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Calculation Of Resources of Parts of The Type Shaft of Agricultural Equipment

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Annotation. This article provides the calculation of resources of parts of the type shaft of agricultural equipment, drawings and basic work.

Key words: wear, resource, shaft, bushing, wear rate, pressure, friction rate, hardness, hard alloys.

Introduction

Many modern agricultural techniques are used to grow a wide variety of agricultural crops around the world. Using existing techniques, one-third of the energy produced worldwide is used to overcome friction, and a quarter of the annual metal produced is used to recover the part lost as a result of wear and tear on machine parts and components. The main direction of reducing these costs is to increase the wear resistance of friction parts and joints. That is why research is being conducted around the world to increase the abrasion resistance of friction parts.

It is known that the wear resistance of the friction pair parts depends on the friction speed, the pressure force applied to it, the material composition, structure, physical and mechanical properties of the friction surface of the parts, and so on.

Based on the above, the following is an account of some of the parameters associated with wear, which leads to an increase in the resource of the friction pair of roller parts.

In determining the resource of a workpiece under friction conditions, the law of variation of the amount of wear over time is usually used. It is known that based on the three-stage process of machine parts wear, the amount and speed of wear of parts is determined as follows.

$$i = kt = \gamma \cdot t, \qquad (1)$$

The amount of erosion, taking into account the amount of erosion during the period

$$i = i_{ob} + \gamma \cdot t, \qquad (2)$$

That i_{ob} –the amount of wear during the period; *t*-time.

If we replace the amount of wear in this expression (2) with the allowable amount of wear, we determine the time of wear, y represents the resource of the detail:

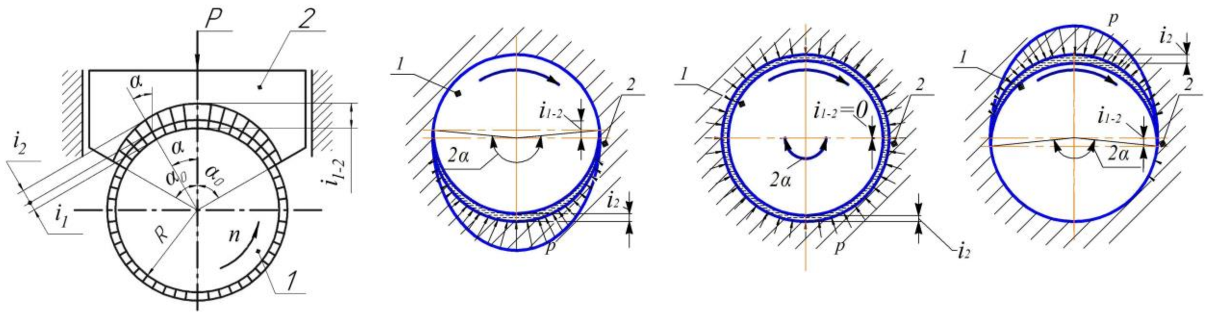
$$T = \frac{i_{ruh} - i_{ob}}{\gamma}, \qquad (3)$$

In here T– detail resources.
By identifying the constituents of this expression, it will be possible to determine the resource of the friction pair details. The erosion rate in the expression is determined as follows:

$$\gamma = kP^m v^n, \qquad (4)$$

where m and n are exponents, *m = 0,5-3,0* and for many friction pairs *n = 1*; *k* – a coefficient that takes into account the material and wear conditions of the friction pair; *P*- compressive strength; *v*- friction speed.

The value of the bending coefficient k is influenced by the type, composition, structure, hardness of the material used in the details of the friction pair, the conditions at the joint surface and, first of all, the degree of lubrication of the surfaces. It is known that most of the friction pair parts in machines are made of steel and cast iron. They are heat treated to increase their wear resistance. This increases the hardness of the friction surfaces and, as a result, increases the abrasion resistance of these parts to a certain extent. To study the effect of compressive force and friction speed on the bending speed, for example, the friction pair between the rotating shaft and the stationary pad was determined $\gamma_1 = k_1 pv$ and $\gamma_2 = k_2 pv$ were identified (Fig 1).



a *b*

Figure 1. Schemes of friction pairs consisting of a shaft-pad (a) and a shaft bushing (b)

As a result, the expression for determining the wear rates of the shaft and the bushing and their combination was obtained:

$$\gamma_1 = 2\pi R k_1 P n; \qquad (5)$$

$$\gamma_2 = 2\pi R k_2 P n; \qquad (6)$$

$$\gamma_{1-2} = \frac{2\pi k_2 P n}{l_o\left(0{,}5\, sin 2\alpha_o + \alpha_o - \frac{k_1 sin\alpha_o}{\pi k_2 + \alpha_o k_1}\right)} \qquad (7)$$

From the formula it can be seen that the shaft is evenly distributed over its entire surface due to the wear rotation.

From these formulas (5), (6), (7) the following can be obtained. Since the joint depends on the materials of the details (k1 and k2), operating mode (P; n), dimensions (lo; ao), and it allows you to choose the values of these parameters.

