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MAIN REGULARITIES WEAR AND TEAR MATERIALS IN CORROSIVE ENVIRONMENTS

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ABSTRACT

Changes in the physical, chemical, and mechanical properties of the outer layers of machine parts during wear depend on the chemical composition and structure of the metal, as well as on external friction conditions (pressure, speed, temperature, environment, etc.). This article presents an analysis of scientific results on this.

Keywords: Machine, mechanism, repair, equipment, storage, tractor, rust, protection, operation.

Introduction

The wear load, changing the conditions of deformation of the outer layers, has a strong effect on the intensity of heat generation and the development of diffusion and oxidation processes. To understand the physical nature of wear of machine parts in corrosive agricultural environments, it is very important to know the nature of the change in the properties of the surface layers when the load changes.

Theoretical and experimental studies available at present show that two wear modes are realized during friction depending on the loading conditions and the environment – normal and pathological. In this case, the friction forces and wear rates in these modes differ in the order of magnitude. In pathological modes, the most diverse processes of microscopic damage (crushing, welding, plowing, etc.) can occur in the friction zone. The normal mode is characterized by the occurrence of strictly defined mechanical and physicochemical processes localized in thin surface layers. In this case, a dynamic equilibrium of the processes of destruction and restoration of secondary structures occurs, leading to a metastable state of friction surfaces. The microscopically small thickness of the films (of the order of hundreds of angstroms), in which the wear processes occur, does not allow conducting studies at the level of microscopic concepts.

Previous studies have shown that during wear in a free abrasive mass, a slight deviation from the linear dependence of the wear rate on the load is observed. This is explained by the fact that with a change in pressure on the friction surface, the relative sliding speed of the particles also changes, i.e. the friction path for the same time at different loads will be different, which disrupts the linear dependence between wear and pressure. During wear in fertilizers with low flowability, such as sylvinite and

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ammonium nitrate, the deviation from the linear dependence between wear and pressure is hardly noticeable.

Analysis of these data, as well as other works on corrosion-mechanical wear, showed that to date there are no studies reflecting the role of the corrosion factor with a change in load. The study of this dependence has practical significance for the selection of materials for working parts in specific operating conditions.

The method of determining the share of the corrosion factor under different loads is based on comparing the wear rate during friction in corrosive and neutral environments under the same abrasive action. The experiments were conducted in quartz sand, moistened in one case with a saturated solution of mineral fertilizer, and in the other - with distilled water. The ratio of the wear rate in a corrosive environment to the wear rate in a neutral environment can be used to judge the corrosion factor under a given load. The greater this ratio, the stronger the influence of corrosion processes during wear by the load.

The studies were conducted on a laboratory setup of the "sleeve" type according to the method. Wear during the tests was estimated gravimetrically on an analytical scale with an accuracy of 0.1 mg. Preliminary experiments allowed establishing the optimum sand moisture content equal to 8%. The maximum load was limited to 0.18 MPa, since with further increase, strong heating of the worn sample occurred. An increase in temperature increases the rate of corrosion processes and thus violates the experimental conditions.

The results of the studies showed that with increasing load, the influence of the corrosion factor in combined corrosion-mechanical wear decreases according to a hyperbolic law.

$$K = a e^{bp}$$

Where K – corrosion factors;
P – load, MPa;
a, b – proportionality coefficients (table 1)

Table 1 The meaning of the coefficients a ,

Wear environment	**A**	**b**
Ammonium nitrate	1.49	- 2.48
Ammonium sulfate	1.36	- 1.93
Sylvinite	1.22	- 1.19
Water	1.04	- 0.21

In fertilizers with greater corrosive activity, the influence of the corrosion factor is more significant. At loads over 0.1 MPa, the role of the latter is insignificant.

This character of the dependence of the corrosion factor on the load is explained by a different wear mechanism. At low pressures, wear in corrosive environments occurs due to the formation and destruction of a film of corrosion products not to the full depth. At a load above 1 MPa, complete destruction of secondary structures and partial wear of the metal itself occur.

This position is confirmed by electron microscopic studies. The surface of steel 45, worn in sylvinite under a load of 0.03 MPa, has no scratches, but only traces of corrosion. On the surface, worn under a pressure of 0.15 MPa, there are marks and scratches - obvious traces of the mechanical action of abrasive particles.

When steels are rubbed directly in bulk mineral fertilizers, the same dependence of the influence of the load on the corrosion factor is maintained, but in a less pronounced form, since the abrasive effect of fertilizer particles is much lower than that of quartz sand.

The regularities of the dynamic equilibrium of the processes of destruction and restoration depending on the modes of loading during wear in corrosive agricultural environments were studied using methods of measuring the electrochemical potential, taking polarization curves and electron microscopy, allowing to record the kinetics of the processes and to directly observe the surface. The methods of measuring wear and geometric parameters of friction surfaces were used as control methods.

The main parameters of secondary structures that determine wear patterns are their total area on the friction surface and thickness. These parameters were measured using the methods.

The change in the thickness and area of secondary structures with increasing load confirms the data that corrosion processes have a significant effect on wear only at loads up to 0.1 MPa. In this case, the films of secondary structures thicken and the ratio of their area to the total area of the worn surface increases. With a further increase in load, these values decrease. This indicates that at pressures above 0.1 MPa, wear occurs mainly due to mechanical factors.

As can be seen from the figure, the most intensive increase in film thickness occurs in fertilizers in which corrosion processes tend to rapid passivation (nitrophoska, superphosphate). Films during wear in ammonium nitrate are significantly thinner.

When metal is rubbed in corrosive agricultural environments, molecules and anions adsorbed on the surface being worn will be continuously partially or completely removed mechanically. As a result, the anodic dissolution process is significantly facilitated.

Based on the obtained data , it can be concluded that with a sufficiently intensive renewal of the surface, the anionic composition of the medium will not have a noticeable effect on the course of the anodic polarization curves. Experimental data allow us to assume that the process of active anodic dissolution of iron during friction in acidic agricultural environments occurs in two stages. The first stage is associated with the inhibition of charge transfer, which has very little significance in the overall inhibition of the process of anodic dissolution of metals. The second stage - the transition of iron ions with two positive charges from the metal surface to the wearing medium through the adsorption barrier of molecules and anions - is the stage that mainly determines the magnitude of the iron ionization overvoltage. Inhibition at this stage is completely eliminated with a sufficiently intensive renewal of the wearing surface.

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