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DEVICE STUDYING THE WEAR PROCESS OF DIFFERENT MATERIALS

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Abstract: Corrosion occurs as a result of friction between moving parts of machines, which leads to the destruction of surfaces. As a result, the dimensions of parts change and the deviation from the required technical and technological indicators increases.

Practice and research studies have shown that friction and excision intervals are the main cause of frictional and excited intersection failure. Special devices for studying wear of surfaces in gears and sliding surfaces of machines have been studied. A simple design of a device that studies wear under laboratory conditions is proposed.

Keywords: gear wheel, wear, friction, oil, plastic, steel, cast iron, machinery, machine tool, kinematics, devices, gears.

Introduction. Ensuring the reliable and long-term operation of machines is the main task of mechanical engineering. Practical and scientific research studies show that the main reason for the failure of the moving parts and working bodies is their wear. Therefore, it is necessary to take into account factors affecting wear during the design and operation of machines. Currently, it cannot be said that engineers and designers take it into account all the time. As a result, companies are forced to spend a lot of money. Because they are obliged to build repair enterprises, produce spare parts, train and employ repair specialists [1].

Methods. Friction and wear can be considered as deformation of solids. There are two main processes in external friction: the first is the formation of points of contact due to the mutual penetration of bumps, and the second is the occurrence of a phenomenon of "welding" under the influence of high pressure in the clear contact track. The total pressure in the friction pairs is large even with a small load due to the small contact footprint. Due to the fact that the particles are located at different levels under the influence of a large load, they come into contact one after the other. Therefore, the real contact area will be due to the increase in its traces and sizes.

It is known from the scientific-research works carried out so far that the real pressure is very large on well-treated and rough surfaces. This pressure eats away peaks and decreases with increasing radius.

One of the main reasons is the nature of the deterioration of the adhesive bond during friction and eating. Disruption occurs either at the point where the bond is formed (adhesive discontinuity, positive gradient) or slightly deeper (cohesive discontinuity, negative gradient).

Results. According to the above, the shear resistance gradient law was developed. The magnitude and direction of the gradient is affected by changes in the surface layer. Pressure build-up on the unit contact trace causes the unit bump to flatten or enter.

Flattening, in turn, creates an irreversible shape of the bumps in contact and cannot provide a stationary mode of friction. The penetration process is not only characteristic of objects in contact with different hardness and modulus of elasticity, but also occurs in objects of the same hardness. In this case, if the shape of the touching irregularities of the objects in contact (radius of curvature, angle of curvature) is different, there will be a process of penetration. Figure 1 shows the relationship between the γ angle and the condition of the determined edges of the contact with the coefficient of the geometric shape of the bump.

As can be seen from the graph, the corresponding effective stress at the transition to the plastic state is characterized by the angle γ.

It is good to distinguish three types of mechanical interaction on a deformable counterbody: elastic contact, plastic contact, and microshear.

In single contact, stress and deformation on a unit surface (modeled on a spherical bump) are determined by the Hertz formula. When a spherical bump is immersed in a half-space material, the material is initially elastically deformed, and when it is immersed deeper, the deformation turns into plastic deformation.

From the analysis of the stressed state of an elastic half-space body loaded under the influence of normal and tensile forces, it is known that the given tensile stress is equal to:

$$\sigma_{Ku} = \kappa \cdot f \cdot p_r = \kappa\tau,$$

where k is the strength hypothesis, depends on Poisson's ratio and varies mainly from 3 (for medium elastic material) to 5 (for brittle material).

Despite the general load, a high specific pressure is formed in the actual contact track, reaching 1/5-1/10 of the theoretical strength of the material.

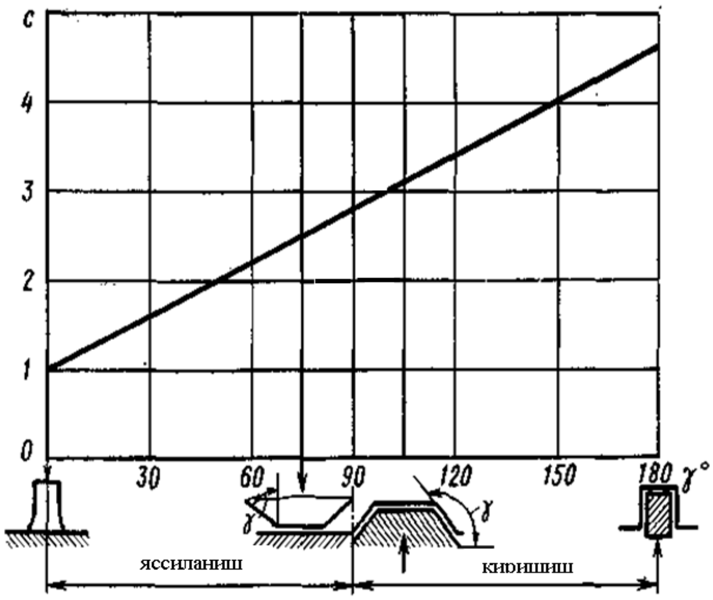

Figure 1. In contact with the coefficient of the geometric shape of the bump, the condition of its edges determined by the angle γ connection graph between