As the wear of the friction pair parts increases, their kinematic accuracy decreases, the dynamic loads increase, the lubrication quality decreases, and as a result, the efficiency of the mechanism decreases. As a result, the mechanism breaks down or breaks down. In order to prevent such a situation, the allowable amount of wear for each detail of the friction pair is determined. If we take into account the wear of both parts of the friction pair, then the allowable amount of wear is equal to the sum of the allowable wear of both parts of the friction pair:

$$i_{ruh} = [i_1 + i_2] \qquad (8)$$

As can be seen from Figure 2, the wear of the friction pair parts increases with the compressive strength and friction rate applied to it, inversely proportional to the surface hardness and the amount of hard alloys in the surface material, i.e. its wear rate decreases with increasing surface hardness. In this case, the friction pair retains its dimensions of the surface of the parts for such a long time, which increases its resource.

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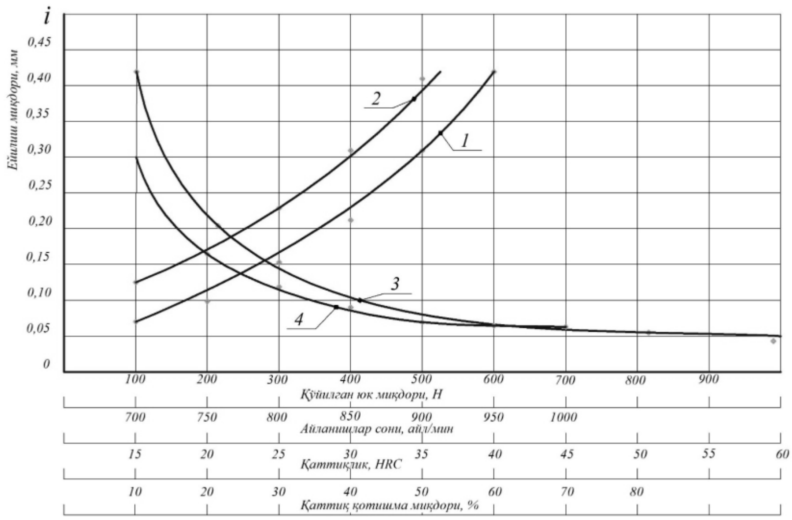

Figure 2. Erosion graph of the friction pair depending on the compressive strength (1), friction velocity (2), surface hardness (3) and the amount of solid alloy in the surface material (4).

Based on the expressions (3), (7), (8) above, we determine the resource of the friction pair and details.

for shaft:

$$T_{val} = \frac{i_{ruh} - i_{ob}}{\gamma_1} = \frac{[i_1] - i_{ob}}{k_1 p v} = \frac{[i_1] - i_{ob}}{2\pi R k_1 p n}, \qquad (9)$$

here $T_{val} = \frac{i_{ruh} - i_{ob}}{\gamma_1}$ – the resource of the friction pair shaft; $i_{ruh} = [i_1]$ - the allowable amount of wear of the shaft in the friction pair; i_{ob} – the amount of wear of the shaft in the friction pair during the period; i_1- the amount of wear of the shaft; k_1- coefficient depending on the material of the shaft; *p*- pressure acting on the friction surface; *n*- the speed of rotation of the shaft relative to the bushing; *R*- the radius of the shaft.

for sleeve:

$$T_{vtulka} = \frac{i_{ruh} - i_{ob}}{\gamma_2} = \frac{[i_2] - i_{ob}}{k_2 p v} = \frac{[i_2] - i_{ob}}{2\pi R k_2 p n}, \qquad (10)$$

In here $T_{vtulka} = \frac{i_{ruh} - i_{ob}}{\gamma_2}$ – the resource of the bushing in the friction pair; $i_{ruh} = [i_2]$- the allowable amount of wear of the bushing in the friction pair; i_{ob} – the amount of wear of the bushing in the friction pair during the period; i_2- the amount of wear of the bushing; k_2- coefficient depending on the material of the bushing; *p*- pressure acting on the friction surface; *n*- the speed of rotation of the shaft relative to the bushing; *R*- the radius of the shaft.

For the friction pair:

$$T = \frac{i_{ruh} - i_{ob}}{\gamma} = \frac{([i_1 + i_2] - i_{ob}) \cdot l_o (0{,}5 \sin 2\alpha_o + \alpha_o - \frac{k_1 \sin\alpha_o}{\pi k_2 + \alpha_o k_1})}{2\pi k_2 P n}, \qquad (11)$$

In here $T = \frac{i_{ruh} - i_{ob}}{\gamma_{1-2}}$ – the resource of the friction pair; $i_{ruh} = [i_1 + i_2]$- the allowable amount of friction of the friction pair; i_{ob} – the total amount of wear of the friction pair during the period ; i_1- the amount of wear of the shaft ; i_2- the amount of wear of the bushing; l_o- the length of the friction surface;

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α_o- friction angle; k_1- and k_2– coefficients depending on the material of the shaft and bushing; *P*- the force acting on the friction pair; *n*- the speed of rotation of the shaft relative to the bushing.

If experimental connections such as those in Fig. 2 are determined for a given friction pair, the required data are obtained from it and 9 for that friction pair; using expressions 10 and 11, it will be possible to identify their resources.

Conclusion

1. The wear rate of the friction pair of parts in machines and mechanisms has a correlation with the law of increasing pressure and friction, the hardness of the surface and the amount of hard alloys in the surface material.

2. It is possible to increase the resource of friction parts by reducing the pressure force acting on the friction pairs of machines and mechanisms and their speed relative to each other, increasing the hardness of the friction surface material of the friction parts and the amount of hard alloys in them.

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