UDC 621.893

ANALYSIS OF NANOSCALE ADDITIVES INCLUDED IN THE LUBRICATING OIL REALIZING THE EFFECT OF TRIBOLOGICALLY FRICTION SURFACES

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Considered modifying nano-sized additives of lubricants used to improve wear resistance of the friction surfaces of machines and mechanisms.

Losses from friction and wear in developed countries reach 4 – 5 % of national income, and overcoming the friction absorbs worldwide 20 – 25 % of the energy produced per year [1]. Providing the required level of coefficient of friction, decreasing the wear of the friction surfaces and preventing clogging of the friction depends on the nature and properties of the lubricant and its components.

Traditional methods of improving the wear resistance and durability of friction include the use of mineral, vegetable, animal and synthetic lubricants, parts of magnesium alloys, magnetic traps of wear particles, the magnets impact on grease and others Continuous improvement of the load-speed modes of machine operation, exhausted the possibilities of these methods. Therefore, the scientists face the task of further improving the design of parts and assemblies, methods of maintenance and repair.

Currently one of the priorities of improving the durability of the friction surfaces is the development of lubricants, realizing the effect of tribomodification. The modification of the friction surfaces is mainly due to the introduction in to lubricants nano-sized additives. These additives are solid insoluble substance with a characteristic size of from 0,1 nm to several tens nm, which support high antifriction and antiwear properties of the lubricant material in the process of friction.

Foreign and domestic scientists developed many different compositions based on the minerals of natural and artificial origin, which received the name geomodifires of friction (GMT). Getting on the friction surface along with oil or grease, they initiate the process of formation in friction surfaces of nano-sized structures with high wear resistance and low coefficient of friction. As a result of application of concentrated suspension GMT on the basis of serpentine with the dispersion of a natural mineral from 0,01 to 5 micrometer in all mechanisms and devices the wear of friction is reduced on 50 – 70 %, the losses due to friction are reduced 1,5 – 2 times and vibroactivity is reduced on 50 – 100 % [2]. This is due to the increase in the effective contact area and the formation of the original structure of the dynamic ultra-thin layer of hydrocarbon chains of particles GMT and wear products of less than one micrometer (quasiliquefied l layer).

On the basis of serpentine and concomitant impurities the compound for treatment of friction pairs, was developed. It includes the fine powder of diamond or stones, and metal-containing additive which is a mixture of fine powder of metals, selected from the metal base and the metals, forming a stable system with the base material taken from a number of Cr, Ni, Mo, Nb, Ti and their alloys [3]. This combination of components provides for the formation of strongly bound with the friction surface of a modified hardened surface layer of specified composition, and this makes it possible to achieve a stable reduction of wear and friction coefficient and improv the technical parameters of machines and mechanisms. For example, for the pair of friction steel 45 – steel 45, the surfaces of which are treated by this composition, by the following technical and operational characteristics are characterized: hardness 390 – 410 HRC, the coefficient of friction 0,006 – 0,008, compensation for wear of 1 – 3 mm [3].

Modern nano-sized additives also include ultrafine diamond-graphite powder (UDP-AG). Diamond plays the role of abrasive material on the account of which during operation the process of submicrocutting of single microsystems takes plays and that leads to a noticeable increase of the effective contact area of friction pairs. The smaller the particle size of the diamond powder, the more of them get into the area of frictional contact, and this offers more anti-wear performance. Presented in work [4] results show that the introduction of UDP-AG into plastic lubricant CIATIM-201 enhances its anti-friction properties, allows to reduce the operating temperature of the friction on 13 – 15 % and the coefficient of sliding friction on 25 – 32 % (Fig. 1) and to reduce the roughness of the rubbing surfaces in 1,5 – 2 times.

