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Reliability Assessment in Mechanical Wear of Deforming Rollers on the Combinedtools for Cutting and Surface Plastic Deformation

KEYWORDS: Reliability, Tribology combined tools for cutting and SPD

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ABSTRACT *In this work is proposed a methodology for assessing the reliability indicatorpreservabilityin mechanical wear of deforming elements of combined tools for cutting and surface plastic deformation (SPD) by evaluating the quantitative parameter - intensity of wear. Sampled value reflect important processes accompanying plastic deformation characterizing wear such as friction fatigue deformation of micro roughness, thermo-dynamic processes operating at non- deterministic modes with and without application of the lubricant cooling liquid (LCL) and others.*

INTRODUCTION

Despite the workflow impact deformation of rollers engaged process of surface plastic deformation (SPD) in multipurpose tools for cutting and SPD is accompanied by their intensive wear due come into being processes friction of the supporting cone and separator of tools head - Figure 1.

Here occurred predominantly abrasion [7]. It is characterized by the enteringof micro components formed from the processed material on the tool's surface, and from there on the surface of the supporting cone and separator. As a result of the wear the geometry of distorting elements is modify, the force required to deforming increases and significantly deteriorate the quality of the machined surface. The shape and the area of contact with the workpiece are changed, whereby the number of operating cycles in the contact area increases.

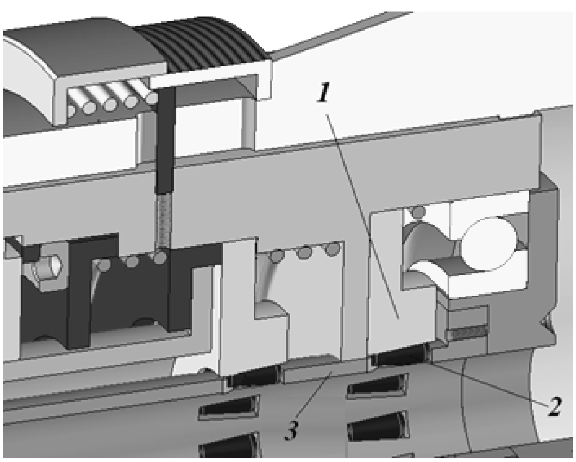

Fig. 1. The deforming modulus of multipurpose cutting and SPD tools: 1- A supporting cone, 2- Deforming elements - rolls, 3- Separator.

Precise prediction of reliable indexes requires maintaining relatively stable regimesSPD whose values are determined by a complex optimization analysis performed by apparatus linear programming, resulting in numerous technical reasoned decisions satisfying set of technological constraints.

EXPOSITION

The development of computing the reliability of deforming elements of combined tools for cutting and SPD is related to reporting important processes related to their wear, friction fatigue associated with deformation of the micro roughness, thermal processes operating at the wrong mode of lubrication and others. [1, 2, 3, 6].

The abrasion resistance is characterized by the parameters intensity of wear I, which is equal to the thickness of the wearing layer in a unit path of the friction. In the general case introduces the function W of so-called linear wear of the components [1]:

$$W = I \cdot V \cdot t \qquad (1)$$

wherein: V is the speed of the relative movement of the friction surfaces; t- current time for work wearingcomponent.

Especially for machine products and in particular for the deforming elements is proposed evaluation of reliability by using the following formula to calculate the intensity of wearI[2]:

$$I = k_1 \cdot P^m \qquad (2)$$

wherein:k_1 here and hereinafter is a factor of proportionality having a different index; P is the pressure in friction contact surfaces; m is exponent dependent on the operating conditions.

In formula (2) need to undertake a clarification of the main factors that affect the wear and have a significant scatter in the technical operation. Professor Michael Hrushtev [1] found that to metal in naturally condition and steels with friction between them or abrasive the wear intensity I is proportional to the pressure P and inversely proportional to the hardness of the wear of the material H. It is determined by:

$$I = k_2 \cdot \frac{P}{H} \qquad (3)$$

wherein:k2 is a coefficient of proportionality.

Thus provided law (3) is stored to the material hardness value not exceeding 0.6 ... 0.75 on the hardness H of the abrasive particles in the SPD. For large values of H the

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dependency of the intensity of wear I of the hardness is lowered in comparison with the calculated value. For hardened steel wear dependence of hardness is obtained as a linear function with the presence of a free member.

