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STUDY OF ANTI-CORROSION PROPERTIES OF LUBRICANTS

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Annotation: *One of the functions of the oil is to protect the surface of parts from corrosion. As a result of corrosion processes, the surface layer of parts is loosened and destroyed, which inevitably leads to their increased wear and a decrease in the overall service life of the engines.*

Corrosion becomes especially intense when the engine is operated or stored in hot, humid climates.

In this case, oil plays a double role: on the one hand, it protects the surfaces of parts from the aggressive influence of the external environment; on the other hand, the oil itself is corrosive due to the presence of corrosive substances in it.

In order to combat corrosion, special additives are added to the oils. Anti-corrosion additives are mainly polar substances that easily adsorb to metal surfaces.

Key words: *corrosion, wear, concentration of additives, anti-corrosion additives, surfaces of parts, viscosity, sulfur compounds, alkalis, mineral acids.*

In recent years, increased requirements for protective properties have been imposed on petroleum oils for various purposes. One of the functions of the oil is to protect the surface of parts from corrosion.

Corrosion becomes especially intense when the engine is operated or stored in hot, humid climates. In this case, oil plays a double role: on the one hand, it protects the surfaces of parts from the aggressive influence of the external environment; on the other hand, the oil itself is corrosive due to the presence of corrosive substances in it.

The reason for the corrosive properties of oils is that they contain organic and inorganic acid peroxides and other oxidation products, as well as sulfur compounds, alkalis and water. Corrosion increases sharply in the presence of moisture. When sulphurous fuels are burned and moisture is present, corrosive sulfurous and sulfuric acids are formed.

Sulfur oxides SOx, nitrogen oxides NOx and water formed as a result of hydrogen combustion, which form mineral acids H_2SO_3, H_2SO_4, HNO_3, enter the circulating lubricating oil from the combustion chamber of the engine together with the exhaust gases, which cause corrosion of the engine lubrication system parts. In the presence of water and air dissolved in the fuel, iron equipment is subject to rusting. When there is a bound or adsorbed film of water on the metal surface, low-polarity media, which include oil products, will poorly wet the metal surface.

The combined action of oxygen in the air and water present in the lubricating oil causes rusting of the crankshaft, liner walls, cylinders of an internal combustion engine, etc. Corrosion is especially intensified after the engine is stopped, since when it cools, moisture condenses on the parts, lubricating oil, flowing down from the lubricated surface, is not able to protect the metal from corrosion.

At high temperatures, sulfur compounds become especially aggressive towards silver, copper and lead. Particularly dangerous is the corrosion of non-ferrous metal bearing shells, which can be caused by acidic oxidation products and sulfur compounds.

Oxidation is most intense in relatively thin layers of oil on highly heated metal surfaces.

The corrosiveness of the oils towards the lead bronze from which the crankshaft bearing shells are made is assessed by the breakdown on the lead plate. In this case, the loss of its mass is determined when it is in oil for 50 hours at 140 ° C. The corrosiveness of oils increases significantly when they contain water, which can enter the crankcase from the atmosphere or from the engine cooling system.

To neutralize acids, alkaline additives are introduced into oils, the concentration of which is estimated by the total base number TBN, expressed in mg KOH / 1 g of oil. To neutralize acids in oil, the TBN must be greater than the TAN.

The temperature factor especially affects the rate of general corrosion. An increase in temperature from 20 to 80°C at 5% by volume of water causes an increase in corrosion from 0.1 to 0.25 mm/year. If we assume that the permissible corrosion rate is 0.2 mm/year, then this value is achieved at a temperature of 80°C by 2%, and a further increase in the water content in the oil leads to a significant increase in the corrosion rate (Table 1).

Table 1.

Dependence of the rate of general corrosion of metal (St-20) on the amount of water in oil M-10V$_2$ and on temperature

Temperature, °C	General corrosion rate, mm / year at water content,% vol.						
	0%	0,5%	1,0%	2,0%	5,0%	10,0%	50%
20	0,050	0,060	0,065	0,078	0,104	0,204	0,496
40	0,065	0,078	0,098	0,122	0,188	0,466	0,850
60	0,065	0,104	0,098	0,124	0,204	0,504	1,244
80	0,100	0,107	0,135	0,196	0,253	0,608	1,723

In order to combat corrosion, special additives are added to the oils. Anti-corrosion additives are mainly polar substances that easily adsorb to metal surfaces. The mechanism of their action is to create a protective monomolecular layer on the metal that prevents acidic and other active agents from acting on the metal. Such substances include: high molecular weight fatty acids, salts of fatty and naphthenic acids, hydroxy acids, amines, etc.

The introduction of surface-active compounds into hydrocarbon media should, therefore, first of all, increase the wettability of metals by them in the oil product - water system and create conditions for the inhibitors to display their main functional properties. The wetting ability of surfactants can manifest itself through the formation of strong hydrogen bonds with water and the displacement of water from the metal surface.

As an anticorrosive additive, nitrogen-containing compounds $C_6H_5NH_2$, which are derivatives of ammonia, deserve considerable attention.

In this case, the activity of water molecules adsorbed on the metal surface will be significantly reduced. The displacement of water from the metal surface can occur as a result of its binding: due to solvation by metal cations, the inclusion of hydrophilic additives in the hydrate shells, and also due to solubilization or emulsification and stabilization in the form of water - oil product emulsions.

When the oil burns, high molecular weight organic acids are formed, which in the presence of oxygen have a detrimental effect on metals. Oxygen is part of peroxides, therefore, in the presence of oxygen and water, the metal undergoes electrochemical dissolution.

In corrosive terms, this concentration is practically not dangerous. Due to the high molecular weight, the acids in the fresh oil dissociate weakly, and the acids formed during the oxidation of the oil become the most dangerous since their low molecular weight has increased corrosiveness due to good solubility in water and better dissociation.

Anti-corrosion additives are mainly polar substances that easily adsorb to metal surfaces. Such substances include high molecular weight fatty acids, salts of fatty and naphthenic acids, hydroxy acids, amines.

The most active additives of this type are surface-active compounds such as sodium salts of petroleum sulfonic acids, esters of stearic and other fatty acids, as well as dibasic fatty acids, some nitrogen- and phosphorus-containing compounds, for example, compounds of the RSO_2NHCOO C_4H_9 type, dicyclohexylamine nitrite. Additives obtained by oxidation of ceresin and petrolatum, containing esters and internal esters, are very effective.

We have studied various salts of sulfoalkyl succinic acid as a universal additive, including for improving the anticorrosive properties of oils. The action of alkyl sulfates depends on the structure and length of the carbon chain, as well as on the position of the sulfo-ether group. Thus, they are greatly reduced with the branching of the carbon chain, as a result of which alcohols and olefins with a straight chain of carbon atoms are used for the synthesis of alkyl sulfates. The ability is observed in alkyl sulfates with a terminal position of the sulfoester group and gradually decreases as this group is further from the end of the chain.

Research has shown that this compound has a number of advantages over other additives. The anticorrosive activity of such additives is associated with their ability to orient themselves on the oil-water surface so that hydrophilic groups are firmly bound to water, and the hydrocarbon radical remains in the oil. In this case, the activity of inhibitors is the greater, the more hydrocarbon atoms the radical contains.

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