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THE EFFECT OF OXIDATIVE PROCESSES OF ENGINE OILS ON ENGINE OPERATION

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Annotation: *Among the numerous properties on which the evaluation of the quality of lubricants is based, the antioxidant properties are important. The main reason leading to the formation of high-temperature deposits in engines is the oxidative processes occurring in the volume of oil and on the metal surface. These deposits negatively affect the reliability, efficiency and durability of the engine. The article analyzes the effect of the oxidation process of engine oils on engine operation. The results of laboratory studies of industrial oil samples and samples with the addition of new additives and recommendations for their use are presented.*

Keywords: *oxidation, hydrocarbons, additives, engine sediments, chemical composition, lubricants, operational properties.*

The highest quality oils will not ensure the operation of mechanisms without wear if they contain at least a small amount of mechanical impurities. The amount of mechanical impurities is strictly limited and for motor oils should be no more than 0.015%. Studies of the contamination of lubricating oils in the operating conditions of machinery show that in hot climates and highly polluted air, engine oils are intensively contaminated with mechanical impurities, water, fuel and organic products, which leads to premature aging of the oil.

The oxidation of oil on heated engine parts occurs under two conditions - dynamic and static (in flow and at rest). The oxidation of oil in the flow occurs during engine operation, when there is a continuous circulation of lubricating oil and engine parts are constantly lubricated with new portions of it. Oil oxidation at rest occurs only when the engine stops, when oil circulation stops, and the parts remain at a sufficiently high temperature for a certain time after the engine stops.

The products of hydrocarbon oxidation (resins, organic acids) present in the oil in the dissolved state contribute to an increase in viscosity and acid number, and asphaltene compounds, which are the basis for the formation of lacquers and particularly dangerous sticky sediments, contribute to the occurrence and burning of piston rings. Increased air pressure accelerates the oxidation process, as the process of mutual diffusion of oil with

atmospheric air increases. In this case, temperature has a decisive influence on the oxidation process.

The purpose of this work is to study the oxidation process of engine oil during engine operation and propose ways to improve its antioxidant properties. The primary products of hydrocarbon oxidation are hydroperoxides. The process develops according to a radical chain mechanism, and thus it can be considered autocatalytic. Hydroperoxides further decompose and turn into other oxygen-containing compounds. More and more new oil hydrocarbons are involved in the oxidation reactions.

As a result, depending on the conditions and chemical composition of the oil, the following products can accumulate in the oxidized oil: low-molecular and high-molecular acids, oxy acids, alcohols, aldehydes, ketones, phenols, lactones and other substances. The catalytic effect of metals has an important effect on the oxidation of oil. The catalytic effect of metal ions on oil oxidation is suppressed by metal deactivators, which are organic compounds that bind metal ions into inactive complexes. The catalytic effect of metals ceases when it is covered with a protective film created by oxidation products.

