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BASING THE PARAMETERS OF WEAR RESISTANCE IN PROFILE PART OF CAM

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ABSTRACT

In the article, taking into account the increasing wear of the profile, the intensity of wear of the surface of the cam in contact with talc during operation is studied, and the change in this intensity depending on the pressure angle is estimated. The effect of chamber profile wear on the gas distribution mechanism (GDM) and engine operation has been studied. the possibility of a significant improvement in the tribological properties of a cam-pusher pair is analyzed on the basis of a numerical method for formulating the law of motion of the pusher.

Key words: Agriculture, cam, pusher, wear, pressure angle, intensity, normal pressure force, strength.

1. Introduction

Failure of the engine gas distribution mechanism in 43 percent of cases is the result of wear that takes place in the pusher pair. That is why it is important to optimize the resource and smoothness of the cam-push pair of the distribution shaft, the concentration of abrasive particles in the oil, and the coefficient of roughness on the surface of the cam in contact with the pusher. In addition, the results obtained during experimental studies can be used only in friction pairs whose geometric and kinematic indicators are known. Therefore, as a result of modeling the wear of the friction pair made of the sleeve profile and the pusher sleeve with roller analogs, it becomes possible to speed up the testing process on the friction machine.

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2. Materials and research methods

The total rate of friction of the parts that rub against each other is determined by the sum of the rates of the rate of friction that occurs with the participation of abrasive particles in the working environment and the twists and turns of the parts in the joint.

In the grinding process, abrasive particles with larger sizes are involved. Research studies show that if the size of the abrasive particles that have not undergone the grinding process is equal to the size of the abrasive particles that have been ground, then the grinding of the particles with this size will practically stop, because the particles with this size cannot participate in the grinding process due to the fact that they are not in contact with the friction pair.

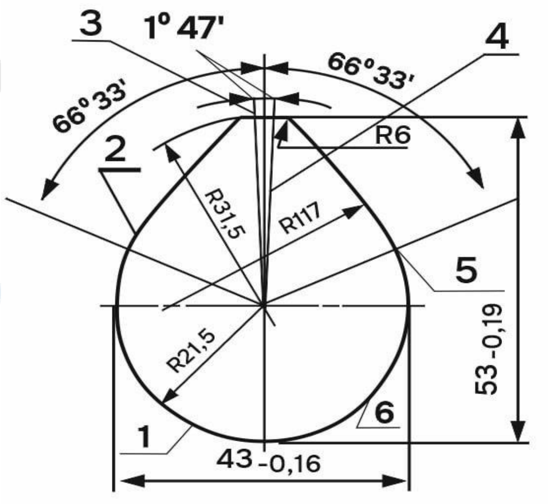

Fig.1. Scheme of placement of the characteristics parts of the cam

In cases 1 and 6, the cam profile has a constant radius of curvature, the center of which corresponds to the center of rotation of the bushing, in which the friction pair consisting of the bushing and the pusher sleeve receives a constant, minimum load, therefore, the bending of this part of the bushing profile is the same as that of the rest of the bushing profile. will have the smallest value relative to the parts.[4]

Cases 2 and 5 of the cup profile are characterized by constant radii of curvature, the center of which is located outside the center of rotation of the cup. In this case, due to the vertical deformation of the valve spring, a variable load is applied to each connection point of the sleeve profile.

3. Research results and discussion

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The probability that an abrasive particle settles on the friction surfaces is determined by the movement path of the abrasive particles that entered the slot-like gap of the friction surfaces:

the sliding path of the input cam,

$$S_k = \frac{s \cdot H_i}{H_i + H_o}; \qquad (1)$$

the sliding path of the output cam,

$$S_o = \frac{s \cdot H_o}{H_i + H_o};$$

where s – is the total sliding path, which occurs due to the difference between the lengths of the profiles of the input and output cams; ; H_i, H_o- the hardness of the input and output cam materials, respectively.

