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RESEARCHES ON AN INFLUENCE OF THE PROCESSING AND INSTRUMENTAL GEOMETRICAL PARAMETERS ON THE PARAMETERS OF WARMING AT THE USE OF FREE ROLLING METHODS

Summary. It is shown, that the cutting layer width at the processing by the free rolling method is increased with an increase of the corner of the crossing of the shaving axes and the processing wheel, the number of teeth and the tools gearings modules.

Keywords: axes, cutting layer, increase, processing

As finishing operations of cogwheels at present apply grinding in, tooth-honing, tooth-shaving, tooth-rolling, electrochemical processing. The processing of toothed wheels surfaces is usually carried out by the rolling method. The method is divided into two kinds: compulsory and free. Ways of processing of cogwheels with application of abrasive tools (grinding in and tooth-honing) are used at the hardness of the working surface tooth HRC > 46. The processing of cogwheels by cutting the tool and methods of plastic deformation (tooth-shaving and rolling) is applied at the hardness of the working surface HRC < 36.[1, 2]. Electrochemical processing and grinding is applied to the processing of cogwheels with any hardness of the working surface tooth. The process of grinding is characterized by a small section of shavings, small efforts of cutting and insignificant temperatures in the processing zone. All this allows to receive high quality of a surface and small depth of a deformable layer. Tooth-honing is used for finishing processing of the tempered cogwheels with 7-12 degrees of accuracy for GOST 1643-81. Advantages of tooth-honing in comparison with tooth-grinding and grinding-in are high efficiency, rather low speeds of cutting and the temperature of cutting that ensures absence of pressure and micro-cracking of the processed surfaces and simplicity of adjustment of the used equipment. Features of the tooth-honing process are the presence of the connected abrasive in the tool and applications of the free rolling method. At the proc-

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essing there is a mutual rotation and moving the honing or wheels along an axis of a wheel. The process of tooth-honing allows to delete the fine drive and nails at the height up to 0.3 mm; a defective layer is formed due to chemical - thermal or thermal operations, roughness of the processing surfaces tooth up to the required one to improve the condition of the surface layer and to lower separate elements of errors. Apart from that at the use of tooth-honing as finishing operation it is possible to achieve improvement in the characteristic sound of gear pairs. The roughness of the processing surface in tooth-honing can be reduced up to Ra = 0.08 microns. Accuracy of processing by the method of tooth-honing in many respects depends on the choice of the circuit tooth-honing, wear resistances of the tool. Tooth-shaving is one of the most effective kinds of cogwheels processing with 6-8 degrees of accuracy for GOST 1643-81. The essence of tooth-shaving is reduced to mechanical composition from the processing surface of thin shavings as a result of mutual sliding of the connected surfaces in tooth shaving and preparations. Thus plastic deformation of metal in the zone of processing also takes place. Toots-shaving also provides increase of accuracy of a gear wreath by 1 ÷ 2 degrees on many parameters, considerably allows to reduce roughness of the working surfaces in tooth (*Ra* = 0.32 microns) [3]. A big advantage of tooth-shaving is high efficiency, simplicity in the adjustment of the used equipment, low speeds of processing. It provides no pressure or micro-cracking on the processed surfaces. For the realization of the process in tooth-shaving a wide circulation has been received in disc-shaving. The disk-shaving is basically done by the free rolling method. At present the equipment for the realization of the processing by the compulsory rolling method is already developed. During the shaving process the form and the sizes of a tooth of the processing wheel continuously change. It results in the continuous change of conditions of contact of working surfaces in shaving and preparations. At the proximity of the shaving and processing wheels the stain of contact is formed due to radial submission. The sizes of the stain limit the working part of the edges participating in the processing. The stain of contact of a tooth of preparation and shaving has an oval form and has received the name of a contact ellipse (Fig. 1). The length of the contact ellipse defines the number of the working edges participating in the processing, and width extent within the limits of the zone of contact. In work [3] it is marked, that in the process of tooth-shaving the instant zone of cutting changes the orientation to the surfaces of tooth-shaving and the processing wheel. At radial submission shaving there is a stain of contact focused to a rectilinear forming surface of a tooth of a wheel under a corner φ_1. The size of this corner depends on normal radiuses of curvature of the shaving surfaces and wheels ρ_0 and ρ_1 in the point of contact to a direction of radial submission and corner *G* between the rectilinear forming characteristics connected with the evolving screw surfaces. The corner φ_1 is defined by the following formula:

$$tg2\varphi_1 = \frac{\sin 2G}{\cos 2G + \dfrac{\rho_0}{\rho_1}} \tag{1}$$

In Fig. 2 the contact of the left surfaces of the right shaving tooth and a cogwheel is shown. In plane P there is an instant screw axis of the relative movement with parameter p equal to the relation of instant speed U of relative sliding and instant angular speed of the relative reference ωc . The axis of shaving O_0O_0 located below plane P, and the axis of cogwheel $O_0^{'}O_0^{'}$ is higher than this plane. Projections of the specified axes to plane P are designated $O_0^{'}O_0$' and O_1'O_1'. Plane S, a tangent to the initial shaving cylinders and a cogwheel is located in the distance O_0' from plane F [4]. A surface of a tooth imagined intermediate river k a tangent to the surface of tooth pairs of a shaving-wheel with lines of contact C-C and g-g.

