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EFFECT OF LUBRICATION ON CHANGES IN FRICTION CHARACTERISTICS IN A TRIBO-FATIC SYSTEM

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Abstract

Effects of experimental researches regularity of agency of greases (the consistent graphite lubrication and a liquid transmission oil of Naftan TI 5-2) on a modification of performances of abrasion and chafing in tribo-fatigue system are introduced.

It is installed that the is recurring-variable straining is capable to adjust significantly abrasion processes in tribo-fatigue systems. Repeated stresses (from a flexure), operating in allowed band of contact interacting, can, depending on conditions of loading and lubrication, to increase (~ 25 %) or to reduce (~ 25 %) meanings of performances of abrasion and chafing. It allows to put and solve a problem regulating of durability and reliability of various nodes of computers and the equipment, by

rationalized matching: an aspect of a grease, an expedient of its supply in allowed band of abrasion, magnitude and the sign of operating repeated stresses in tribo-fatigue systems.
It is installed that for researched tribo-fatigue systems graphite lubrication is represented to more preferential, than transmission oil.

Key words: lubricants, liquid gear oil, graphite lubricant, tribo-fatigue system, highly elastic mixture.

1. Introduction

If rolling friction occurs against the background of cyclic deformation of at least one of the contacting bodies, then the system is said to operate under conditions of contact mechanical fatigue (CMF) [1]. The laws of CMU are studied within the framework of tribo-fatigue [2–5], the object of study of which are tribo-fatigue systems: the most critical and massive units of modern machines and equipment, the vast majority of which are operated in lubricating media to reduce power losses due to friction, as well as to reduce wear of rubbing surfaces. At the same time, liquid lubricants also cool and clean the friction surface from wear products and, to some extent, protect them from corrosion. However, any external environment reduces the fatigue strength of steels compared to vacuum. For example, it is known that lubricants cause an adsorption reduction in the endurance of steels by 7–26% relative to their endurance in air [6].
In this regard, the purpose of this report was an experimental study of the nature of the influence and the magnitude of the change in friction and wear characteristics in a tribo-fatigue system when using various lubricants.

2. Experimental studies

Studies of the effect of grease graphite lubricant and liquid transmission oil Naftan TI 5-2 on the change in the resistance characteristics of CMU were carried out in relation to the tribo-fatigue system steel 18 KhGT (shaft) / steel 18KhGT (roller). on a universal modular machine for wear-fatigue tests of the SI-03M series at a frequency of 3000 min-
An example of a loading program is shown in Figure 1, a.
A cylindrical sample - a shaft fixed in the spindle of the testing machine, rotated with an angular velocity ω_1. A bending load Q was applied to its free end. The contact load F_N was set stepwise, 2 minutes after the start of testing. Its initial level was F_N = 10 N, at the last stage of loading - F_N = 1325 N. The transition from stage to stage was carried out without intermediate pauses. The tests were carried out continuously up to a given number of loading cycles (10^6 cycles). The duration of each loading step was 33

minutes (n_i = 10^5 cycles). The bending load was set 4 minutes after the start of the tests and was directed downward, that is, tests were carried out with the organization of friction in the tension zone of the bent shaft. The values of bending stresses reached σ_a = 500 MPa (Figure 1, a). On figure 1, b, c presents the results of measurements of the convergence of the axes and the moment of friction obtained during the tests.

