New approach to investigating plasma processes occurring in friction units of machines and mechanisms

S Sharifullin and N Rogozhkin
Kazan (Volga region) Federal University, Kazan, Russia
E-mail: Saidchist@mail.ru

Abstract. Under the low temperature plasma usually we realize discharge plasma with a temperature of up to 50,000 °C. It turns out there is a discharges, which at first glance do not manifest themselves immediately, but play a crucial role in the creation of competitive vehicles, machinery and equipment with increased service life.

1. Introduction

Current national technical policy aimed at creating a competitive machinery and equipment with increased service life. However, no matter what technical solutions are not applied in engineering development, finite resource of the machine linked to the degree of surface wear-its friction units. Depreciation is the result of friction. The process of friction can not be eliminated, i.e. A. It is associated with the movement of the body and of course the conversion of mechanical energy into other forms of it. But to a certain extent reduce the effect of wearing out, you can. Or, without changing the friction process, you can improve the wear resistance of the material of the friction surface. Currently, there are so called resource conservation technologies (RES-technology), allowing not only extend the life of the machine, but also to ensure its without the wear operation.

The essence RES technology is that when administered to an established oil or grease composition of special machines called RVS additive on the surfaces of the friction units under the influence of pressure and temperature conditions are created for the return of wear on the worn seat surface with partial or complete restoration of the geometric dimensions of parts. Instead, wear the reverse process. Wherein at the friction surfaces are formed of layers with a high wear resistance and low friction coefficient [1].

Despite the fact that the first results of RES technologies have been obtained in the 80-ies of the last century to the present day it has not received widespread introduction into production. There are several reasons. One of them is the lack of a clear understanding of the mechanism of formation on the surface of the friction unit coating with high wear resistance and low friction. In recent decades, there have been some studies that reveal the essence of the processes in the friction of machinery in the presence of additives in them PBC. It was found that in these processes play a major role in the emerging contact patches mating surfaces friction unit electrical discharges. The question arises. From these ranks, and what role they are given in RES-technologies?

Sparking on impact and friction have long known. Only a few delved into its nature. In such technique called friction sparks sparks. They are the result of the transition of the mechanical energy into heat. When the relative sliding of two bodies due to the deformation of the material involved in the formation and destruction of frictional bonds in a thin surface layer formed by heat. Increased temperature can thus cause local softening and melting the material. Heat spreads from contact spots deep both contacting bodies, and heat...
flows are allocated depending on the thermophysical properties of the contacting bodies, the size of the heat sink and the conditions [2]. At steady-state thermal regime mechanical energy converted in micro surface layer into heat is transferred into the interior of the mass of the rubbing bodies by conduction from complete. Part of it is the result of structural transformations in the surface layers, thermionic and thermionic emission, thermal diffusion, and so on. D. Dissipated directly into the environment [2]. When a rough surface slides on the other, the touch occurs only at certain points which are quite a short time in contact. During the existence of a single spot can be 10-7 - 10-8 s [3]. Single spot on a short-term single temperature flash. Flashpoint can reach considerable size, which affects the conditions of interaction of the rubbing surfaces. According to the beliefs of the German physical chemist P.A. Thießen, blow each other grains during grinding leads to the concentration of energy in the microscopic surface area (1967). As a result, at very short time intervals, about a thin layer of melt, and even the substance in Detects high-cal state, similar to plasma or magma. This "MAGMA-plasma" vposledstii Wii-called "Triboplasmoy" (Fig. 1 and 2).

Fig. 1. Model of 'Magma-plasma'

the original structure; 2 - molten structure; 3 - plasma; 4 - thermionic emission electrons 5 - atoms, photons, phonons, ions, excited molecules, the fast electrons.

Fig. 2. Model of "Magma-plasma" in the zone of impact of irregularities in surfaces. The impact direction shown by arrow
In spring 2008, Emeritus Professor Yoshiki Arata (Yoshiaki Arata) from the University of Osaka, and his Chinese counterpart Zhang Yuechan (Yue-Chang Zhang) from Shanghai University demonstrated public beaut-st experiment. In this demonstration experiment was recorded not provided the known laws of physics, the energy release and the formation of gen-Leah [4]. In numerous articles devoted to the description of cold fusion (fusion at room temperature), focusing in particular on the fact that in experiments with deuterated substances heat is recorded neutron emission, tritium and helium.

