

- a method for purification of used motor oils using ultrasonic activation and subsequent adsorption purification with a vermiculite sorbent;

- optimal operating conditions for ultrasonic treatment of used motor oil: temperature  $25 \pm 5^{\circ}\text{C}$ ; argon gas supply (Ar) at a speed of  $5 \text{ m}^3/\text{min}$  to increase cavitation intensity; 20 kHz ultrasonic treatment for 60 min; the use of surfactants in case of insufficient degree of emulsification; the use of  $\text{NaBH}_4$  1% by mass, which, creating an oxidizing environment, creates favorable conditions for the generation of a sufficient amount of radicals in the system;

- the results of the activation of the Kulantau vermiculite by the thermal, acid method and intercalation, the main regularities of changes in the composition, physical-chemical and adsorption properties of the sorbent;

- design of a combined adsorber filter for the purification of used motor oils;

- calculation of the economic efficiency of the technology for the regeneration of used motor oils;

- the results of pilot testing of a two-stage technology, including ultrasonic destabilization of polluting components and subsequent adsorption cleaning with vermiculite sorbent.

**Theoretical significance.** The basic regularities of changes in the composition, physical-chemical and adsorption properties of the vermiculite sorbent of the Kulantau deposit, depending on the activation method, are established. The mechanism of the influence of ultrasound on undesirable components of used motor oil is described.

**Practical relevance.** The implementation of the results of the dissertation research allows you to put in the recycled waste motor oil, and also allows you to solve the environmental problems of their disposal.

**Relation with research scientific works and government programs.** Part of the dissertation research (chapter 5), devoted to the study of the aspects of the use of multifunctional sorbents, was carried out in the framework of the grant financing project of the Ministry of Education and Science of the Republic of Kazakhstan: “Development of the technology for producing multifunctional adsorbents to improve the quality characteristics of oil, oil products and industrial waters” - 2015-2017, No. 0993 / GF4.

**Test of the thesis work.** The materials of the dissertation were reported and discussed at various international, republican conferences and symposia: International

scientific-practical conference “Auezov Readings - 15”, Shymkent, 2017; Scientific Practical Conference of Annual Caspian Petrocongress, Almaty, 2017; IV International Conference “Industrial Technology and Engineering” ICITE - 2017, Shymkent, 2017; II International Scientific and Practical Conference “Bulat Readings -2018”, Krasnodar, Russia, 2018; V International Conference "Industrial Technologies and Engineering" ICITE - 2018, Shymkent, 2018; International scientific and practical conference “Auezov readings - 16”, Shymkent, 2018; XII International Conference of Young Scientists in Petrochemistry, Zvenigorod, 2018; International scientific-practical conference "Auezov Readings - 17: New Impulses of Science and Spirituality in the World Space".

**Publications.** The main results of the dissertation research were published in 18 publications, including:

- in 3 articles published in an international scientific periodical included in the Scopus and Web of Science databases, Oriental Journal of Chemistry, CiteScore =0,58;
- in 3 articles published in journals recommended by the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan;
- in 8 materials and abstracts of international and national scientific seminars and conferences, 2 of them - in materials of foreign conferences;
- in 2 monographs, one of which is published in English;
- in 2 patents for a utility model of the Republic of Kazakhstan.

**Volume and structure of the thesis work.** The thesis work is presented on 136 pages of typewritten text and includes 40 figures and 26 tables. The work consists of introduction, literature review, description of objects and research methods, results and their discussion, conclusion and list of used sources from 195 items.