As the load increases, the real pressure on the bumps in contact increases imperceptibly. ~1/25 degrees of loading along the length of a flat surface, ~1/5 degrees for surfaces with a curved contour. A solid bump is a periodically significant pressure gradient on the surfaces of the body, as individual bumps are periodically loaded when interacting with the contour of the body.

The effect of high specific pressure and temperature together with the environment on the material significantly changes the geometric, physical and mechanical properties of the surface layer of the rubbing body. Even small changes in properties have a significant effect on corrosion, so degradation occurs as a result of multiple exposures.

All changes can be divided into three classes:

I - refers to the geometric configuration of the surface;

II - refers to the structure of the upper layer of the solid body, it affects the mechanical structure of friction;

III - refers to the film formed on the surface, it affects the molecular structure of friction.

Each of these classes can be divided into the following groups:

1. From changes in contact geometry: surface roughness; wave; presence of geometric classification of intermediate particles (abrasive, erosion particles) in contact.

2. From a change in the structure of a solid: a) point, line, surface, volume defects due to the increase of defects in the crystal structure; b) from a change in the composition of the metal: turning into a crystal lattice; formation and mixing of carbides; diffusion of one body to another; phase change; recrystallization.

3. Formation of a film on the friction surface: adsorption from the environment (gas, oil); chemisorption curtain and chemical barrier curtains in the environment (oxides, sulfides, chlorides); a curtain formed by the material that has passed to the surface of the contra body.

Along with sliding, the roughness of the surface changes and tends to a stable value. Initially rough surfaces are smoothed, and initially smooth surfaces become rough. The same materials are processed in the same conditions, and their surface roughness is unified within a few hours.

A veil appears when liquid or gaseous phases are introduced from the outside. The mechanism of oil transfer applied to the liquid phase to the edible surface is not well defined. It can be diffusive, or it can be absorbed, etc.; the smoother the surface, that is, the longer the contact trace, the longer it will take to soak this contact trace.

Corrosion of rubbing surfaces occurs mainly as a result of particles released from materials. Their size can be from a fraction of a micrometer to several micrometers. The release of such particles is caused by loading on single unevenness, multiple exposure to temperature pulses. As a result of irreversible changes on the surface, its structure changes, stress occurs, and then cracks appear, from which corrosion particles are released [2, 3, 4, 5].

Decay is classified as decay is important and under different conditions. For example: oiled and non-oiled, rolling or sliding friction; friction of separated solids with polishing powder; adhesion, corrosion, shearing friction; oxidation; heat friction, etc.

In the case of elastic contact of the contact irregularities, there is minimal wear. The geometrical configuration of irregularities changes until it goes to the plane of elastic deformation. Every friction system can be analyzed as tending to elastic contact in the friction zone. In this case, the main role of elastic contact in wear under friction conditions can be considered as the process of friction fatigue.

The change of the structure between the plastic deformation and the number of steps, the periodic character and the type of analytical connection to the decay testify to the fact that the nature of the decay of metal surfaces from low-level fatigue in frictional impact is confirmed.

We considered that the reason for the formation of particles from corrosion is the separation of some surfaces from the main material as a result of multifaceted impact. Some scientists, from a different point of view, say two stages of the formation of corrosion particles: in the first stage - a multifaceted adhesion process that transfers the material from one surface to another, in which the passing layer increases each time; in the second stage - when this layer reaches a critical point, it is massaged and turns into a particle of food.

Regardless of the mechanism of corrosion, there must be a "weak point" that leads to corrosion. In addition to the formation of a loose layer inside the material, it is necessary to form a protective film and break it as a result of the impact of the solid body with the environment. At first, the protective film ensures the strength of the material, then as its thickness increases, its strength decreases and it separates under the influence of friction.

Discussion. There are many rubbing parts in textile machines and looms. The most common of them are gears and sliding parts. Different factors affect their eating. It is known from the scientific and research work carried out so far that the real pressure is very large on surfaces that are not well processed and have poor surface roughness. This pressure eats away peaks and decreases with increasing radius. The effect of high specific pressure and temperature on the material together with the surrounding environment significantly changes the geometric, physical and mechanical properties of the surface layer of the rubbing body. Even a small change in properties has a significant effect on eating [6].