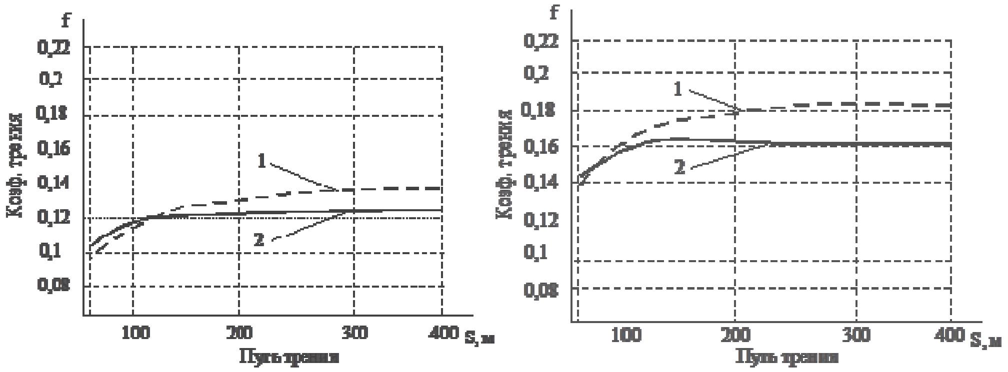

Fig. 1. Dependence of the change of friction coefficient on road friction lubrication CIATIM-201 at a load of 150 N and 250 N (b): 1 – without filler; 2 – filled with UDP-AG [4]

UDP-AG in lubricating oil is often used in combination with ultra dispersed and other additives. In this case, the nature of their interaction and concentration determine the properties of lubricants, as well as technical and operational characteristics of treated by this compound friction surfaces.

When UDP of iron and UDP-AG are used together the diamond-metal composite is formed on the friction surface. It combines high hardness (resistance to wear), cladding properties (thickness up to 4 micrometer), as well as a synergistic effect (the coefficient of friction at the stage of break-in does not exceed 0,23 for the pair steel3-steel3) [5]. Investigations of lubricant containing UDP-AG (0,2 – 5 %) in combination with fine salt of sulfate tin show a 2 time decrease in the wear rate and the coefficient of friction is decreased by 12 – 15 %. At the same time, the load capacity is increased by 25 %. In the case of reducing the concentration of UDP-AG friction regime is the same as with usual lubricants without additives. If the concentration is greater than 5 %, the friction passes into unstable mode of boundary friction, combined with an increase in coefficient of friction and wear [6].

The staff of the scientific-production Association «Altai» developed and conducted a series of industrial tests of antifriction grease for abrasive materials, which included ultradispersed diamond and molybdenum disulfide. As a result of application of the lubricant with cluster diamonds the efficiency of the operation of grinding and sharpening increases by 10-25 %, and the purity of the treated surface in 1,5 – 2 times, while the ecological conditions of work are improved [7].

At the end of the last century in the UK Neil Gretton developed and widely used a special liquid SLIK-50 on the bases of polytetrafluoroethylene (PTFE), but then its use was suspended. But even now PTFE is a part of many lubricants as a polymeropoulos composition. As a result, on the friction surface a thin (about 1 micrometer) structured coating is formed. It provides increased adhesion, anti-wear and anti-friction effects. The efficiency is preparations is determined by the level of ultradispersed PTFE, dispersion of particles in the solvent, the presence of surface-active substances (surfactants), reinforcing the mechanical interaction. Many modifications of PTFE (polyflon, algoflon, teflon-3, vidar and others), are also developed. They have found application in automobile and chemical industries, but also in many other areas.

Currently there is also a large number of lubricants, with dispersed ferromagnets. Transition metals and some of their intermetallic compounds, such as iron-nickel, iron-cobalt are of practical importance. Magnetite is the most widely used. It has good adsorption ability with respect to surfactants, and is also capable of forming a colloidal dispersion with high magnetization. Magnetite is a constituent of many metalloplastic lubricants. The separating layer, preventing the interaction of parts of friction in such greases, forms particles of metals or metal-containing compounds, filling the microscopic irregularities of friction surfaces and thus reducing the amount of contact pressure. Such additives are fine powders of zinc, bronze, copper, lead and some others with a particle size of 10 – 40 micrometer. Salts of monocarboxylic acids with metals or metal powder which is industrial waste of electrochemical electroplating processes containing copper and mixed with oleic acid are also used. When metalloprotease film is formed in the contact zone the accelerated migration of magnetic particles from the volume of lubricant takes place. That reduces wear, friction torque, and improves anti-wear resistance of friction [8].

Discussed in the article nanoscale additives can significantly improve the wear resistance of friction surfaces (70 %), technical and operational performance in 1,5 – 2 times, reduce the time and improve the quality of their extra earnings, lower the temperature of working units (up 15 %), noise and vibration, which significantly contributes to increasing the reliability and durability of machines and mechanisms.

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