RESEARCH OF TEMPERATURES ON A FORWARD SURFACE OF THE CUTTING TOOLS EDGE

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Temperature is one of the major parameters of the cutting system. It determines as serviceability of the cutting tool and quality of the processable details surfaces. Now alongside with experimental methods of the researches the importance of theoretical methods essentially is increasing. They allowing not only to expect a level of temperatures on surfaces of the contacting bodies but also to determine inside temperature fields.

The serviceability of the cutting tool appreciably is defined in temperature of cutting. At research of the wear process laws on the tool edge it is rather important to know not only average temperature on its contact platforms but also meaning of temperatures in each point of an edge. In the present work the researches of the laws of distribution of temperatures on a forward surface of an edge are carried out depending on the tool parameters.

For the decision of the specified task one of the most widespread analytical methods - method of sources of heat is used [1]. At a schematisation of components of researched system the tool is submitted as unlimited wedge with a corner β. Source of heat on a forward surface of the tool edge is submitted as flat rectangular with the sizes ***bxl*** equal to a platform of contact of a shaving with a forward surface and with uniform density of distribution of a thermal flow. Advantage of the method of sources is the opportunity to reach of the decision in the analytical kind.

The temperature field on a forward surface of an edge arising under action of a rectangular source of heat in regular intervals distributed on a platform of contact of a shaving with a forward surface ***bxl*** at the established heat exchange is described by expression:

$$\Theta(x,z) = K(\beta)\frac{ql}{4\pi\lambda}T(\psi,\zeta), \qquad (1)$$

where ***K(β)*** - factor dependent on a corner of an edge β; ***q*** - density of the thermal flow; λ - factor of the diathermicness; ***T(ψ,,ζ)*** - law of distribution of temperatures in the dimensionless kind:

$$T(\psi,\zeta) = \int_0^l d\psi_u \int_{-0.5b}^{+0.5b} \frac{d\zeta_u}{\sqrt{(\psi-\psi_u)^2 + (\zeta-\zeta_u)^2}} .$$

(2)

$$\psi = x/l;\ \psi_u = x_u/l;\ \zeta = z/l;$$
$$\zeta_u = z_u/l;\ \eta = 0.5b/l$$

Dimensionless function ***T(ψ,,ζ)*** is shown in the fig. 1 as a surface constructed at $\eta = 1$ for a source which width ***b*** is twice more than length ***l.*** Width of a source ***b*** represents width cutting, length

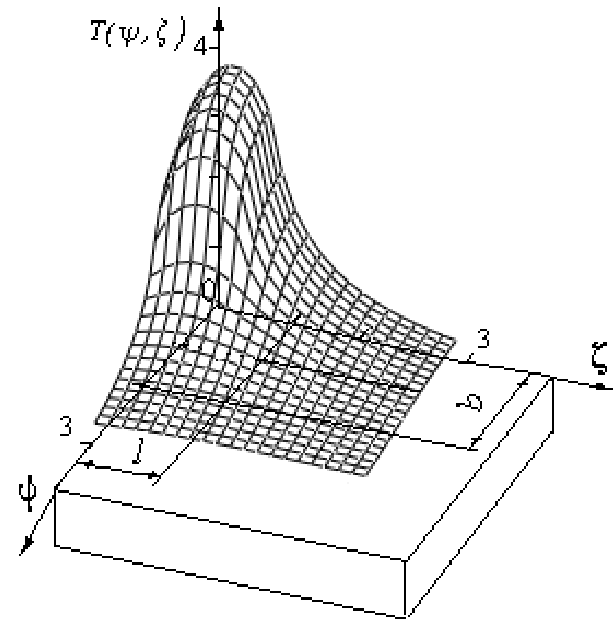

Figure 1. Dimensionless temperature field on forward surface of the tool edge

l characterises length of contact of a shaving with a forward surface of an edge. The axis ψ is directed along main cutting list, axis ζ - along auxiliary. The submitted diagrams evidently illustrate character of distribution of temperatures on a forward surface of an edge of the tool. Maximal temperature takes place at meanings $\psi = 0{,}5$; $\zeta = 0$.

