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ANALYSIS OF METHODS OF REGENERATION OF WASTE OILS

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Annotation
This paper provides an analysis of the methods of regeneration of waste oils. To solve the problems of preventing environmental pollution and import-substituting environmentally safe lubricating oils based on local raw materials with the involvement of additives of vegetable origin.

Keyswords: mineral oils, waste oils, raw materials, additive, impurities, coagulation, chemical analysis, temperature greases, regeneration, adsorption.

Introduction

During the period of use of motor and industrial oils, oxidation products, pollution and other impurities begin to accumulate in them, which sharply reduce the quality of oils. Oils with contaminants should be replaced with fresh ones. Used oils are collected and regenerated in order to preserve raw materials – it is economically profitable.

Depending on the regeneration process, 2-3 fractions of base oils are obtained, from which commercial oils (motor, transmission, hydraulic), as well as coolant and greases can be prepared by compounding and introducing additives. The average yield of regenerated oil from waste oil containing about 2-4% of solid pollutants, water and up to 10% of fuel is 70-85%, depending on the regeneration method used [1].

Various technological operations based on physical, physico-chemical and chemical processes are used to restore used oils. They consist in the processing of oils in order to remove the products of aging and contamination from them.

As technological processes, the following sequence of methods is usually followed:

Mechanical: to remove free water and solid impurities from the oil

Thermophysical: evaporation, vacuum distillation

Physico-chemical: coagulation, adsorption

If this is not enough, chemical methods of oil regeneration are used, associated with the use of more complex equipment and, accordingly, high costs [1,3].

Physical methods make it possible to remove solid particles of impurities from oils, microdrops of water and, partially, resinous and coke–like substances, evaporation - light-boiling impurities. Oils are processed in a force field using gravitational, centrifugal, electric, magnetic and vibrational forces, filtration, water washing and vacuum distillation are performed. The physical methods of waste oil purification also include various mass and

heat exchange processes that are used to remove oxidation products of hydrocarbons, water and low-boiling fractions from the oil [2].

Settling is the simplest method based on the process of natural deposition of mechanical particles and water under the influence of gravitational forces. Depending on the degree of contamination of fuel or oil and the time allotted for cleaning, settling is used as an independent method or preliminary, preceding filtration or centrifugal cleaning. The main disadvantage of this method is the long duration of the particle settling process until complete cleaning, removing only the largest particles with a size of 50-100 microns.

Filtration is the process of removing particles of mechanical impurities and resinous compounds by passing oil through mesh or porous filter partitions. Metal and plastic nets, felt, fabrics, paper, composite materials and ceramics are used as filtration materials. In many organizations operating SDM, in order to improve the quality of engine oil purification, the number of coarse filters is increasing and another stage is introduced into the technological process – fine oil purification.

Centrifugal cleaning carried out with the help of centrifuges is the most effective and high-performance method of removing mechanical impurities and water. This method is based on the separation of various fractions of inhomogeneous mixtures under the action of centrifugal force. The use of centrifuges ensures the purification of oils from mechanical impurities up to 0.005% by weight, which corresponds to purity class 13 according to GOST 17216-71, and dehydration up to 0.6% by weight [1,2].

Physico-chemical methods of oil regeneration have found wide application. These include coagulation, adsorption and selective dissolution of impurities contained in the oil. A type of adsorption purification is ion exchange purification.

Coagulation, i.e. the enlargement of particles of contaminants in the oil in a colloidal or finely dispersed state, is carried out with the help of special substances – coagulants, which include electrolytes of inorganic and organic origin, surfactants that do not have electrolytic properties, colloidal surfactant solutions and hydrophilic high-molecular compounds.

The coagulation process depends on the amount of coagulant injected, the duration of its contact with oil, temperature, mixing efficiency, etc. The duration of coagulation of impurities in the waste oil is usually 20-30 minutes, after which the oil is cleaned from enlarged impurities by settling, centrifugal cleaning or filtration.

Adsorption purification of waste oils consists in using the ability of substances serving as adsorbents to retain oil-polluting products on the outer surface of the granules and on the inner surface of the capillaries penetrating the granules. Substances of natural origin (bleaching clays, bauxites, natural zeolites) and artificially obtained (silica gel, aluminum oxide, aluminosilicate compounds, synthetic zeolites) are used as adsorbents. Adsorption purification can be carried out by the contact method – in this case, the oil is mixed with the crushed adsorbent, by the percolation method – then the purified oil is passed through the adsorbent, or by the counterflow method – when the oil and the adsorbent move towards each other [2,3].