During the operation of the friction pair consisting of the input (output) cam and the pusher sleeve, the abrasive particles located in its pin-shaped groove are crushed until they touch the friction surfaces, in this case, the depth of immersion of the abrasive particles located in this slot into the sleeve surface before being crushed, the thickness of the oil film involved in the friction process taken into account can be determined from the following expression:

$$h_{i,o} = \frac{(d_a - h_o) \cdot \sigma_a}{4H_{i,o}}, \quad \text{m} \qquad (2)$$

In this d_a- the average size of the abrasive particle in the oil; h_o- the thickness of the oil film that exists between the cam and the bearing sleeve during friction; σ_a- compressive strength of the abrasive particle; $H_{i,o}$- the hardness of the material of input (output) cams[11].

The following expression was proposed to calculate the thickness of the oil film between the input (output) cam and the abrasive particle [8];

$$h_м = \frac{4,6 \cdot \mu_0 \cdot e^{a \cdot p} \cdot \rho_{к,ч} \cdot \left(v_{к,ч} + v_a\right)}{d_{\max} \cdot c \cdot \theta \cdot \sigma_{Тк,ч}}, \text{ m.} \qquad (3)$$

Where, μ_0 – the dynamic viscosity of the lubricating material involved in the friction process; a – Pezo coefficient of oil viscosity; p – oil pressure in the friction

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pair; d_{max} – is the largest size of an abrasive particle in oil; $\sigma_{T\kappa,\text{ч}}$ – the yield point of the material of the input (output)cam.

k_v=1.0003 when there is significant sliding in the friction pair (tooth height coefficient k=1), and k_v =1.103 in the rolling region (k=0), therefore k_v =1 in cases where k=1 is close is recommended.

When calculating the abrasion resistance of the cam profile, it is possible to increase the accuracy of the obtained calculation results by taking into account the recommendations given in solving the problems related to the determination of the geometric parameters of the abrasive particles involved in the abrasion process.

The amount of immersion of an egg-shaped abrasive particle on the surface of the ash can be determined by the following expression [9]:

$$V = \frac{2\pi \cdot k_v \cdot d_a^2 \cdot h_{i(o)}}{12}, \quad mm^3 \qquad (4)$$

Where, k_v- the coefficient that takes into account the degree of penetration of the abrasive particle into the pore-like slot; $h_{i(o)}$- the depth of immersion of the abrasive particle on the surface of the input (output) cam.

In order to calculate the distance between two adjacent abrasive particles, the following is assumed: the abrasive particles in the oil are assumed to be evenly distributed over its entire volume, then the calculation expression will look like this:

$$L_{1L} = L_{1h} = \frac{B}{n_L} = \frac{0{,}72 \cdot d_a \cdot \sqrt{\gamma_a}}{\sqrt{\varepsilon_k \cdot \gamma_o}}, \quad mm \qquad (5)$$

Where, ε_k - the amount of abrasive particles in the oil; γ_a - abrasive particle density; γ_o- oil density[1,2]:

The number of abrasive particles in the pin-shaped gap between the cam and the pusher sleeve before fragmentation:

$$n_s = \frac{S_k}{L_{1L}} \qquad (6)$$

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The number of abrasive particles determined by the lengthwise displacement of the abrasive particles located in the pin-shaped slot between the cam and the pusher sleeve until they are fragmented:

$$n_s = 0{,}5 \cdot n_L \cdot n_s = \frac{0.237 \cdot B \cdot s \cdot \sigma_a \cdot \varepsilon_k \cdot \gamma_m}{H_k \cdot d_a^2 \cdot \gamma_a} \qquad (7)$$

The contact area of the cam profile and the pusher bush corresponding to a single abrasive particle:

$$F_{1a} = \frac{0{,}53 \cdot d_a^2 \cdot \gamma_a}{\varepsilon_k \cdot \gamma_m}, \quad mm^3 \qquad (8)$$

