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METHODS FOR DETERMINING THE AMOUNT OF EATABILITY IN TESTING MACHINE PARTS

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Annotation. *In article, on base of the called on studies is offered methods of the calculation to length wear-out test toothed issues under active and passive participation of the abrasive particles. The Got results of the studies allow on stage of the designing unit tractor and agricultural machines, solve the problems, connected with determination of length износного test toothed issues. Explored for different conditions change to velocities of the wear-out under active participation of the abrasive particles.*

Key words: *abrasive wear, gear transmission, micrometers, shaft.*

INTRODUCTION

Methods for determining the amount of wear by micrometers, mass and the amount of iron in the oil. Currently, the micrometer method is most often used to determine the wear of machine parts. It is based on measuring the exact dimensions of the part before and after the wear test with a micrometer or indicator measuring instrument. The difference in the linear dimensions of the part provides information about the amount of its linear wear, but wear can be detected in different places on the friction surface. However, the determination of wear by the micrometer method is associated with a significant degree of error in all cases.

Micrometer measurements can be performed not only with devices that have a mechanical contact, but also with other devices that provide the same result. For example, contactless devices with inductive or wire contact sensors and pneumatic sensors, which have higher sensitivity than devices with mechanical indicators, can be cited.

In most modern machine assemblies, the permissible clearances are within a very small range, from a few microns to a few tens of microns. These figures give an idea of the permissible wear amounts and the accuracy of wear measurement, as well as the requirements for determining it. The determination of the permissible wear amount is carried out in the same way, the required accuracy can be from a few fractions of a micron to several microns, depending on the measurement objectives.

The improvement of the micrometer consists in determining the wear of the part by using special devices from the wall of the part, which is a constant base for determining wear, in relation to the non-wearing part of the part. When determining the wear of the part hole using this device, instead of the diameter, the amount of radial wear is determined in the usual micrometer method. The device consists of one or two disks, at the end of which a scale indicator is attached to the hole being measured. The scale is marked with dividing lines, which allow you to determine its position relative to one of the disks, and there is also a disk divided into sections, with the help of which the angle of rotation of the disk is determined.

With this device, pre-determined points are marked on the surface (marked with a scale and divisions on a disk), and their position is determined by the indicator. The difference between the indicators determined after the test and the subsequent position of the parts indicates wear.

If during the test not only the wear of the cylinder, but also its deformation occurs, then using the presented device, not the amount of radial wear of the wall, but the value of the radial displacement, which takes into account its wear and deformation, is determined. This method also has the same drawback as the micrometer. In addition, due to the presence of a sliding assembly consisting of the centering washers and scales of the bending device fixed to the measured part and the uncertainty in them when processing the parts, the results obtained for determining the wear cannot be considered sufficiently accurate.

One of the methods used to determine the wear of parts with a small mass is the method of determining the mass of the parts before and after the test [3]. The largest mass of the part to be determined on analytical scales should not exceed 200 g. The sensitivity of VLA-200 scales with an optical device is 0.1 mg, the maximum load on technical scales of the 2nd class is 5 kg, the uncertainty at the maximum load is ±0.5 g, the maximum permissible load on sample scales of the 3rd class is 50 kg, the sensitivity is 0.5 - 2.5 g, depending on the amount of load.

Linear wear associated with mass loss is determined by calculation, in which the wear is assumed to be evenly distributed over the friction surfaces, but in practice, depending on the operating conditions of the part, the distribution of linear wear may vary according to a different law. If there are several friction surfaces on the part, the laws of wear distribution between them must be known. To calculate the average linear wear, it is necessary to know the dimensions of the surface on which wear occurs and the density of the part material. For example, when determining the wear of a piston ring by mass, it is necessary to know the distribution of linear wear between the three wear surfaces (working cylindrical and two edge) surfaces. It is known that the wear of the working cylindrical surface is unevenly distributed. Therefore, in some cases, the calculation of linear wear is abandoned, and when testing a part (piston ring), wear by mass is included in its operating characteristics. This method is used to test the effect of fuel or oil on the wear of parts of the piston group. If the change in part size during erosion occurs not only due to particle separation, but also due to plastic deformation, the mass method is generally unsuitable.

Disassembly of the machine consists in determining the dimensions of the parts subject to wear using the micrometer method. In most cases, disassembly is not recommended, since after each disassembly and assembly, the relative position of the parts changes slightly, which requires additional adjustment of the friction surfaces. In such cases, the integral wear assessment method is effectively used. In this case, the aggregate oil is enriched with wear products.

The products of wear of parts are small metal particles, which are formed from metal oxides, substances formed by the chemical reaction of metals, most of which are suspended in oil and move together with the oil. A sample of the oil is taken, it is burned in an electric arc, and the metal composition is determined from its ash using spectral analysis.

The method is used to assess the wear of parts of the cylinder-piston group of tractor engines, determined by the change in the iron content in the oil, and to study the effect of lubricating materials on the wear of engine parts, especially their adaptation process. In particular, a graph is constructed in the iron coordinate in the unit of wear - the engine operating time - according to the amount of iron in the oil. In this case, a wear line is formed, and the wear rate at different times of the test can be determined.

The method of evaluating the digestibility of oil by enriching it with iron is also used to test samples for digestibility in laboratory conditions.

The method of determining the amount of metal in oil by “identified atoms” or radioactive isotopes belongs to this group. In this case, the amount of metal in oil is determined by chemical analysis based on the radiation intensity of a radioactive element entering the oil with corrosion products. A radioactive isotope of an element included in the alloy is introduced into the composition of the part during its manufacture. Another method of using radioactivity is based on inducing radioactivity in the part material as a result of special treatment of the part material in an atomic furnace. The method of chemical analysis of radioactive tracers in oil has a higher level of sensitivity than other methods of determining corrosion by the amount of metal in oil and allows for continuous assessment of the amount of radioactive elements in the flowing oil.