Corrosion of rubbing surfaces occurs mainly as a result of particles released from materials. Their size can be several micrometers. The separation of such particles is caused by loading on individual irregularities, multiple exposure to temperature pulses. As a result of irreversible changes in the surface, its structure changes, a state of tension occurs, then cracks appear, from which corrosion particles are released. As a result, the size of the details will change, and in turn, the movement they transmit will also change. The error resulting from wear in machines and mechanisms is transferred to the manufactured product. Therefore, it is necessary to study gear wear in machine tools.

Currently, it is difficult to carry out research for a long time in production conditions due to some technical and economic reasons. Therefore, the scheme of the experimental stand was developed for researching gear wheels and sliding parts in a mode close to production conditions. Its structure is as follows (Fig. 2): the 9th and 10th axes are mounted on the 1st base on the basis of sliding bearings. 7- and 8-toothed wheels are installed on the console part. The distance A between the axes can be adjusted if the 10th axis is made to move.

Rotational motion to the gear wheels is provided by the 2nd electric motor through the 5th belt transmission. The required speed can be adjusted using pulleys 4 and 6. The 10th axis acts as a working body for us. Therefore, it is necessary to put the necessary loading on it, for this we use the loading device. The loading device is configured as follows: roller 14 is mounted on bracket 13, which is movably mounted on cup 12. The 12th cup is attached to the 1st base. The load is given by the spring 15, which is taxed. To do this, slide the plate 23 through the bolt 16 and compress the spring 15 to the required distance.

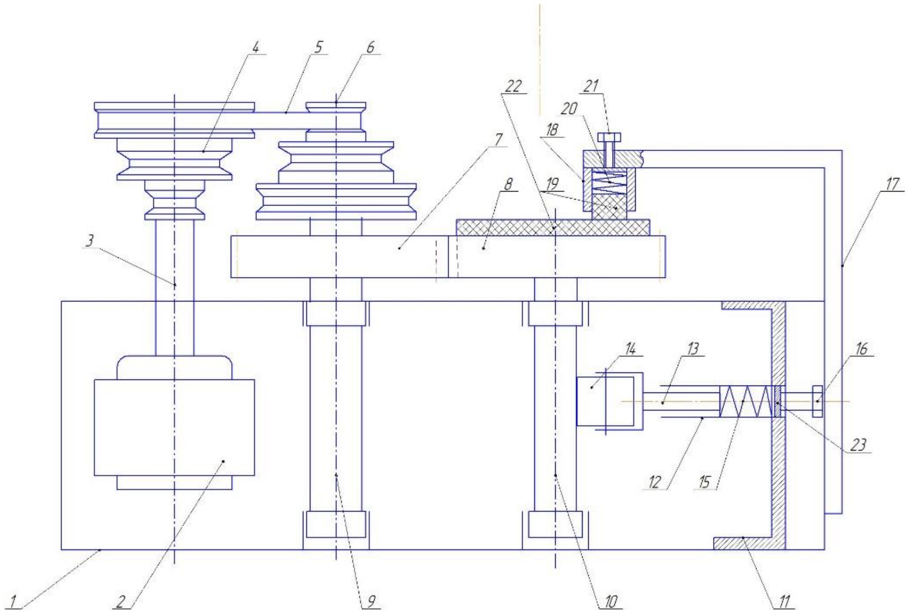

Figure 2. Scheme of the device that studies eating

To study the wear of sliding details, a bracket 17 (Fig. 8) is installed on the base of the device, and a cup 18 is attached to it for placing the sample details. The spring 20 is installed on the glass, and then the sample part 19 is installed. The load is adjusted using the 21-bolt installed on the back of the 18-glass. The second sample 22 of the sliding detail is installed on the upper part of the 8th wheel.

This device allows you to carry out research by changing gear wheels in different modes: speed, load, lubrication.

As known from tribotechnics, loading can have different effects on the wear of surfaces with the same hardness. The spindle mechanism in machine tools works under different loads applied by the cutting tool during the mechanical processing of the part.

Spindle gear wear under these conditions may not have been sufficiently investigated. Therefore, a stand is prepared according to the given scheme (Fig. 3), and wear of the gear and sliding parts under variable loading is studied on the stand.

For this, prepared gear or sliding parts are taken. In order to create a friction pair with constant uniform teeth, the number of teeth of the gear wheels was uniformly 66. In order to take into account the effect of the distance between the axles of the gear wheels on the wear, the teeth on the opposite sides of the driven gear wheel are selected and marked "1", "11".

