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Research Article

CAUSES OF CHANGES IN THE PROPERTIES OF MOTOR OILS IN THE HIGH TEMPERATURE ZONE OF THE ENGINE

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Alimova Zebo Hamidullayevna
Candidate Of Technical Sciences, Professor. Tashkent State Transport University, Uzbekistan

Ibrahimov Karimjon Ismailovich
Candidate of Technical Sciences, associate Professor. Tashkent State Transport University, Uzbekistan

ABSTRACT

This article examines the causes of changes in the properties of motor oils in the high-temperature zone of the engine. The main reason leading to the formation of high-temperature deposits in engines are oxidative processes occurring in the oil volume and on the metal surface. These deposits negatively affect the reliability, efficiency and durability of the engine.

We conducted a study of samples of industrial oils M12V2 with a sulfonate additive SK-3. To conduct experiments, the M-12V2 engine oil with the added sulfonate additive SK-3 was analyzed according to physico-chemical parameters for compliance with the requirements. When using such an additive, the service life of the engine oil will increase.

KEYWORDS

Engine oil, anti-oxidative properties, oxidation, high-temperature deposits, oxidation products, carbon deposits, durability.

INTRODUCTION

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When used under the influence of various factors, the oil loses its original properties. The high thermal tension of the parts of the forced engines, with which the engine oil has to come into contact, and the interaction with gases from the combustion chambers bursting into the crankcase (at the compression stroke their temperature is about 150-450°C for gasoline engines and about 500-700°C for diesels) sharply worsen their working conditions.

The chemical composition of oils and their operational properties change dramatically during operation — under the influence of high temperatures, air oxygen, products of incomplete combustion of fuel, condensing water, crankcase gases, catalytic action of metals and old oxidation products.

RESEARCH ANALYSIS

In the high temperature zone of the engine, hydrocarbons and other components of oils are oxidized and form poorly evaporating, highly viscous, practically insoluble in oil oxy-acids, asphaltenes and acid resins, which are deposited on the parts in the form of a thin shiny layer called a varnish deposit. Lacquer deposits are carbon-rich substances formed as deposits in the grooves under the piston rings, on the skirts and inner walls of the pistons. The deposition of varnish causes the piston rings to burn and the parts on which these deposits were formed to overheat. Combustion of piston rings, which causes a breakthrough of gases into the crankcase and a decrease in compression in the cylinders, and as a result – a drop in engine power. The accumulation of carbonaceous deposits on the cylinder walls, pistons, rings, valves, etc., occurs not only due to oxidation products, but also as a result of purely thermal transformations of polycyclic hydrocarbons and resinous substances. At the same time, engine oil consumption increases significantly, wear increases, even bullying on cylinder mirrors and piston rings breakage with piston jamming are possible.

In the high temperature zone, the oil burns completely or carbonaceous particles remain, which cannot remain on the surface devoid of a binding medium. The products of deep oxidative polymerization, which differ in high temperature zones and flow back into the crankcase, as well as other precipitated deposits, continue to have a negative effect on the oil. The greatest danger of varnish deposition is for piston rings. By filling the gaps formed by the piston rings and the grooves drilled in the pistons, it reduces the mobility of the rings. High-carbon compounds are formed, which are deposited in the grooves in the form of films. Piston rings wear out these films, and detergent additives contribute to the ultrafine grinding of carbon deposits. As a result, the compression ratio increases, a detonating metallic knock occurs, and the engine power decreases. As a result of the pumping action of the pistons during engine operation, the engine oil partially enters the combustion chamber, where it burns together with the fuel, but some of it, spreading over the bottom of the pistons and the hot walls of the combustion chamber, remains on their surfaces in the form of a layer of thick resinous mass, and then as a result of deep chemical transformations is converted into solid carbonaceous substances, which are called carbon deposits.

Depending on the quality of the oil and the technical condition of the engine, up to 5-10% of unburned fuel can accumulate in the oil, which more than halves the flash point of the oil and worsens its lubricity. The chemical composition of carbon deposits depends on the quality of oil and fuel, on the operating mode of the engine, the dustiness of the air, the presence and nature of additives, etc. Its main part consists of carbenes and carboides – 50□70%, asphaltenes and oxy