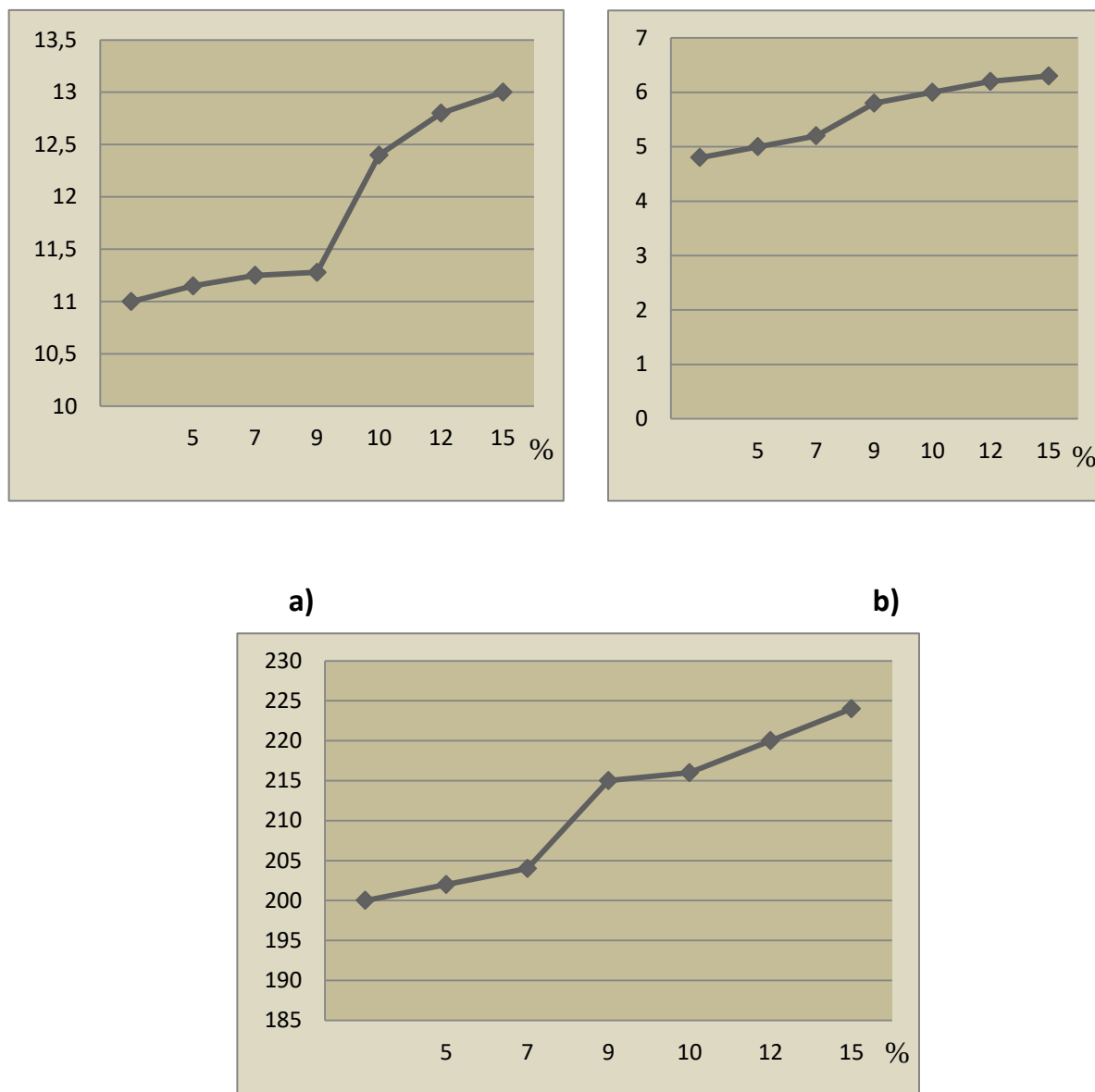
As a result of oxidation, the chemical composition of the lubricant and its physico-chemical properties change. All this affects the ability of the lubricant to perform its intended functions, limits its service life, and worsens the technical condition of the engines. Oils that are unstable to oxidation form precipitates faster and to a greater extent than stable oils. Oils with special additives are less prone to precipitation than pure oils, since additives make it possible to better retain insoluble impurities and better resist oxidation. Antioxidant additives also include substances that reduce the activity of the catalytic action of metals, their oxides and salts on the oxidation process - metal passivators.

However, the existing antioxidant additives cannot sufficiently slow down the oxidation of oils in the medium-temperature zone and completely prevent the formation of lacticizing substances in it. Analyses show that substances containing both sulfur and nitrogen have very effective anti-oxidative properties. Testing of several dozen of these compounds as oil additives has shown that they are very effective not only in fresh oils, but also in spent and regenerated ones.

As antioxidant additives, we used the additive alkylaryl calcium sulfonate (SK-3) - calcium salts of aromatic sulfonic acids. These additives have the ability to improve the quality of oils. During the oxidation of hydrocarbon mixtures, aromatic hydrocarbons have an inhibitory effect on the oxidation reactions of naphthenes. This is due to the fact that the oxidation products of aromatic hydrocarbons, phenols, have antioxidant functions. This additive protects oils from oxidation by acting to break the chain by reducing the amount of radicals formed. The effect of such additives is based on their ability to loosen, wash away deposits from the surface of parts and transfer insoluble substances into suspension and retain these particles in this state without coarsening. The advantage of this additive compared to other additives is that it is quite effective at relatively low temperatures (up

to 150-175 °C) and stable up to 300 °C. To achieve the desired effect, it is required to apply it in quantities of 5-10%.

We analyzed M10V₂ engine oils and calcium alkyl salicinate antioxidant additives. After introducing this additive concentration into the oil, we observed its dissolution. Having determined the dissolution of additives into engine oil and the additive calcium alkyl salicinate, we determined the physico-chemical parameters of engine oil for various concentrations of additives.



c)

Fig 1. Physico-chemical parameters a) viscosity, b) base **number** and c) flash **point of** engine oil for various concentrations **of** additives

According to the results of laboratory tests, when the additive was introduced into the M-10V₂ engine oil, the physico-chemical parameters gave a positive result compared to the M10V₂ oils. The base number increased from 5.0 to 6; and the flash point rose to 224⁰C, which indicates the effectiveness of the added additive.

This means that using such an additive will increase the service life of the engine oil. From the results of the analysis, we selected an additive content of 9%, which shows the optimal viscosity and base number. With a further increase in concentration, the viscosity increases significantly, which can lead to increased friction losses. As the viscosity increases, the thickness and resistance to mechanical stress of the oil layer between the rubbing surfaces increases.

In the future, these oils can be approved for the next stage – for operational tests on special equipment.

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