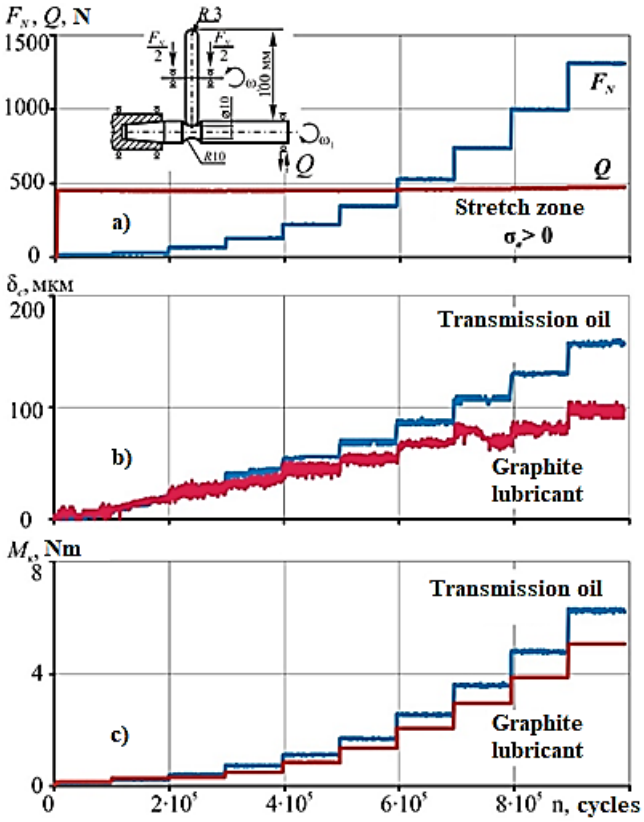

Figure 1. Investigation of lubricants at CMU, with the organization of friction in the tensile zone of the bent shaft: test program (a); change in the approach of the axes (b) and change in the moment of friction (c) during the experiment

The analysis showed that when considering the effect of the two lubricants used on the change in the friction and wear characteristics of the tribo-fatigue system under study, the best values for the convergence of the axes (values less than ~ 40%) and rolling friction moment (values less than ~ 35%) are achieved when using graphite lubricant .

Figure 2 shows the dependences of the approach of the axes and the coefficient of rolling resistance on the value of the contact load for the studied tribo-fatigue system under the influence of selected lubricants.

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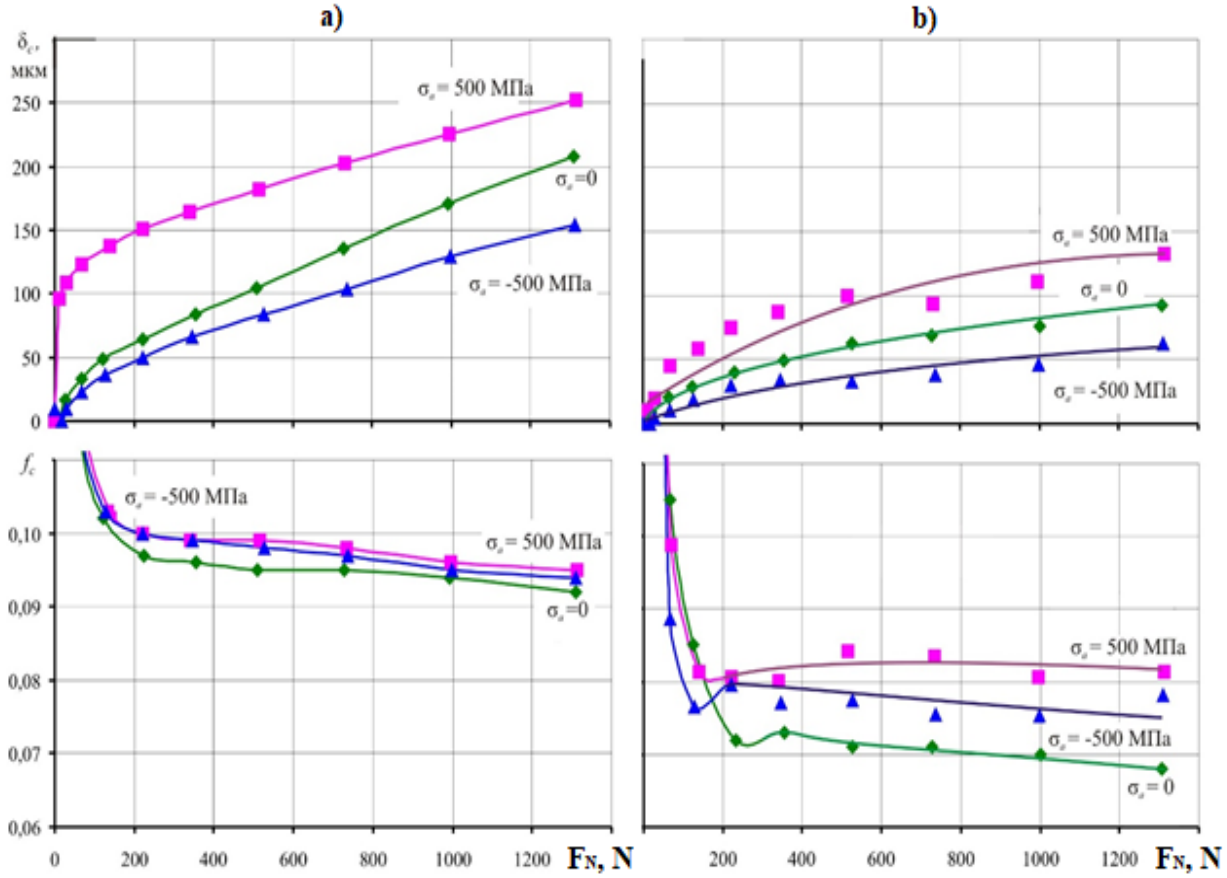