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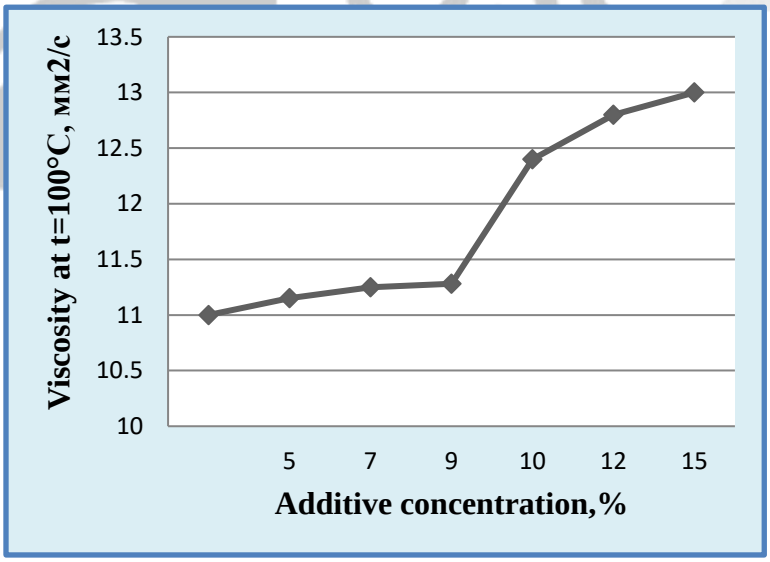
acids – 3–6%, resins and oils – 15–40% and ash -1–10%.The colder the walls of the combustion chamber, the more carbon deposits are formed on them.

Abundant carbon deposits worsen the cooling of the combustion chamber and reduce its volume. As a result, the viscosity of the oil will noticeably decrease, its oxidation will occur faster, the lubricity will deteriorate, deposits will increase, and the mode of liquid friction will be disrupted.

One of the measures to combat varnish formation is the introduction of antioxidant and detergent additives into the oils, which inhibit the deposition of the resulting resinous-asphaltene substances and reduce the formation of varnish deposits and carbon deposits on hot surfaces of engine parts.

We conducted a study of samples of industrial oils M12V2 with a sulfonate additive SK-3. The advantage of this additive compared to other additives, it is quite effective and stable at relatively high temperatures.

To conduct experiments, the M-12V2 engine oil with the added sulfonate additive SK-3 was analyzed according to physico-chemical parameters for compliance with the requirements. Having determined the dissolution of the additive in the engine oil, we determined the physico-chemical parameters of the engine oil for different concentrations of additives (Fig. 1).



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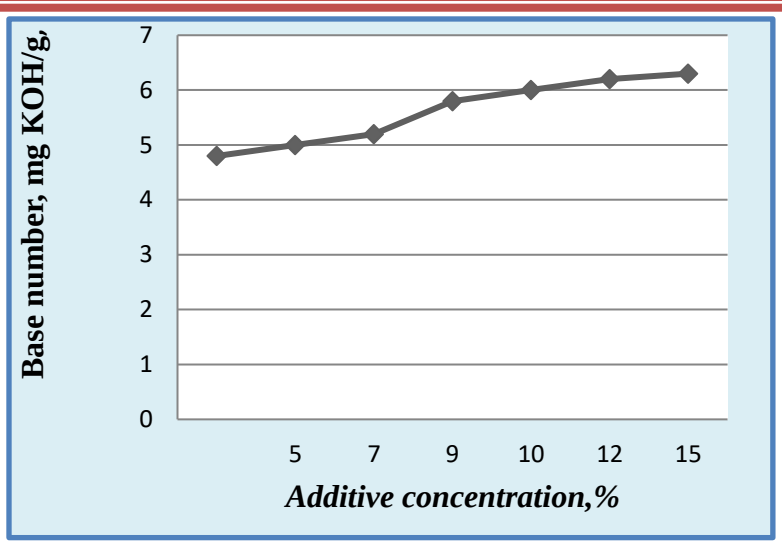

Fig.1. Physico-chemical parameters of engine oil for different concentrations of the additive SK-3

CONCLUSION

The indicator of the antioxidant properties of motor oils is the alkaline number, which can vary from 5-10 mg KOH/g. When establishing the service life of oil in engines, so-called rejection indicators are used, when reaching the maximum permissible values of which it is necessary to replace the oil. Rejection indicators are usually: changes in viscosity, flash point, alkalinity, the content of contaminants, water.

To determine the alkaline number, samples of oils with different concentrations (5%-15%) of the additive were taken and the most optimal concentration was determined. From the results of the analysis, we selected the content of additives SK-3 9%, which shows the optimal value of the alkaline number. To ensure normal operation, the alkaline number of fresh oil should be at least:

for medium–powered engines – 3.5 - 4;

for high–powered – 6 - 6.5 mg KOH/g.

According to the results of laboratory tests, when introducing the SK-3 additive 9% into the M-12V2 engine oil, the physico-chemical indicators gave a positive result compared to the M-12V2 base oils. The alkaline number increased from 4.5 to 6; and the flash point rose to 224°C, which indicates the effectiveness of the added additive. When using such an additive, the service life of the engine oil will increase and which can also lead to a decrease in the wear of the piston rings by 3-4%.

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