Keiji Nakayama in 2002 experimentally confirmed the presence triboplazmy around the sliding contact of the diamond sapphire sphere by rotating the disc (Fig. 3). Intense infrared radiation shows that the friction surface is heated. On the other hand intense ultraviolet radiation of the gas discharge observed outside the sliding contact between the localization of which has per-zorom sphere and disc ranging from 1.3 μm and 7.8 μm.

The observed plasma emits triboplazmu in sliding contact friction caused by heat or high energy formed in the deformed layer for sliding contact. Besides the emission intensity around how-zyaschego contact increases with increasing resistivity materials. This go-way indicates that that triboplazma electrification generated by friction.

The basis of the approach to the description of the structural features and behavior of matter tribomating in a state can be considered triboplazmy ideas about abnormally enhances the process of diffusion mass transfer in friction associated with changes covering the structure of the surface layer of tribocoupling [6]. At the same time observed as transformation has been accompanied by defects in the structure, and the reverse. On the phenomenon of surface flaw detection impose special imprint thermal processes, in particular, the diffusion coefficients, coefficient D0 corresponding triboplazme can be calculated using the equation:
D_0 = \frac{R_D^2}{h}(Q^* - W_0); [D_0] = \left[ \frac{m^2}{c} \right]

R_D – Debye radius, m;

h – Planck constant, J·s;

Q^* = kT + Q – quantity characterizing the kinetic energy of thermal motion of the particles triboplazmy, J;

k – Boltzmann constant, J/K;

T – Temperature triboplazmy, K;

Q – heat released by friction, J;

W_0 – activation energy for diffusion processes, J.

From this relation it follows that thermal activation surface greatly increases the activation energy of diffusion processes and leads to anomizing the diffusion coefficient. In further calculations we can obtain in the expression that reflects the proportionality of the diffusion coefficient of the square root of temperature field of frictional contact. From this it can be assumed that triboplazma their properties close to gases.

2. Conclusions

1. An electric discharge that occurs in friction machines and equipment, refers to the section of low-temperature plasma.

2. Triboplazma can be described by equations, applied to the Low Temperature-temperature plasma.

3. Research triboplazmy is relevant not only in terms of on-uchnogo interest, but also in terms of practical significance.

Acknowledgements

This work was funded by the subsidy of the Russian Government to support the Program of Competitive Growth of Kazan Federal University among World’s Leading Academic Centers.

References

[1] Anatoly Dounaev. Friction Surfaces Modification Using Tribo-Compounds /Anatoly Dounaev and Said Sharifullin // World Applied Sciences Journal. ISSN 1818-4952, 2014. - Vol. 31 (2). - P. 272 - 276.

[2] KRAGELSKY IV Friction and wear. Ed. 2nd Revised. and ext. /I.V. KRAGELSKY. - M .: Mechanical Engineering, 1968 - 480s.

[3] Garkunov D.N. Tribotechnics /D.N. Garkunov. - M .: Mechanical Engineering, 1985 - 424c.

[4] Arata Y., and Zhang Y.-C. Formation of condensed metallic deuterium lattice and nuclear fusion. Proceedings of the Japan Academy. Ser. B: Physical and Biological Sciences. 2002. - Vol. 78. - No. 3. - P. 57 - 62).

[5] Tribology of Diamond-Like Carbon Films. Fundamentals and Applications. Christophe Donnet, Ali Erdemir Editors. (Christophe Donnet, University Institute of France and Uni-versity Jean Monnet, Laboratoire Hubert Curien, UMR 5513 18th avenue; Professeur Benoît Lauras 42000 Saint-Etienne, France. Donnet@univ-st-etienne.fr.

[6] Dolgopolov K.N. Improving the performance of household machines through intensification processes lubrication tribocoupling: Author. Dis. on soisk. Uch. steppes. cand. tehn. Sciences. / Dolgopolov Kirill Nikolaevich. SRSUES. - Mines, 2009. - 28 p.