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ANALYSIS OF THE BASIC METHODS OF TRIBO MODIFICATION

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The article is devoted to the analysis of tribo modification main methods and describing their advantages and disadvantages.

The wear resistance increase of a part depends largely on the dimensions of mating surfaces and conditions of the loading and lubrication regime.

The increase of the parts wear resistance is achieved by protecting them from abrasive action; the use of special lubricants and additives to lubricants, allowing the creation of a film on all rubbing parts; creating conditions for liquid lubrication by applying the thinnest film of powder mixtures to the parts; using the vibrating rolling, allowing to create an optimal roughness of rubbing surfaces of parts, etc.

Tribo modification methods include methods for reconstructing friction surfaces in a mode of continuous operation with the use of additives to lubricants containing dispersed natural layered silicates. The use of such additives can ensure the restoration of worn surfaces with the formation on the friction surfaces of metal-ceramic coatings which have increased wear resistance.

Technological methods for improving the tribotechnical properties of friction pairs and increasing the service life of tribo-joints by operating them in the presence of the lubricant containing nano-sized solid components, in particular, nano-sized diamonds, should also be referred to tribo technological methods. Solid nano-sized particles introduced into the lubricating medium have a complex effect on the tribo system, increasing its longevity.

This method of wear resistance increase is one of the most promising, so the purpose of this work is to analyze and study the basic methods of tribo modification.

Among the processes that positively affect the tribo system in the use of lubricants with nano-sized solid additives are: the formation of separation layers of increased bearing capacity, stabilization of rheological characteristics of the lubricating layer over a wide temperature range, the decrease in the roughness of the friction surface, and hardening of surface layers.

One of the factors affecting reliability and durability of machines is the run-in of mating surfaces of parts. The use of run-in preparations in the manufacture and repair of machines and mechanisms allows to integrate the run-in, thereby shortening the duration of the running-in phase and prolonging the zone of the steady wear regime. Due to this, the number of failures of machines and mechanisms during operation is reduced and their service life is increased.

Lubricant compositions containing solid components (diamond-graphite powder, carbides, silicon oxides, etc.), polymers are used as run-in compositions [1].

Running preparations based on nano-diamonds can reduce the running-in time and optimize the quality of rubbing surfaces. Diamond performs the role of abrasive material, due to which, the process of submicrometry of single microprotrusions takes place in the process of operation. That leads to a significant increase in the actual contact area of friction pairs.

Repair and recovery compounds (RVS) are used with the exhaustion of the repair and overhaul life of the friction pairs of machines and mechanisms. They form anti-friction anti-wear coatings of long-term action on friction surfaces. RVS use makes it possible to restore worn surfaces of tribo-conjugations to original parameters. Currently known RVS for the component composition, physico-chemical processes of their interaction with rubbing surfaces can be divided into three groups: remetallizants (metal-plating compounds), polymer-containing preparations and geomodifiers.

Metal-clad lubricants can be used for all types of friction units: frogs, tips of steering rods, bearings, gears, etc. Such lubricants include powders of metals, their oxides, alloys, salts, complex and other compounds. The mechanism of their action lies in the metal plating of rubbing surfaces due to the deposition of metal components that make up their composition in a suspended or ionic form.

At the same time microdefects are partially eliminated. The coefficient of friction decreases, the wear resistance of clad surfaces significantly increases, the interval between grease changes increases. They successfully work in heavily loaded friction units. However, for the existence of a metal-cladding layer, the constant presence of remetallisant in the oil is necessary.

At present, to improve the technical and operational characteristics of tribo-conjugations, the spectrum of input materials in the lubricating compositions used is expanding, and new methods for obtaining already known materials are being developed. For example, a metal-clad lubricant composition containing ultrafine copper powder obtained by electric wire exploding has been proposed.

The composition was developed on the basis of lithol using highly dispersed filler powder (zinc, bronze or lead), obtained by evaporation and condensation in the atmosphere of neutral gas in a vacuum installation, ensuring non-vanishing work of friction pairs in course of their operation and allowing the already worn friction surface to be restored while maintaining main technological parameters of lubrication [1].