Figure 2. Dependences of the convergence of the axes and the coefficient of rolling resistance on the value contact load when using gear oil (a) and graphite grease (b)

In this case, tests were carried out on the CMU in the tension zone or in the compression zone of the bent shaft and for rolling friction (there was no bending load). The analysis showed that when lubricating with gear oil, the effect of cyclic stresses has the following feature. Under the action of compressive cyclic stresses, the value of the convergence of the axes decreases by ~ 27% compared to the rolling friction test (σ_a = 0); under the action of tensile cyclic stresses, the convergence of the axes increases by ~ 23% compared to the rolling friction test (σ_a = 0) (Figure 2, a). The value of the rolling resistance coefficient, for all three types of tests, is reduced. At the same time, its value in tribo-fatigue systems is higher than the similar coefficient of rolling resistance in a friction pair.

In particular, at F_N = 1000 N in a tribo-fatigue system σ_a = 500 MPa, the rolling resistance coefficient f_c = 0,096; at σ_a = –500 MPa – f_c = 0,095; and for a friction pair at σ_a = 0 - f_c = 0,094 (Figure 2, a). With graphite lubrication, the same patterns are observed for the dependences of the magnitude of the approach of the axes and the coefficient of rolling resistance on the contact load (Figure 2, b), which were presented in Figure 2, a. In this case, the value of the convergence of the axes decreases by 2 times compared with tests with gear oil lubrication, and the value of the rolling resistance coefficient decreases by approximately 1.5 times (Figure 2, b). This is due to the better properties of this graphite grease, which have a positive effect on changing the friction and wear characteristics of the tested tribo-fatigue system.

From the foregoing, we can conclude that, depending on the type of lubricant (consistency, viscosity, temperature range of operation), the type of friction unit, as well as the magnitude and direction of the action of cyclic stresses in tribo-fatigue systems, the values of wear and friction characteristics can significantly increase , and decrease. This confirms the idea that their rational selection will increase the durability and reliability of various machine and equipment components.

3. Influence of the lubrication method on the change in friction characteristics

The problem of lubrication is complex and includes issues of lubricants and structural materials, as well as lubrication equipment designed to deliver lubricant to surfaces in the required amount and at the required time [7].

The influence of the lubrication method on the contact endurance of surfaces can be considered in two ways. First, the method of lubrication affects the amount of lubricant that comes into contact. Secondly, it depends on the lubrication method whether the lubricant is in the contact zone in the form of a continuous liquid (or, perhaps, even hardened under high pressure) mass, or whether the lubricant in the contact zone is a highly elastic mixture of oil mist with air. As experience shows, under appropriate conditions, in both cases, a change in the bearing capacity of the contacting surfaces is observed [8].

In the course of the work, the influence of lubrication conditions on the change in friction characteristics was studied. Studies have shown that the lubrication method has a significant impact on the friction and wear characteristics. In particular, under the experimental conditions (Figure 3), an increase in the rolling resistance coefficient up to 4.5 times and beats up to 10 μm were observed in case of violation of the lubrication regime. In this case, the lubricant was a grease (polymer), it was

applied manually in small portions to the counter-sample of the tribo-fatigue system every 2-3 minutes.

