Triboplasma - the main component of plasma-chemical processes occurring in the friction units of machines and mechanisms in the presence of these drugs Tribo

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Abstract. In this paper, a technology capable of repairing worn surfaces of the friction units of machines and mechanisms. This technology can successfully be used in any production of engineering products. The proposed technology is low-cost, efficient and easy to use. It is shown that the processes occurring in the friction units of machines and mechanisms in the presence of these drugs tribo triboplasma plays a fundamental role, which arises in the contact mating surfaces.

1. Introduction
At present, the state technical policy aimed at the modernization of worn equipment, including agriculture, through the application of high-performance technologies, called nanotechnology. However, the power of this modernization, says a lot, but in reality little has been done. Under the modernization of equipment worn understood its restoration to the achievement of the above parameters passport.

In this article we will focus on the technology dimension to rebuild worn surfaces of friction units of machines and mechanisms. The foundations of this technology has been incorporated in the 80-ies of the last century. It was used in the serpentinite Tribo drugs basis. These were named RVS Tribo drugs additives and surface treatment technology of friction units with their application - RVS technology. The essence of this technology is that the RVS additive is introduced into the standard oil or grease. The preparation was then transported to the oil on the surface of the friction units and under the influence of pressure, temperature and triboplasmy create conditions for the return of wear on the worn surface of the seat with a partial or full recovery of the geometric dimensions of parts [1–4]. When this occurs the formation of layers with a high wear resistance and low friction. The result is a so-called no-wear operation of equipment and machinery actually become later a new passport with the parameters of the above values.

This technology was based on the so-called opening of "The effect of low friction surfaces of friction units in the presence of layered silicates." The availability of this technology, simplicity, low cost, and the economic benefit it allowed widespread development of various kinds of practices experimentalists. But it is almost to the present day has not been studied mechanism of wear-resistant coatings on the surfaces of friction units and aggregates in the presence of Tribo drugs not conducted in-depth research on the study of processes occurring at the same time. So do not otrabotanom PBC
technology, its use of "blind", sometimes led to negative results. Hence, some caution in the technology and the lack of its large-scale application.

Should not be confused with each other, "RVS additives" and "Additives" [1]. Unlike addition of additives commonly known that when the additive oil change requiring repeated application, and additives remain on the friction surface and continue to work when replacing the oil. Experience has shown that in this case the effect of the treatment, depending on the operating conditions, for example for cars continues to operate from 50 to 100 thousand miles of their run.

There are several versions of the mechanism of forming a coating on the surfaces of friction units at their processing RVS additives. On one of them, supplements, getting oil on the friction pair, activate the defective surface. Under the action of catalysts and triboplasmy RVS additive cleans the friction surfaces of the layers, oxide films and fragile structures deformed crystals. At the same time on the cleaned surfaces appear free molecular bonds, which as "octopus" attract crystals additives and wear products. Begins the formation of new crystals in the valleys of roughness, accrued on the crystal lattice of the surface layer of the metal. In the future, these crystals are oriented along the field and coalesce to form over the entire surface of the contact point diamond-like coating. I would like to draw attention to the fact that with all this catalysts RVS additives remain in the gaps of friction units and how - to "duty." In the event of further deterioration surface they again begin the process of recovery. Thus, there is no exploitation of the wear art.

It is necessary to say more about the following. The surface roughness is characterized by its peaks and valleys. Depressions on the surface can be represented as an area of wear. Friction modifier, getting into the zone is captured and held by the metal atoms having free communication. During the loading energy activator directs excess energy to create a new crystal lattice. After a while the depression is filled with diamond-like coating. As soon as the surface of the cavity due to the coating compared with the projection, the energy conditions necessary for recovery. So the item, will never gain in the amount of more than the seizure will not happen mating surfaces. The system has stabilized.