The disadvantages of contact cleaning include the need to dispose of a large amount of adsorbent that pollutes the environment. During percolation purification, silica gel is most often used as an adsorbent, which makes this honey expensive. The most promising method is adsorbent oil purification in a moving adsorbent layer, in which the process proceeds continuously, without stopping for periodic replacement, regeneration or filtration of the adsorbent, however, the use of this method is associated with the use of rather complex equipment, which hinders its widespread use [2].

Ion-exchange purification is based on the ability of ionites (ion-exchange resins) to detain impurities dissociating into ions in the dissolved state. Ionites are solid hygroscopic gels obtained by polymerization and polycondensation of organic substances and are not soluble in water and hydrocarbons.

The cleaning process is carried out by the contact method when the waste oil is mixed with ionite grains of 0.3-2.0 mm in size or by the precolation method when the oil is passed through an ionite-filled column. As a result of ion exchange, mobile ions in the spatial lattice of the ionite are replaced by contamination ions. Restoration of the properties of ionites is carried out by washing them with a solvent, drying and activation with a 5% solution of caustic soda. Ion-exchange purification allows you to remove acidic impurities from the oil, but does not ensure the retention of resinous substances [1].

Selective purification of waste oils is based on the selective dissolution of individual substances that pollute the oil: oxygen, sulfur and nitrogen compounds, as well as, if necessary, polycyclic hydrocarbons with short side chains that worsen the viscosity-temperature properties of oils. Furfural, phenol and its mixture with cresol, nitrobenzene, various alcohols, acetone, methyl ethyl ketone and other liquids are used as selective solvents.

Selective cleaning can be carried out in devices of the "mixer-sump" type in combination with evaporators for solvent distillation (step extraction) or in two extraction columns to remove impurities from the oil and rectification for solvent distillation (continuous extraction). The second method is more economical, therefore it is used more widely [2,3].

A kind of selective purification is the treatment of waste oil with propane – in this case, the hydrocarbons of the oil dissolve in it, and the asphalt-resin substances in the oil in a colloidal state precipitate.

Chemical cleaning methods are based on the interaction of substances polluting waste oils and reagents introduced into these oils. As a result of chemical reactions, compounds are formed that are easily removed from the oil. Chemical methods of purification include acid and alkaline, oxygen oxidation, hydrogenation, as well as drying and cleaning from contamination using oxides, carbides and metal hydrides. The most commonly used are sulfuric acid purification, hydrotreating, as well as various processes using sodium and its compounds [1,2].

In terms of the number of installations and the volume of processed raw materials, processes using sulfuric acid are in the first place in the world. However, as a result of sulfuric acid purification, a large amount of acid tar is formed – a difficult to dispose of and

environmentally hazardous waste. In addition, sulfuric acid purification does not ensure the removal of polycyclic arenes and highly toxic chlorine compounds from waste oils.

Hydrogenation processes (hydrotreating) are increasingly used in the processing of waste oils. This is due both to the wide possibilities of obtaining high-quality oils and increasing their yield, and to the greater ecological purity of this process compared to sulfuric acid and adsorption purification [3].

The disadvantage of the hydrotreating process is the need for large amounts of hydrogen, despite the fact that the threshold of economically feasible productivity (according to foreign data) is 30-50 thousand tons / year. The installation using hydrotreating of oils is usually blocked with the corresponding oil refining production, which has an excess of hydrogen and the possibility of its recycling.

Processes using metallic sodium are used to purify waste oils from polycyclic compounds (resins), highly toxic chlorine compounds, oxidation products and additives. In this case, polymers and sodium salts with a high boiling point are formed, which allows the oil to be driven away. The yield of purified oil exceeds 80%.

The process does not require pressure and catalysts, is not associated with the release of chloro- and hydrogen sulfide. Several such installations are operating in France and Germany. Among the industrial processes using a suspension of metallic sodium in petroleum oil, the Recyclon process (Switzerland) is the most widely known. The Lubrex process using sodium hydroxide and bicarbonate (Switzerland) makes it possible to process any waste oils with a yield of up to 95% of the target product.

For the regeneration of waste oils, various devices and installations are used, the action of which is based, as a rule, on the use of a combination of methods (physical, physico-chemical and chemical), which makes it possible to regenerate waste oils of different brands and with varying degrees of reduction in quality indicators.

It should be noted that during the regeneration of oils, it is possible to obtain base oils identical in quality to fresh ones, and the oil yield, depending on the quality of raw materials, is 80-90%, thus, base oils can be regenerated at least twice more (subject to the use of modern technological processes).

One of the problems that dramatically reduces the economic efficiency of the disposal of used motor oils is the high costs associated with their collection, storage and transportation to the place of processing.

The organization of mini-complexes for the regeneration of oils to meet the needs of small territories (edges, regions or cities with a population of 1-1.5 million people) will reduce transportation costs, and obtaining high–quality end products - motor oils and greases, brings such mini-complexes in economic efficiency to the production of these products from oil.

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