

On the mechanism of formation of wear-resistant coatings on the friction surfaces of technical products in the presence of these drugs Tribo

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Abstract. Extending the service life of technical devices by exposing the surface of the friction tribo different drugs is an established fact. There are various hypotheses to explain the mechanism of formation of coatings with high wear resistance and low coefficient of friction on the mating surfaces of friction units of machines and mechanisms during their operation with the presence of drugs Tribo. All these conflicting hypotheses. The proposed technology without the wear operation of equipment using Tribo drugs differ in content and methodology of processing machinery. In this paper, an analysis of existing hypotheses formation mechanism of these coatings. The authors have their own experience in the development and application of technologies without the wear operation of equipment using Tribo drugs. This allows them to develop their own hypothesis of the mechanism of formation of coatings with high wear resistance and low coefficient of friction on the mating surfaces of friction units of machines and mechanisms during their operation with the presence of drugs Tribo.

1. Introduction

In the operation of any technical product having a friction units, as wear parts loses its efficiency and as a result is unable to perform specified functions with the parameters set by the requirements of the technical documentation. Today, all over the world have been exhausted technological possibilities of manufacturing different machines and mechanisms without noticeable wear the mating surfaces of friction units. Lubricants used to reduce friction, and have exhausted the limits of its perfection. In addition, they do not eliminate wear mates. Steel is used for modifying the Tribo environment, so-called additives. Purpose additives - Improving the quality of lubricants and, primarily, to improve their antiwear and antifricion properties. They are based on high molecular weight polymers, Detergent and dispersant components, oxidation inhibitors, rust and corrosion, anti-silicones or poliloksany. However, additives allow only modify Tribo environment with improved lubrication properties. When changing the lubricant additives require re-application.

Almost impossible to eliminate wear. Therefore the search for unusual ways to prolong the service life of technical devices by acting on the friction surface is an urgent task. Currently, one such method is known. It is based on the exploitation of the machinery to the presence of friction tribo different



drugs. This method allows, under certain conditions actually produce the so-called operation without the wear art. The essence of the technology without folding restore worn surfaces of friction units of machines and mechanisms is that RVS additive introduced into regular oil or grease. The preparation is then transported oil on the surface of the friction units, and under the influence of pressure, temperature and and tribes plasma creates conditions for the return of wear on the surface of the worn-out place with a partial or full recovery of the geometric dimensions of parts [1-7]. Thus the formation of layers with high wear resistance and low friction.

2. Results and discussion

In the world there are different Tribo drugs to prolong the service life of machinery. These preparations can be organic and inorganic nature. Preparations inorganic nature called tribo additives or modifiers, and organic nature - geomodifiers or mineral friction modifiers. Unlike additives tribo preparations of both organic and inorganic nature on the friction surfaces of parts creates notable protective film [1]. Preparations of inorganic nature on part surfaces form a short-lived anti-friction coatings, and organic - long-lasting anti-friction coating. When changing the lubricant reapplication Tribo preparation is required. Studies have shown that the anti-friction coating of organic products Tribo close to diamond-like coatings. Their hardness is 70 HRC, wear resistance several times higher than the wear resistance of the original surface of the workpiece, and the coefficient of friction is reduced by more than 2 times, and sometimes up to 90%.

Since the 60s of last century began to emerge new scientific and technical sphere - management of friction, wear and restoration of worn surfaces during the operation of machines and mechanisms using artificially caused by physico-chemical phenomena in friction, manageable introduction to the tribological interface products with feedback on operating parameters of interfaces. Education layers with high wear resistance and low coefficient of friction on the mating surfaces of friction units of machines and mechanisms during their operation is an established fact. Therefore, at the end of the last century, manufacturers Tribo drugs, both in our country and abroad, technology without collapsible rebuilding worn friction units of machines and mechanisms using geomodifiers steel used in commercial purposes. This technology is based on the so-called opening "effect of low friction surfaces of friction units in the presence of phyllosilicates." The availability of this technology, simplicity, low cost and economic benefits allowed its widespread development of different kinds of practices, experimenters. But it almost to the present day has not been studied mechanism of wear-resistant coatings on the surfaces of friction units of machines and plants in the presence of Tribo preparations not performed indepth research on the study of processes taking place at the same time. Therefore, not otrabotanom this technology, its use of "blind", and sometimes led to negative results. Hence some caution in the technology and the lack of its large-scale application [8].

In recent decades, there have been some studies that reveal the essence of the processes taking place in the friction units of machines and mechanisms in the presence of these drugs Tribo. It turned out that these processes play a major role in the resulting contact points mating surfaces friction unit electrical discharges, was later called "Triboplasma" [9]. Existing studies have shown that an electrical discharge that occurs in friction machines and equipment relates to the section of low-temperature plasma. Then triboplasma equations can be described as applied to lowtemperature plasma. But here it is necessary to consider that the existence of a single spot on the mating surfaces of the friction unit is about $10^{-8} - 10^{-7}$ c. This further complicates the development of the theory of the mechanism of action of repair and restorative composition (RVS) on the surface of the friction units, which is the main hindrance RVS optimization technology, and its large-scale deployment in the industry and repair production.