2. Materials and Methods of Research

In today's world there are many different additives, including the Russian production. Raw material for the manufacture of additives is essentially opaque mineral called serpentine. Before it becomes a resursoenergosberegayuschnyy additive initially undergoes a special milled to nano-sized, and then filtered of impurities. The basis of the serpentine is serpentine. Available today for the 18 varieties of serpentine, in practice, mainly used antigorite, chrysotile, lizardite-1T. They are described by general structural formula Mg$_6$[Si$_4$O$_{10}$](OH)$_8$, but are identified by x-ray diffraction is different. For example, in the analysis of drugs in PBC diffractometer XRD 6000 library spectra of the International Institute of ICSD shows them to 12 slightly different minerals. [1, 2] Component composition of serpentine: MgO - 43%, SiO$_2$ - 44% H$_2$O - 12.9%. In the serpentine also contains about 13% of the constitutional water; constitutional water is represented in minerals hydroxyl ions (OH), and in rare cases with H + ions, ranging in lattice sites. This mineral water is held firmly at room temperature, but is released during heating in the temperature range of 300 - 1300 °C. Allocation of water is accompanied by the destruction of the crystal lattice of the mineral with an additional release of large amounts of thermal energy. However, in the serpentine rock includes several varieties serpentine, magnetite inclusions, chromite and accompanying plurality of minerals based on iron, aluminum, calcium, nickel, and some other elements. In serpentinites different fields all this "walking" in a large range. Therefore, a more general formula serpentine Tribo drugs, taking into account their variable composition is: (MgO) x (SiO$_2$) y (H$_2$O) z, where x, y, z - variables.

Was held X-ray fluorescence analysis of the elemental composition of eight types of powders and supplements RVS source of serpentine [5]. The analysis showed that in all the major chemical additives RVS elements are magnesium, silicon and iron. In almost all formulations the presence of aluminum, calcium, chromium, manganese and nickel. RVS supplements from different manufacturers have about the same elemental composition. By quantitative content of these additive elements, taking
into account the errors have a close. In some compositions, as well as on data from Nanocentre GOSNITI in small amounts include sulfur, copper and zinc. Apparently, the producers included in the data elements based on their research results. It should be noted that the addition of LLC «Tehnodar» (Karelia) is very different from the elemental and quantitative composition of all the additives that may be due to the difference of the feedstock. At the same serpentine are almost all of the above elements.

3. The mechanism of action of repair and restorative composition in the friction units of machines and mechanisms

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 additives in them RVS. It turned out that these processes play a major role in the emerging contact points mating surfaces friction unit electrical discharges. 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 additives in them RVS. It turned out that these processes play a major role in the emerging contact points mating surfaces friction unit electrical discharges. The question arises. From these ranks, and what role they are given in the PBC technology?

Sparks impact and friction has long known. Only a few people delved into its nature. In such technique called spark friction sparks. They are the result of the transition of the mechanical energy into heat. With relative sliding of the two bodies due to deformation of the material involved in the formation and destruction of the friction relationships in the thin surface layer formed by heat. Increased temperature can thus cause local softening and melting of the material. The heat spreads from contact spots deep both contacting bodies, the heat flows are allocated depending on the thermal properties of contacting bodies, the size and conditions of the heat sink. [6] At steady-state thermal regime mechanical energy transformed in micro surface layer into heat is transferred into the interior of the mass of the rubbing bodies by conduction is not completely. Part of it is a result of structural transformations in the surface layers, and thermionic emission, thermal diffusion, and so on. Dissipated directly to the environment [6]. When a rough surface slides on the other, the contact occurs only at certain points which are quite a short time in contact. The lifetime of a single spot can be $10^{-7} - 10^{-8}$ s [7]. On a single spot having short-term individual temperature flashes. Flash can reach considerable size, which affects the conditions of interaction of the rubbing surfaces. As a result, a very short period of time, a thin layer of molten material, and even in the high-energy state, similar plasma or magma. This "MAGMA-plasma" later called "Triboplasma."

According to the model "Triboplasmy" "released by mechanical action on the material can greatly exceed the energy heat melting due to poor thermal conductivity of solids not only leads to the melting of the substance but also to its sublimation, and then rise to a state in which it is in the form of ions and electrons (plasma state). For such applications, the laws of classical thermodynamics are not met; a thin surface layer of material is converted, resulting in a collision zone formed irregularities plasma (triboplasma); the process is accompanied by the emission of electrons.