The lubrication mechanisms of such lubricating compositions are largely determined by the type of additives or fillers introduced therein and the load-temperature conditions of their application, i.e. operating conditions of the friction unit. Most often, the main role in reducing the intensity of wear of rubbing parts is taken away from formation of metal films on the friction surface.

The main disadvantage of plastic greases with metal-clad components is the fragility of the disperse phase of the lubricant therefore the use of additives of metallic powders in antifriction plastic greases is limited. In order to decrease the effect of minimizing, the cladding components of the lubricant must have a stable nanoscale level. They should be placed in a special protective envelope to prevent their oxidation, and have a trigger mechanism for the interaction reaction with the friction surface during the operation.

Another method of increasing the life of tribo-joints due to the modification of friction surfaces is the use of metal-plating lubricants, in which dispersed ferromagnets are introduced. Transitional metals, as well as some of their intermetallic compounds, for example iron-nickel, iron-cobalt, are of practical importance. The most widely used magnetite. It has a good adsorption capacity with respect to surfactants, and is also capable of forming colloidal dispersions with high magnetization [2, 3].

To increase the reliability and economy of engines, polymer-containing preparations containing PTFE, surface activated fluoroplast-4, perfluoropropylene oxide, perfluoropolyether carboxylic acid (epilam), silicone and some other polymeric substances are used. These drugs appeared before the others and were originally used to ensure a short-term preservation of mobility of military equipment in the event of a serious damage to the oil system.

One of the ways to improve the quality and wear resistance of the working surfaces of parts at the stage of manufacturing (recovery) and during their operation is the use of FANT (Finishing antifriction non-abrasive treatment). The essence of FANT means that the steel or cast-iron parts after the traditional final machining of their surface are covered with a thin layer (1 ... 3 mm) of antifriction copper-containing coating by friction. In this case, the phenomenon of selective metal transfer during friction is used [4].

The advantages of using FANT process are: extremely low material consumption; low consumption of mechanical energy; harmless to the environment; short duration of coating (several seconds and minutes); stable and good quality coating; economic feasibility with a large and small number of products.

The main methods of FANT by a number of authors are conventionally divided into two groups:

1. application of metal coatings with a friction-mechanical method, a tool made of copper-bearing alloy (frictional brass, bronzing and copper plating); friction-chemical method (FANT in metal-plating media containing various surfactants and metal salts capable of restoring on the surfaces to be treated when exposed to rollers, discs, bars, brushes, tampons, etc. from non-metallic tool); friction coating of plastic alloys in metal-plating media.

2. application of layered solid lubricating coatings in the form of graphite, molybdenum disulphide and other compounds by contact spreading by various methods.

Application of FANT together with metal-plating compositions allows to increase service life of tribo-conjugations in 2-2,5 times. However, this is possible only with the constant presence of metal-plating compounds in the contact zone of friction surfaces [4].

The method of cladding by a flexible tool based on the use in standard grinding technologies as an instrument instead of abrasive wheels of disk wire brushes made of metals and alloys forming a metal-plating layer on the working surface of the workpiece allow intensifying the FANT, increasing productivity and improving the economic parameters of metal plating of friction units.

Conclusion. Analytical review of scientific literature and patent sources devoted to the methods of tribo technology have shown that these methods make it possible to increase their wear resistance significantly (up to 70%), technical and operational indicators in 1.5 – 2 times, shorten the duration and improve the quality of their running-in, reduce the temperature of working units (up to 15%), the noise and vibration level, which significantly affects the reliability and service life of machinery and machines.

The modification of plastic lubricants with nanoscale diamond-containing additives provides an increase in extreme pressure properties and has an additional effect due to an increase in the hardness of the contacting surfaces when the structure of the friction surface is grinded during intense plastic deformation of micro roughness under the action of solid diamond particles and as a result of dispersed hardening when diamond particles are introduced into the friction surface and contributes to the reduction of the coefficient of friction due to reduction roughness of the friction surface and partial replacement of sliding friction by rolling friction.

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