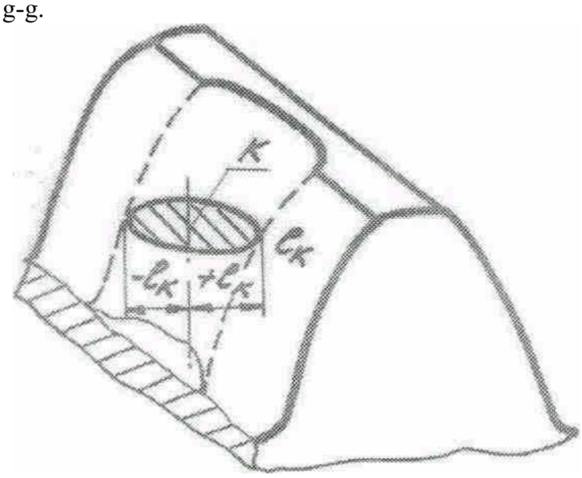

Fig. 1. A stain of contact of a tooth of preparation

Individual vectors characterize: b - a direction of the greater axis of a stain of contact; m - a direction of a line of gearing. In view of these features, the formula for the definition of the length of the greater and smaller axis in the contact ellipse looks like:

$$Z = v\sqrt{\frac{2S_{рад}.\sin\alpha_n}{\frac{\sin^2\varphi_1}{\rho_0}+\frac{\sin^2(G-\varphi_1)}{\rho_1}}} \qquad (2)$$

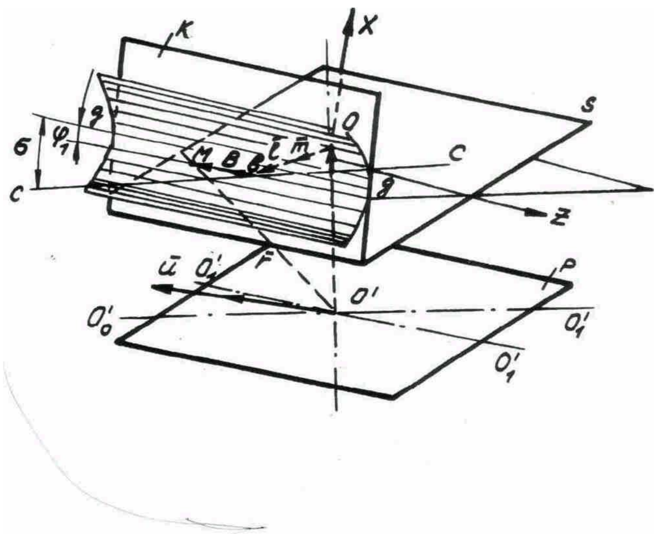

Fig. 2. Contact of the left surfaces of the right shaving-tooth and a cogwheel

$$b = v \sqrt{\frac{2S_{рад} \cdot \sin \alpha_n}{\frac{\cos^2 \varphi_1}{\rho_0} + \cos^2 (G - \varphi_1)}} \tag{3}$$

Where:

ρ_0 and ρ_1 – normal radiuses of curvature of the surfaces of shaving-tooth and wheels, mm;
G-A – corner between rectilinear forming connected with the evolving surfaces of shaving-tooth and wheels.
v- the factor which is taking into account elastic deformations of tooth e.g. an error.
φ_1 - a corner between a rectilinear forming surface of a shaving-tooth and the greater axis of a stain of contact.

Analytical researches of change of the area of a stain of contact allow to draw a conclusion that the sizes of a contact ellipse are functions of the given radiuses of curvature. The length of a contact ellipse depends on the given radiuses of curvature of surfaces of shaving-tooth and the wheels, measured in directions of the greater axis of this ellipse and width – from the given radius of curvature measured in directions of its smaller axis. The height of a shaving-tooth and wheels influence the character and intensity of change of width of a stain of contact parameters to the gearings determining the position of an active part of a line of gearing on a full part of a line of gearing. The layer elements , during processing by the method of tooth-shaving depend on the sizes of a contact ellipse. For the case of processing straight wheels the formula for the definition of width cut layer looks like:

$$C = \frac{2b_0 \sin \beta_0}{tg \alpha_{S0}} \tag{4}$$

Where:

b_0 – width-shaving, mm;

β_0 – a corner of an inclination of a tooth-shaving on the basic cylinder, a hailstones;

α_{S0} – A face corner of gearing in a face plane shaving, a hailstones.

On the basis of analytical researches of this dependence it is possible to draw a conclusion about the volume that the width of the cutting layer is increased with an increase of the corner of crossing of axes shaving and the processing wheel, number of teeth and the module tools gearings. The width of the cutting layer is the size of a variable on the height of a tooth and on the sites of interface of tooth located close to the basic cylinders it considerably decreases. For the case of processing slanting wheels modified shaving the formula which is taking into account alongside with the other parameters the elastic deformations arising at the processing is received:

$$C = \nu \cdot tg\lambda \sqrt{\left(S_{pa\partial} \cdot \sin\alpha \cdot \rho_1 \rho_0\right) / \left(\rho_1 + \rho_0\right)} \tag{5}$$

Where:

ν- factor taking into account elastic deformations of technological system;

S_{pad} – radial submission shaving in mm / course;

ρ_1, ρ_0 – normal radiuses of the curvature of tooth-wheel and shaving, mm;

α – a corner of gearing in face section, the hailstones;

λ – a corner between a working line and an edge which cuts, the hailstones.

CONCLUSIONS

The cutting width of a layer, at the processing by free rolling methods, is increased with an increase of the corner of the crossing of shaving axes and the processing wheel, teeth number and the tools gearings modules.

The cutting width of a layer is the size of the tooth height variable, and on the sites of interface of tooth surfaces closely located to the basic cylinders it considerably decreases.

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