The approach to the description of features of the structure and behavior of matter tribomating in a state can be considered triboplasma idea of anomalously enhances the process of diffusion mass transfer in friction associated with changes covering the structure of the surface layers of friction units [8]. At the same time observed as transformation has been accompanied by structural defects, and the reverse processes. On fault detection surface phenomenon special mark superimposed thermal processes, in particular, the diffusion coefficient $D_0$ corresponding triboplasme can be calculated using the relation:

$$D_0 = \frac{R_d^2}{h} \left( Q^* - W_d \right); \quad [D_0] = \left[ \frac{m^2}{s} \right], \quad (1)$$

Where $R_d$ - Debye radius, m; $h$ - Planck constant, J/s; $Q^* = kT + Q$ - quantity characterizing the kinetic energy of the thermal motion of particles triboplamy, J.; $k$ - Boltzmann constant, J / K; T -
Temperature triboplasmy, K; Q - the heat released by friction, J; W_0 - activation energy of diffusion processes, J.

From this relation it follows that the thermal activation surface greatly increases the activation energy of diffusion processes and leads to abnormal strengthening of the diffusion coefficient. In further calculations we can obtain an expression that reflects the proportionality of the diffusion coefficient of the square root of the temperature field of the frictional contact. From this it can be assumed that triboplasma with properties close to gases. Therefore, it can be described by an equation similar to the low-temperature gas-discharge plasma [9-16].

4. Results and discussion

In general, laboratory and production testing pioneers RVS-technology form the basis of a fundamentally new direction in tribotechnology - restoration of the worn surfaces of interfaces to their nominal values, and in some cases above, under the influence of natural mineral additives introduced in tribosredu.

In 2012, our high school together with "RealInProekt" (St. Petersburg) has developed its own PBC supplement on the basis of serpentinite, entitled "TATGEO" to upgrade the worn equipment. Appointment of friction modifier "TATGEO" - restoration of worn surfaces of friction units of machines and mechanisms without disassembly with a further resource of their work up to 2 thousand. Moto hours or up to 100 thousand. Kilometers car. Our friction modifier from existing analogues differ by more than ten items, including feedstock composition, lower cost manufacturing technology and application.

A couple of words about the source of raw materials and manufacturing techniques.

Manufacturers PBC additives feedstock collected ore deposits. However, not everyone is suitable for PBC serpentinite powder. Distinguish mikrocheshuychaty serpentinite sheet called antigorite, fine fiber, called chrysotile, and fine-grained, called lizardite. Based on many years of experience our experts choose the most effective serpentinite. It is with the addition of chrysotile antigorite. After grinding us RVS powder added in certain proportions various surfactants, inhibitors, scavengers, stabilizers, and catalysts.

The scope of surface treatment technology of friction units tribo drugs:

- The machinery industries (rolling and sliding bearings, shafts, bearings and Screws, etc.);
- Motor vehicles (engines of all types and sizes, gears, joints, the hinge of equal angular speeds, mechanical gearbox);
- Rail transport (engines, gearboxes, wheel-rail pair, etc.);
- Sea and river vessels (engines, diesel generators, etc.);
- Weapons and military equipment.

Achieved the effect of surface treatment of friction units tribo drugs:

- Increased service life of parts and machinery in 2 - 3 times;
- Increasing the power of internal combustion engines by 10 - 15%;
- Reduce energy consumption by 10 - 20% (machine tools, generators, blowers);
- Reduced consumption of fuel and lubricants for 7 - 15% (internal combustion engines, bearings, gears);
- Increased oil change intervals of oils and lubricants 1.5 - 2.5 times;
- Reduction of CO and C x H y in the exhaust gases of internal combustion engines in the 2 - 3 times;
- Improving the performance characteristics of military equipment, including small arms;
- Reduce the cost of production of parts, repair and maintenance costs in the 1.5 - 2.0 times.

5. Conclusions

1. The electrical discharge that occurs in friction machinery and equipment refers to the section of low-temperature plasma.
2. Triboplasma equations can be described as applied to low-temperature plasma.
3. Research triboplasmy is relevant not only in terms of scientific interest, but also in terms of practical significance.
4. RVS is designed to supplement the basis of serpentinite, entitled "TATGEO" for modernization of worn equipment. It differs from existing analogues for more than ten items, among which the feedstock composition, lower cost manufacturing techniques and applications.

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