In condition of wear of ground operations, working bodies - separator and supporting cone are produced by hardened steel [2]. This requires a change in the formula (3) in a new form:

$$I = k_3 \cdot \frac{P^m}{H^L} \qquad (4)$$

If considered total wear I of two conjugate surfaces 1 and 2, it should. Therefore, the total wear of the two surfaces will be presented as converted (4) in the form:

$$\frac{1}{H^L} = \frac{1}{H_1^L} + \frac{1}{H_2^L} \qquad (5)$$

wherein:H_1 and H_2 is the hardness of the conjugate details.

In scientific work [2, 6] noted that the intensity of wear depends crucially on the coefficient of friction***f*** of the two conjugate surfaces. Therefore, the formula (5) is converted in the form (6) and (7):

$$I = k_4 . \frac{P^m . f_{IM}^n}{H^L} \qquad (6)$$

$$k_4 = \frac{k_3}{f_0^n} \qquad (7)$$

wherein:f_{IM} and f_0 are the coefficients of friction of the material examined and the starting material; ***m, n, L*** are exponents dependent on the influence of the lubricant (***m***), the heat treatment of the parts (***n***) and the degree of proximity of the pressure***P***to a valueP_{ACC} at which scratching occurs the material (***L***); k_3 and k_4 are coefficients of proportionality.

From (6) and (7) follows the formula (8):

$$I = k_3 . \frac{P^m}{H^L} \cdot \left(\frac{f_{IM}}{f_0}\right)^n \qquad (8)$$

Formula (8) is useful for calculating the intensity of wear of chemically similar materials as in the case of steels are used in the preparation of the rolls - 65G and the separator and the support cone - 40X. In most cases, it is assumed ***n*** = 1. If there is the presence of friction between the steel and the other material then being accepted***L***=1. To friction between two hardened steel is assumed ***L*** = 2, 3 ... from which it follows significant wear. Proportionality coefficient k_3= 1.

In Fig.2 is shows graphically altering the function of wear of two friction surfaces in pressure***P*** = 183, ... 917kPa, the hardness of the hardened roller ***H*** = 285HB, with dry lubricant ***m*** = 1,1 and the values of coefficients of frictionf_{IM} = 0.5 and f_0= 0.78 [8].

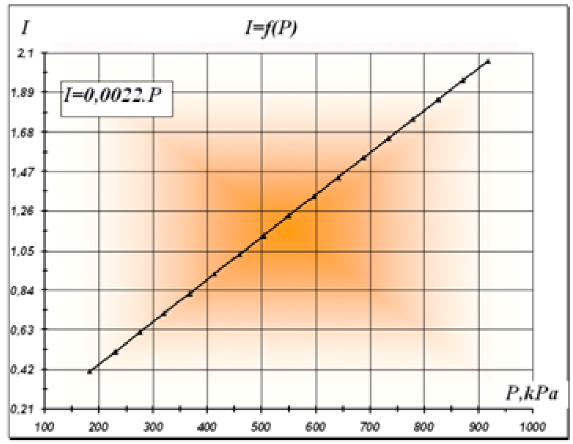

Fig. 2. The graphic altered function of wear of the two friction surfaces I of the pressure P

Graph is linear with the regression equation of the form:

$$I = 0.022 \cdot P \qquad (9)$$

i.e. for rolls, separators, and supporting cones made of materials similar in chemical composition, the function of wear ***I*** depends entirely on the deformation applied pressure ***P***, kPa and the shape the rolls, respectively, by the power of deformation F_0, N.

The reliability of the friction surfaces, the most significant is the degree of closeness the pressure ***P*** to value P_{ACC} that occurs scratching material. For this purpose it is necessary to determine the exponent Lkr. It is therefore necessary to solve equation (8) for determining the value of L_{kr} as a function of other arguments in (8).

Solution of (8) on L_{kr}be determined after a logarithm dependence:

$$L_{kr} = \log_H \left[k_3 \cdot \frac{P_{ACC}^m}{I} \cdot \left(\frac{f_{IM}}{f_0}\right)^n\right] (10)$$

CONCLUSIONS

1. Proposed is methodology for preservabilityconsidering the intensity of wear indicators, applicable to different groups of tools and processed materials.

2. Displayed is dependence on determining the exponent ***Lkr*** which reflects the levels for maximum pressureP_{ACC}prior to onset of scratch as a function of arguments.

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