Determining the amount of wear using a profilograph. From the above, the errors in determining the amount of wear using the micrometer method can be eliminated by choosing a constant base, in which the distance to the worn surface is measured.

The profilograph was used to determine the initial wear, that is, the wear that occurs at the initial micro-roughness height limit of the surface. This method consists of the following. A profilogram is recorded from the microsurface of a surface from different stages of testing. The profilograms reproduce the irregularities of the same contour of the micro-roughnesses, in which the edges of the micro-roughnesses change their shape as a result of wear and the total height of the irregularities decreases. By determining this decrease from the deposition line, it is possible to determine the initial wear that occurs at the height limit of the irregularities.

On the surface of the object to be tested in the form of a shaft (sample), a recess is made using a diamond pyramid of the Vickers instrument. The sample is placed on a prism, then the pyramid is moved so that the recess formed in it falls into the center of the microscope's observation field, the microscope and prism must be mounted on the same plate. Then, a profilograph needle is passed through the surface of the shaft and a profilogram is recorded. The relative position of the prism, microscope and profilograph must remain unchanged. After the sample has been tested for a certain period of time, the sample must be re-mounted on the prism so that the recess formed again falls into the microscope's observation field. Only then can one be sure that the initial surface contour of the profilograph was made in the same section and on the same section where the first profilogram was made. The wear of the working surface of the gear tooth can be determined in the above-described way using a special device for recording the tooth profile. In this case, the unworn head or foot of the tooth profile can be used as a base. By superimposing unworn sections obtained at different test times, it is possible to determine the patterns of wear distribution in the transverse profile of the tooth surface. When determining the wear of a surface with a constant base using a profilograph, a profilograph can be used to measure cases where the wear exceeds the initial roughness values. The profilograph records the actual values of the surface profile.

To determine the linear wear rate up to the constant base wear surface, a groove can be artificially formed in the friction surface itself, the bottom of which is located deeper than the friction surface where the wear is determined. The condition for using this method is that the groove should be in the service profile of the surface. For this purpose, grooves formed on the surface can be made in various ways. The position of the formed groove is not significantly important. What is important is that subsequent profilograms are also recorded from the previous microsection of the friction surface. For this, a scratch is made on the steel surface to be tested and the resulting profilogram is made transverse to this scratch. After a certain period of wear testing, another profilogram is taken from approximately the same section of the friction surface. The superposition of profilograms should be done in such a way that the base contours of different profilograms overlap at the bottom of the scratch, which allows the determination of the amount of linear wear.

In all the methods considered, the determination of wear using a profilograph requires recording the profile of the surface where the friction occurred, which shows how the wear is distributed over a relatively small surface. The disadvantages of these methods include the complexity of the profilography process, and the limitation of its application depending on the shape, size, and location of the surface on which the wear is determined.

In some special cases, devices consisting of a double microscope are used to determine the size of surface irregularities of small-sized parts, which are called Linnik microinterferometers. In this case, a constant base is also required to determine the amount of wear. The Linnik micro interferometer is used to determine very small amounts of wear, in particular, to measure the wear of measuring instruments and their parts.

Determination of the amount of local wear. Testing the wear resistance with the passive participation of abrasive particles was carried out to determine the wear rate of the samples depending on the contact load and the degree of slip. Similar tests were carried out in an oil medium with an active abrasive particle content of 1.3% and a fractional composition of dyer=0.000012 m. The tests corresponded to gear transmissions with a friction modulus of 0.01m and a gear ratio of i=2. During the test, the contact load and the degree of slip between the samples were changed stepwise: contact loads from 720 MPa to 1140 MPa; slip – from 0 to 0.6. After the test, the linear wear rate of the samples was calculated according to the following formula:

$$\gamma = \frac{Q}{2\pi R b t \gamma}, \text{ m/s.}$$

Here, Q is the mass of the sample during the test is equal to t (kg); R is the radius of curvature at which the sample wear rate is determined, m; v is the contact width of the tested samples.

Table 1.1

Friction machine MI-1M for testing gear wheel materials for wear and the main geometric and kinematic parameters of the samples.

Gear pair number	Number of gear teeth	Sample diameter, mm	Angular velocity of the sample in rpm	Slip rate

	leader	leading	slip	above	on the surface	above	
1	64	71	40	40	7,3	7,7	0,055
2	78	57	45	35	7,3	11,7	0,132
2	78	57	40	40	7,3	11,7	0,603
3	84	51	40	40	7,3	13,8	0,880
4	94	41	45	35	7,3	19,5	0,356
4	94	41	40	40	7,3	19,5	1,616

The pattern of changes in the wear rate with the active participation of abrasive particles was also determined for the following conditions: when the fractional composition of abrasive particles is dsp = 0.000012 m, their concentration is gradually increased from zero to 1.4% with 0.2% intervals; when the concentration of abrasive particles is 1.3%, the fractional composition of particles is gradually increased from 0.000004 m to 0.000028 m with 0.000004 m intervals.

CONCLUSION

To determine the pattern of wear rate of gear materials depending on the modulus of adhesion, the modulus value was gradually increased from m=0.001 m to m=0.025 m with intervals of m=0.005 m. In this case, the gear ratio of the engagement was taken equal to i=2.0. To evaluate the wear rate depending on the gear ratio of the engagement, the ratio value was changed from 1.0 to 4.0 with intervals of i=0.5, while the modulus of adhesion was kept constant (m=0.01 m). These tests were performed with the active and passive participation of abrasive particles.

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