ISSN NO: 2770-4491
Date of Publication:18-10-2022

# Causes of Contamination of Lubricants Used in Diesel Engines

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**Annotation**
Studies of the contamination of lubricating oils during operation in hot climates and high dustiness of the air show that lubricants are intensively contaminated with mechanical impurities, water, fuel and organic products, which leads to premature aging of the oil.
During operation, engine components and parts are contaminated with various deposits. The process of sediment formation is associated with thermo-oxidative transformations of incomplete combustion products of fuel and oil components. These transformations occur both in the volume of oil and in its thin layer on a heated metal surface.

**Keywords:** contamination of lubricating oils, sediment formation process, oxidative processes, varnish deposits, dustiness of the air.

Lubricating oil when working in engines, aggregates and friction units is oxidized by air oxygen, as a result of which its composition changes, new substances appear in it (resin, organic acids, etc.).

Studies of the contamination of lubricating oils during operation in hot climates and high dustiness of the air show that lubricants are intensively contaminated with mechanical impurities, water, fuel and products of organic origin, which leads to premature aging of the oil.

During operation, engine components and parts are contaminated with various deposits. The process of sediment formation is associated with thermo-oxidative transformations of incomplete combustion products of fuel and oil components. These transformations occur both in the volume of oil and in its thin layer on a heated metal surface. 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. Such deposits negatively affect the reliability, efficiency and durability of the engine.

The oil's resistance to oxidation by air oxygen is one of the most important factors determining the behavior of oil in friction units during operation.

With any method of organizing the processes of mixing and combustion in diesel engines, there is the formation of a certain amount of solid products of incomplete combustion of fuel in the form of soot particles with a size of 0.03-0.05 microns, prone to aggregation and the formation of larger particles with a size of up to 1 microns. The amount of soot particles falling from the cylinder's working volume into the oil film on its walls and further into the crankcase oil depends on the methods of mixing, the size of the cylinder and the operating mode of the diesel engine, as well as on the quality of the fuel used.

In diesels with a split combustion chamber and a small cylinder diameter, the rate of soot contamination of oil is greater than in diesels with an undivided combustion chamber. Operation in modes close to the smoke limit, as well as in variable speed and load modes contributes to increased oil pollution with soot. Dust, wear products and ash residues from the combustion of fuel and oil are not only abrasive contaminants, they catalytically accelerate the oxidation of oil. For this reason, the content of these impurities in the working oil must be reduced in every possible way by appropriate filtration.

When the diesel engine is running on a constant mode, the rate of depletion of the alkalinity of the oil is proportional to the fuel consumption and the sulfur content in it.

With an increase in the temperature of the oil film on the cylinder wall and in the piston ring zone, the proportion of alkaline additives consumed to neutralize acids formed from fuel combustion products decreases markedly, but the consumption of alkaline additives to neutralize acids formed as a result of high-temperature oxidation of oil increases.

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Results of spectral analysis (elemental composition) active elements and contaminants are presented in Table 1.

**Таблица 1.**
**The elemental composition of contaminants of lubricants during engine operation**

| Name of the element | In the waste oil, % | In purified oil, % |
|---|---|---|
| Iron (Fe) | 0,07 | 0,0006 |
| Lead (Pb) | 0,077 | 0,00021 |
| Chrome (Sg) | 0,001 | 0,00001 |
| Copper (Cu) | 0,002 | 0,00019 |
| Magnesium (Mg) | 0,0025 | 0,0003 |
| Aluminum (Al) | 0,022 | 0,0001 |
| Silicon (Si) | 0,06 | 0,0004 |

Analyses show that the waste oil mainly contains wear products, atmospheric dust and waste additive products in the form of iron (Fe), zinc (Zn), lead (Pb), chromium (Cr), magnesium (Mg), copper (Cu), calcium (Ca) and barium (Ba). The table shows that the active elements in the waste oil are almost 40-45% less than the norm.

To ensure minimal wear of parts, it is better to use oils of higher viscosity. However, such an increase in viscosity, especially for engines not warmed up to operating temperature, causes starting wear and deterioration of fuel and economic indicators.

The transition to the use of low-viscosity oils is primarily caused by the fact that nanotechnology is used in the manufacture of modern engines, the deviation in the size of parts is insignificant and, accordingly, the gaps between the rubbing parts are minimal. More viscous, including medium-viscous oils, cannot penetrate all the gaps during the start-up period, and as a result, dry friction and maximum wear occur within a few seconds.

When a forced diesel engine is running on fuel containing less than 0.2% sulfur, more alkalinity may be consumed for the neutralization of oil oxidation products than for the neutralization of sulfuric and sulfuric acids. The dependences of the relative rate of reduction of oil alkalinity on the sulfur content in the fuel are equivalent in terms of the consumption of oil alkalinity to other sources of acids neutralized by alkaline detergents.

In high-powered diesel engines and gas engines, alkaline additives are used to neutralize nitric acid with the formation of metal nitrates in a fairly large amount. This is due to the formation of nitrogen oxides from the air during the combustion of fuel and a decrease in the temperature of gases during expansion.

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ISSN NO: 2770-4491
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