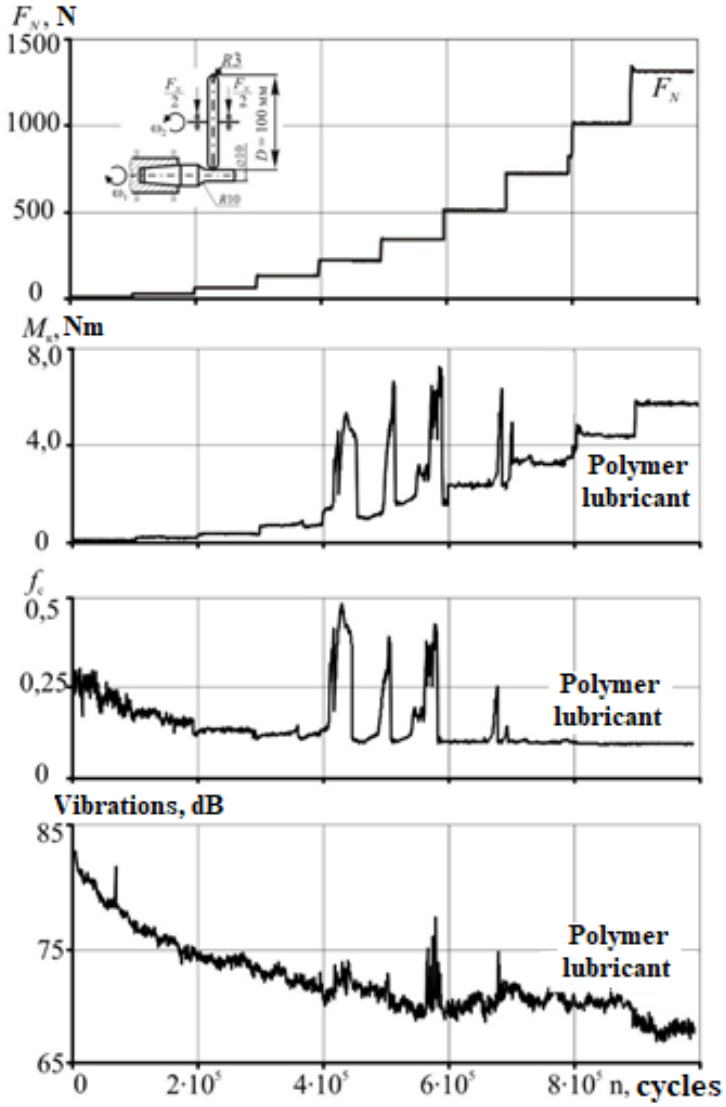

Figure 3. Influence of lubrication conditions on the change in friction characteristics

It can be seen from Figure 3 that large peaks appear at the 5-8th loading stages, characterized by a sharp increase in the numerical value of the friction moment and, accordingly, the value of the rolling resistance coefficient, as well as an increase in vibrations in the same areas. It can be assumed that this is due to the destruction of the boundary layers and the appearance of areas of seizure of the friction surfaces, which leads to the implementation of friction without a lubricant. And in this case, there is a sharp increase in vibrations, the coefficient of rolling resistance and the moment of friction. Therefore, when conducting experiments with grease

lubrication, in order to obtain reliable (more accurate) results, it is necessary to develop automated systems for supplying lubricant to the friction zone.

4. Conclusion

From the results presented in the work, it can be concluded that repeated-variable (cyclic) deformation can significantly correct friction processes in tribo-fatigue systems. Cyclic stresses (from bending) acting in the contact interaction zone can, depending on the loading and lubrication conditions, increase or decrease the force and friction coefficient, as well as damage (convergence of the axes). This suggests that their rational selection will make it possible to regulate the durability and reliability of various units of machines and equipment. In this case, the influence of the method of supplying lubricant to the friction zone should be taken into account.

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