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Factors Affecting the Stability of Lubricants

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Abstract:

This work is devoted to the study of factors affecting the stability of lubricants. During operation, the engine oil undergoes profound chemical changes: oxidation, polymerization, alkylation, decomposition. Deposits form on the heated surfaces of the parts, which can lead to increased wear. Acidic oxidation products contribute to the corrosion of parts. Oxidation resistance is one of the main operational properties of oils.

Keywords: engine oils, additives, oxidation, varnish deposits, peroxide compounds, temperature.

Introduction

The stability of motor oils is strongly influenced by the following factors: chemical composition, temperature conditions, oxidation duration, catalytic effect of metals and oxidation products, oxidation surface area, as well as the presence of water and mechanical impurities in the oils.

During operation, the engine oil undergoes profound chemical changes: oxidation, polymerization, alkylation, decomposition. At the same time, coke, resinous, asphaltene and other substances are formed in the oils.

The duration of the oil in the engine depends on its chemical stability, which is understood as the ability of the oil to retain its original properties and resist external influences at normal temperatures.

The increase in the thermal tension of motor oils depends on the design of the internal combustion engine and the principles of their operation. For example, the use of supercharging, the use of a sealed cooling system, a reduction in the volume of the lubrication system, oil cooling of pistons and other design solutions cause an increase in the danger of thermal and mechanical destruction of the oil film in the main coupled pairs of engine components and mechanisms.

Scientists N. I. Chernozhukov and S. E. Crane, who conducted studies of the oxidative properties of various oils, found that for most hydrocarbons the primary oxidation products are peroxide compounds: monoalkyl peroxides R–O–O–H, dialkilperekisi R–O–O–R and others, in which further oxidation and oxidative polymerization of hydrocarbons proceed in two more directions:

Hydrocarbon peroxides: → acids– oxyacids–esters–acidic resins
→ resins – asphaltenes– carbenes– carboides

The primary oxidation products of hydrocarbons are hydroperoxides. The process develops according to a radical chain mechanism. Hydroperoxides further decompose and turn into other oxygen-containing compounds. The free radical R formed by the branching of the chain begins a chain of oxidative transformations:

$$R\cdot + O_2 \longrightarrow ROO\cdot$$
$$ROO\cdot + RH \longrightarrow ROOH + R\cdot$$

Joining the radical R. access to oxygen occurs very quickly and with almost no activation energy. Then, with the interaction of the radical R OO. hydroperoxide is formed with the hydrocarbon. Alcohols, ketones, and acids accumulate at the deep stages of oxidation. High molecular weight acids in the presence of oxygen and water react with the ferric oxide hydrate formed under these conditions:

$$Fe(OH)_2 + 2RCOOH \longrightarrow (RCOOH)_2Fe + 2H_2O$$

Salts of higher acids are poorly soluble in oils, precipitate and accumulate in the form of sludge on the treated surfaces and in the circulating oil system.

Increased air pressure accelerates the oxidation process, as the process of mutual diffusion of oil with atmospheric air increases. The oxidation of oils is accelerated:

1) when the temperature rises;
2) increasing oxygen access when mixing with air occurs;
3) the catalytic effect of metal ions (especially non-ferrous).

At the same time, temperature has a decisive influence on the oxidation process. The oxidation of hydrocarbons is a process consisting of many stages. At the beginning of oxidation, the initial products, peroxides, accumulate, which subsequently dramatically accelerate the oxidation process. Usually the first stage does not noticeably change the physical properties of the oil. This stage is called the induction period, and its duration serves as an indicator of the oil's resistance to oxidation. After the induction period, self-accelerating oxidation reactions begin, noticeably changing the chemical and physical properties of the oil. Acids and resins are formed, and the viscosity of the oil increases.

As a result, wear of parts, contamination by products of oxidative polymerization of hydrocarbons of oil and fuel with subsequent coking of piston rings, clogging of drainage holes of oil channels, etc. are possible. All these phenomena reduce the reliability of engines, increase the cost of their maintenance, and in some cases are the cause of emergencies and their premature failure.

Deposits form on the heated surfaces of the parts, which can lead to increased wear. Acidic oxidation products contribute to the corrosion of parts. As a result, thermal oxidation processes worsen the operational properties of the oil. Therefore, oxidation resistance is one of the main operational properties of oils. The oxidation of oil at high temperature is called thermal oxidation, and the ability to resist oxidation is called antioxidant stability.

Experimentally, it was found that oils stored at a temperature of 18-20 ° C retain their original properties for 5 years, and starting from 50-60 ° C, the oxidation rate doubles with an increase in temperature at every 10 ° C. Therefore, the high thermal tension of the engine parts with which the engine oil has to come into contact, as well as its interaction with exhaust gases that break into the crankcase from the combustion chambers, sharply worsen its quality.

To slow down oxidation reactions and reduce the formation of deposits in the engine, antioxidant additives are introduced into engine oils, the effect of which is based on inhibiting the formation of active radicals in the initial stage of the chain oxidation process, decomposition of already formed peroxides and their transfer to an oxidation-resistant state, thereby preventing the spread of the chain reaction, reducing the catalytic effect of oxides and metal salts on the oxidation process.

Antioxidant additives, called oxidation inhibitors, inhibit the oxidation of oil in its initial stage by interacting with the primary products of the oxidation reaction– peroxides and break chain oxidation reactions. The catalytic effect of metal ions on the oxidation of oil is suppressed by metal deactivators, which are organic compounds that bind metal ions into inactive complexes. Phenols and amines are used as antioxidants, and organic compounds of sulfur and phosphorus are used as metal deactivators.

Laboratory, bench and motor tests are used to assess the oxidative resistance of motor oils. Laboratory tests are used to predict the service life of the oil and the behavior of the oil during operation. They are carried out during the development of new oils with base oils and finished products in order to determine the effectiveness of additives.

Thus, in order to ensure a minimal change in the properties of the engine oil and to prevent the formation of active products with harmful deposits in it, the oil must have sufficient chemical resistance.

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