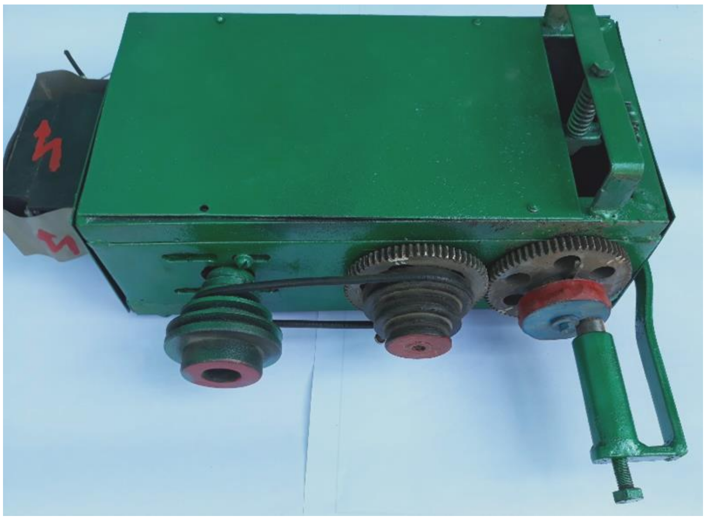

Figure 3. Gear wear study stand

To carry out the study, the load was applied to the drive shaft through rollers (to give the load given by the cutting tool) and the modes were selected as follows: load R = 0; 50; 100 N, the number of maximum revolutions of the spindle n = 1474 rpm. Tooth decay was measured using a micrometer microscope with a magnification of 24 times. The distance between the dividing lines in the microscope is 0.05 mm.

Research work was repeated dry and lubricated. The study was started by applying a load of 100 N. Because if the amount of wear in this loading and the amount of wear in the rest of the loads does not differ significantly, then it follows that the teeth do not have an effect of loading on the wear or vice versa. As the loaded drive wheel rotates counterclockwise in the transmission, the left surfaces of the marked teeth come into contact. Therefore, the wear of these surfaces on the teeth is measured by the diameter of the tooth.

For the study of rubbing surfaces, samples of research materials are prepared according to the diameter of the 18th cup. The 8th wheel is prepared and installed in the form of a disc from this sample of material. To carry out the study, loading and other modes are selected as discussed above, and verification can be carried out. For this, the 15th and 20th springs will be calibrated and the necessary loading will be given. When selecting the speed, the position of the 5th belt pulleys is changed.

In production, it takes a lot of time and money to study the machine tools in the required modes for researching the details that are processed. The results obtained using this device will be close to those in production. Therefore, it will be possible to use it.

As known from tribotechnics, loading can have different effects on the wear of surfaces with the same hardness. The spindle mechanism in machine tools works under various loads given by the cutting tool during the mechanical processing of the detail, or the load given by the working bodies in textile machines is given to the gear train through the shafts. Spindle gear wear under these conditions may not have been sufficiently investigated. Therefore, the wear of the gear under variable loading was studied on the prepared stand (Fig. 9).

For this, a prepared gear made of 40X steel was taken. In order to create a friction pair with the same teeth, the number of teeth of the gear wheels was taken from 66. In order to take into account, the effect of the distance error between the ages of the gear wheels on the wear, the teeth on the opposite sides of the driven gear wheel were selected and marked 1, 11.

To carry out the study, the load was applied to the drive shaft through rollers (to give the load given by the cutting tool) and the modes were selected as follows: load R = 0; 50; 100 N, the number of spindle revolutions n = 1474 rpm. Tooth decay was measured using a micrometer microscope with a magnification of 24 times. The distance between the dividing lines in the microscope is 0.05 mm. Research work was carried out in the prescribed mode for 7 hours. Before the start of the study and after every 7 hours, the teeth were measured with a micrometer microscope. The study was started by applying a load of 100 N. Because if the amount of wear in this loading and the amount of wear in the rest of the loads does not differ significantly, then it follows that the teeth do not have an effect of loading on the wear or vice versa.

Conclusion. As the loaded drive wheel rotates counterclockwise in the transmission, the left surfaces of the marked teeth come into contact. Therefore, the wear of these surfaces on the teeth was measured by the diameter of the tooth and the results obtained were as follows.

Table 1. The amount of gear wear, in mm

Tooth mark			Dry	
	Initial size	100 N	50 N	No download
1	2.25	2.20	2.18	2.17
11	2.35	2.30	2.27	2.26
			Oiled	
1	2.17	2.17	2.17	2.17
11	2.26	2.26	2.26	2.26

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