The diameter of the contact spot of the spherical abrasive particle, which has sunk to the limit before grinding into the friction surface of the pusher sleeve of the cam profile[4]:

$$a_p = 2 \cdot \sqrt{d_a \cdot h_k - h_k^2}, \quad mm \qquad (9)$$

At the threshold level, the contact area of a single abrasive particle embedded in the grinding surface of the cam profile and the pusher sleeve is[10]:

$$F_{1a} = a_p \cdot L_{1L} = 0{,}362 \cdot d_a \cdot \sqrt{\gamma_a} \cdot \frac{\sqrt{4\gamma_a H_k \sigma_a - \sigma_a^2}}{H_k \sqrt{\gamma_m \cdot \varepsilon_k}}, \quad mm^2 \qquad (10)$$

Table 3.1

The possibility of re-deformation of the insertion cam

The status of cam profile	The contact width Vk, mm	The amount of abrasive particles in the oil, ε_k				
		0,2	0,3	0,4	0,5	0,6
1	0,508	0,0001232	0,0001848	0,0002464	0,0003080	0,0003696
2	0,709	0,0000883	0,0001325	0,0001766	0,0002207	0,0002650
	0,741	0,0000845	0,0001268	0,0001690	0,0002112	0,0002536
	0,771	0,0000812	0,0001218	0,0001624	0,0002030	0,0002436

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	0,799	0,0000783	0,0001174	0,0001566	0,0001958	0,0002348
	0,825	0,0000759	0,0001139	0,0001518	0,0001898	0,0002278
	0,849	0,0000737	0,0001105	0,0001474	0,0001843	0,0002210
	0,872	0,0000718	0,0001077	0,0001436	0,0001795	0,0002154
	0,894	0,0000700	0,0001050	0,0001400	0,0001750	0,0002100
	0,915	0,0000684	0,0001026	0,0001368	0,0001710	0,0002052
3	0,764	0,0000819	0,0001229	0,0001638	0,0002048	0,0002458
4	0,764	0,0000819	0,0001229	0,0001638	0,0002048	0,0002458
5	0,915	0,0000684	0,0001026	0,0001368	0,0001710	0,0002052
	0,894	0,0000700	0,0001050	0,0001400	0,0001750	0,0002100
	0,872	0,0000718	0,0001077	0,0001436	0,0001795	0,0002154
	0,849	0,0000737	0,0001105	0,0001474	0,0001843	0,0002210
	0,825	0,0000759	0,0001139	0,0001518	0,0001898	0,0002278
	0,799	0,0000783	0,0001174	0,0001566	0,0001958	0,0002354
	0,771	0,0000812	0,0001218	0,0001624	0,0002030	0,0002436
	0,741	0,0000845	0,0001268	0,0001690	0,0002112	0,0002536
	0,709	0,0000883	0,0001325	0,0001766	0,0002207	0,0002650
6	0,508	0,0001232	0,0001848	0,0002464	0,0003080	0,0003696

The probability of re-deformation shown in table 3.1 is calculated using the following preliminary data: $d_a = 15 \cdot 10^{-3}$ mm; $\gamma_a = 1{,}9\ \mathrm{gm/sm^3}$; The results of $\gamma_a = 0{,}910\ \mathrm{gm/sm^3}$ show that with an increase in the amount of active abrasive particles involved in the friction process in the oil, the probability of re-deformation of the friction pair consisting of the cam profile and the pusher sleeve increases and the value of this probability decreases with the increase of the contact width of the friction pair consisting of the pusher sleeve[7].

4. Conclusion

1. In the presence of abrasive particles, the wear rate of the camshaft bearing profile increases linearly with respect to the strength of the abrasive particle, the frequency of rotation of the bearing profile, the amount of abrasive particles in the oil, and parabolically with respect to their size. causes a decrease in the rate of profile wearing.

2. The largest value of the coefficient of acceleration of the corrosion test of sleeve profiles was 1323.3 in the inlet sleeve and the smallest value was 19.1, and these values in the outlet sleeve were 821.4 and 16.4 respectively.

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