There are various hypotheses to explain the mechanism of formation of coatings with high wear resistance and low coefficient of friction on the mating surfaces of friction units of machines and mechanisms during their operation with the presence of drugs Tribo. All these conflicting hypotheses. The proposed technology without the wear operation of equipment using tribo drugs differ in content and methodology of processing machinery.

To date, there are about ten hypotheses on the mechanism, sometimes conflicting. Their different understanding and ambiguity related to the lack of a clear understanding of the processes occurring in the friction units of machines and mechanisms with the presence of drugs Tribo. Therefore, it is planned to develop its own hypothesis, the most suitable for the actual mechanism of formation of wear-resistant coatings. For clarity, we present some common hypothesis on the subject [8]:

- One of the first in time and the most common - a "technological" hypothesis of the NGO "Ruspromremont", ie cold deformation, which is understood as a mechanical pressing onto the friction surfaces of products crushing and destruction of minerals. The advantage of this hypothesis - keeping the pressure as one of the main factors of the recovery process of the friction surfaces HMT-additives. However, this hypothesis does not explain the complex structure of tumors, significantly different from that of the locus;

- Other pioneers RVS technology with physical positions assumed that the restoration of the worn surface friction and increasing the protective layer, offset by increased gap interfaces friction is the result micrometallurgical processes in local points of frictional contact. The advantage of this hypothesis - account other important factors tribohimii - the temperature in point. However, the evidence of the elemental composition HMT-coating shows the presence of a predominant (70 ... 85%) of the amount of carbon, a small (3 ... 5%) and similar to the amount of iron - silicon, in the absence of appreciable amounts of magnesium, which does not confirm the accuracy of the cermet ;

- In NPIF "anyon Baltica" an important mechanism for the diffusion of the work locus believed some of its components (for example - magnesium) into the metal surfaces of the parts. Hence the name given tribopreparatam "anyon-Baltic": NIOD (focused ion diffusion). This hypothesis requires confirmation CONTENTSon high magnesium surfaces of parts after-treatment of PBC. However, our studies have shown that magnesium is absent in the coatings. In our opinion, the only magnesium plays a catalytic role in the ongoing processes in friction;

- SPC "Converse Resource" explains its action tribo drugs based on copper salts of fatty acids and serpentine from the standpoint of "selective migration". However, rarely implemented selective transfer occurs only under strictly defined combination of materials of friction pairs and only the friction of steel on copper alloys;

- Developers serpentine preparation "SUPROTEC" believe that the active components are formed on the surface of friction cellular structures, retaining grease. These structures form the surface, which the authors called for the preparation triboparah "third layer of the body." They believe that at the beginning of the drug under the influence of high pressure and temperature in the ultrafine powder mates formed iron carbides, which removes the friction surface contamination, and then the surface is covered with juvenile cellular structure;

- Ph.D. Rybnikov Yu, an expert on the glass for the mechanism of recovery of worn surfaces with HMT offered close to the hypothesis sintering secondary structures, the formation of the hypothesis "the iron-magnesium glass." A small presence of iron in the structure of PBC coating explains its high adhesion to the surfaces of parts (only iron-carbon alloy) reaction with iron atoms of the friction surface. With the same hypothesis "vitrification" RVS surfaces consistent high grade purity of the newly-formed film, its high hardness, high electrical resistance, heat resistance, and transparency. But this hypothesis does not explain maslofilnost film and it is dominated by the presence of carbon, not hypothetical glass components;

- The justification of an entire era of crystal-chemical mechanisms work and how to use minerals as friction modifiers are works of one of the pioneers of the RVS technology, Dr. geol.-miner. Sciences, Academy of Natural Sciences VV Zueva;

- Noteworthy recent physicochemical presentation Ph.D. DM Teluha. He states that there are five basic types of serpentine: antigorite, chrysotile, klinohrizotil, ortohrizotil and lizardite. But, according to him, most of the RVS-composition prepared from the lizardite doped with magnetic and chrome iron ore particles of olivine, which determines the instability of the compositions and the variation of their tribological properties - with microimpurities talc, silica and other unwanted clay minerals, oxides of aluminum and silicon, non-adhesion to steel.

In this issue there and our preliminary hypothesis, from our point of view, the most real. It is as follows. From the set of considered viewing versions can be concluded that the major factors of the process are: the pressure and temperature in a local point tribocontact, the presence of a catalyst element (magnesium) in tribo preparation, a large amount of heat (energy) emitted in the destruction of mineral friction modifiers node contact friction surfaces, triboplasma, grinding particles with their abrasive effect on the unevenness and oxide films, the presence of oxidation products tribosrede organic lubricant, polycondensation, tribopolimerizatsiya and adhesion to the friction surfaces of some modified components of the friction of the friction environment, diffusion in the surface friction others chemisorption third.

In general, when the serpentine tribo drugs, early appears, it is cleaned from the friction surface layers, oxide films deformed and unstable crystal structures and cavitation abrasive mineral particles with the opening juvenile, catalytic surfaces. Juvenile surface - a newly formed surface of the part with the free molecular bonds and free of oxides and other contaminants. Only after grinding particles and the opening juvenile friction surfaces occurring serpentine particle conversion processes and modification of the friction surfaces.

3. Conclusions

Presumably, formation of a coating with high wear resistance and low friction takes place in stages: first there is treatment of industrial pollution, then the electrochemical and electrical processes, then the formation of an amorphous coating fragile, after maturation and hardening by peening.

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