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Research Article

RESEARCH OF THE MECHANISM OF ACTION OF THE PROTECTIVE PROPERTIES OF INHIBITED COMPOSITIONS

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ABSTRACT

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 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.

This article presents studies of the mechanism of action of assessing the protective, surface and electrochemical properties of inhibited compounds used in the development of lubricants.

KEYWORDS

Corrosion, adsorption, films, oxidation, corrosion inhibitors, protective properties.

INTRODUCTION

One of the functions of the oil is to protect the surface of the parts from corrosion. The protective effect is based on the ability of oils to quickly displace active compounds from the metal surface, retain it in the volume of the lubricant and form strong adsorption and chemo-sorption films on it, preventing the development of electrochemical processes.

The corrosive aggressiveness of oils increases significantly in the presence of water in them, which can get into the crankcase from the atmosphere or from the engine cooling system. Corrosion inhibitors are designed to protect the surface of engine parts from corrosion caused by organic and mineral acids. The mechanism of their action is the formation of a protective film on the surface of the parts and the neutralization of acids. In this paper, we consider the processes of the mechanism of protective action of corrosion inhibitors used in the development of lubricants.

RESEARCH ANALYSIS

The development of preservative lubricants is carried out on the basis of studying the mechanism of protective action and evaluating the properties of materials using a set of laboratory test methods. Modern ideas about the mechanism of the protective action of the corrosion inhibitor are mainly reduced to two factors:

- Displacement of water and electrolyte present from the metal surface;
- Creation of chemo-sorption and adsorption films on the metal surface

The ability of corrosion inhibitors to displace water from the metal surface is provided by polar components that are part of the combined protective additives. At the same time, the surface properties of inhibitors at the "oil-metal" and "oil-electrolyte-metal" interface are more important.

The essential role of the corrosion factor in the general wear of machines and mechanisms is determined not only by the corrosion of metal products during their transportation and storage, but also by the intensive course of corrosion processes during the operation of engines, transmissions and other components of equipment at high temperatures.

To assess the combined effect of chemical and electrochemical corrosion on the destruction of metals, a method has been developed (GOST 9.044-75), which allows determining the degree of oxidation of oil with moist air, as well as a method that comprehensively evaluates all corrosion processes occurring in the engine, including the thermal oxidative stability of oils. The installation makes it possible to evaluate the corrosion and protective properties of the oil and the kinetics of high-temperature corrosion in the oil volume, the development of electrochemical corrosion in the oil-electrolyte system, the protective properties of the oil in a thin film, the thermal oxidative stability of the oil by changing its physicochemical properties after oxidation.

There is a relation between the adsorption value and the surface tension at constant temperature and pressure:

$$\Gamma = -\frac{a}{RT} \cdot \frac{dy}{da},$$

where:

Γ-the surface concentration (the amount of substance accumulated per unit of the interface surface);

a- the activity of the solute;

dy- the change in surface tension;

R -the universal gas constant; T - the absolute temperature.

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If an increase in the concentration of the solute leads to a decrease in the surface tension, then the solute accumulates on the interface (positive adsorption). On the contrary, if the surface tension increases as the concentration of the solute increases, then the solute is removed from the interface (negative adsorption).

At the same time, the activity of water molecules adsorbed on the metal surface will be significantly reduced. Finally, the components of protective additives can be dissolved in water and the corrosion of metals in electrolytes can be inhibited by an electrochemical mechanism. In this case, the additive components will act as water-soluble corrosion inhibitors. At the same time, the greater the activity of inhibitors, the more hydrocarbon atoms the radical contains. The mechanism of their action is to create a protective monomolecular layer on the metal, preventing the effect of acidic and other active agents on the metal.

Methods for assessing the surface properties of corrosion inhibitors characterize their ability to penetrate cracks and micro-gaps of metal structures during their conservation. The essence of the method of spreading corrosion inhibitors is to determine the diameter of the spot formed when 0.2 ml of the product is applied to a metal surface after 2 hours. The penetrating ability of corrosion inhibitors is determined by measuring the lifting height of the product under study in a narrow gap formed by two steel plates tightly adjacent to each other for a certain time. The impregnating ability of iron oxide powder consists in determining the depth of penetration of iron oxide products by the test subject for a certain time.

The water-displacing ability of corrosion inhibitors consists in determining the diameter of the surface area of a wetted steel disc freed from water by a drop of the product under study. After 5 seconds after applying a drop of the product, the diameter of the initially displaced water is measured, a secondary measurement is made after 5 minutes, then the disc is thoroughly washed with a jet of distilled water and the diameter of the area not wetted with water is measured.

To assess the adhesive-cohesive forces, a method has been developed by which this indicator is estimated by the separation force (in N/cm2) of two steel cylinders tightly pressed together with the product under study at the contact point. The separation force is fixed using a lever dynamometer. After water is displaced from the metal surface to the released active centers of the metal surface, the components of the chemo-sorption action are adsorbed, providing high binding energy with the metal. The chemo-sorption monomolecular film is covered with poly-molecular layers of adsorption inhibitors. Thus, a strong multi-layered structure is created, providing a high protective effect. The basis of this effect, according to modern concepts, is the polarization resistance of the protective film, the resistance to the transfer of electric charges (electrolyte ions, metal, etc.), formed as a result of polarization phenomena on metal under the influence of the medium.

CONCLUSIONS

The presented set of methods allows for a comprehensive assessment of the anticorrosive properties of protective lubricants, as well as the mechanism of action of corrosion inhibitors. Based on the proposed studies, it is possible to further develop corrosion inhibitors for specific lubricants and conduct experimental studies.

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