The dimensionless distribution of temperatures on a forward surface of an edge of the tool in a plane perpendicular to main cutting list is defined as follows (**z** = 0):

$$T(\psi,0)=\psi\, ln\left|\frac{\eta+\sqrt{\psi^2+\eta^2}}{-\eta+\sqrt{\psi^2+\eta^2}}\right|-(\psi-1)\times$$
$$\times ln\left|\frac{\eta+\sqrt{(\psi-1)^2+\eta^2}}{-\eta+\sqrt{(\psi-1)^2+\eta^2}}\right|+$$
$$+2\eta\, ln\left|\frac{\psi+\sqrt{\psi^2+\eta^2}}{\psi-1+\sqrt{(\psi-1)^2+\eta^2}}\right| \quad (3)$$

Temperature of a forward surface of an edge depends on the tool geometrical parameters and first of all from a forward corner γ rendering influence on length of contact of a shaving with a forward surface l and density of a thermal flow q:

$$l = 2s\, sin\varphi[k(1-tg\gamma)+sec\gamma] \quad (4)$$

$$q=\frac{V(P_{Z0}\,sin\gamma+P_{N0}\,cos\gamma)}{2st[k(1-tg\gamma)+sec\gamma]k}, \quad (5)$$

where V - speed of cutting; ***PZ0 = Pz - Ffr*** - difference of cutting force and force of friction on a back surface of an edge; ***PN0 = Py - Ffr*** - difference of normal making force of cutting and force of friction on a forward surface of an edge; s - submission, t - depth of cutting; k - factor longitudinal clutch of a shaving; φ - corner in the plan.

The distribution of temperatures on a forward surface of the cemented carbide alloy cutters edge with various geometrical parameters - forward corner γ and back corner α is submitted in a fig. 2. On temperature of an edge the essential influence renders a corner β as with its reduction the conditions теплоотвода in the tool are worsened. Factor $K(\beta)$ dependent from a corner β is equal:

$K(\beta) = 4$ **для** $\beta = 90°$;

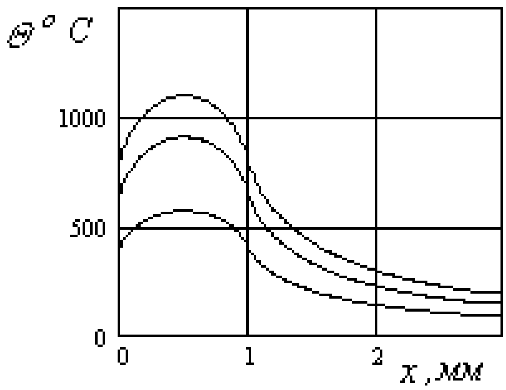

Figure 2. Distribution of temperatures on a forward surface of an edge of cutters with various parameters

$K(\beta) = 6$ **для** $\beta = 60°$.

Under the same conditions of operation temperature on a forward surface for cutters with corners γ = 15°, α = 15 in 2 times is higher than for cutters with γ = -5°, α = 5°.

The specified dependence can be used for account of temperature at an edge top at $\psi = 0$ and also maximal temperature at meanings $\psi = 0{,}5$:

On temperature of a forward surface of an edge the rather essential influence is rendered with properties of a tool material and, first of all, factor of the diathermicness.

The accounts of temperatures for cutters equipped with of the cemented carbide alloy plates are executed for the following conditions: a processable material - steel 45, $\Phi_в$ = 750МПа, factor k=2,0; modes of cutting - depth of cutting t = 2мм, submission s = 0,4мм/about, speed of cutting v = 120 м/min., deterioration on a back surface of an edge h = 0,9мм.

The accounts of temperatures for cutters from other tool materials are executed for the following conditions: a processable material - steel 45, modes of cutting - depth of cutting t = 1мм, submission
s = 0,1мм/about, speed of cutting v = 120 м/mines., deterioration on a back surface of an edge h = 0,4мм.

Geometrical parameters of cutters: corners in the plan $\varphi = \varphi 1$ = 45°, forward corner γ = -5°, back corner α = 5.

The results of account of cutters temperatures are submitted in the table 1.

Table 1. Temperature of a forward surface of a cutters edge from various tool materials

Tool material	Temperature of an edge top, Θ ^oC	Greatest temperature Θ_{max} ^oC	Tool material	Temperature of an edge top, Θ ^oC	Greatest temperature Θ_{max} ^oC
T5K10	285	399	ЦМ332	1023	1609
T14K8	324	453	ВОК60	1011	1323
T15K6	404	565	КНТ16	703	920
T30K4	460	643	B4N	352	460
TT7K12	523	732	diamond	101	132

The results of accounts of temperatures on a forward surface of an edge for cutters from various tool materials testify to significant distinction of temperatures depending on properties of a tool material. The cutters equipped mineralceramics have greatest temperature. The diamond cutters have least temperature. Even for one group of tool materials - cemented carbide alloy the distinction in temperatures is rather essential (more than in 2 times) that can be taken into account at the analysis of the tool operation conditions.

The developed technique is applicable for definition of temperature fields of various tools.

Established on an example of the cutters the laws of influence of geometrical parameters on distribution of temperatures on a forward surface of an edge can be distributed on any tools. The features of various kinds of processing are taken at account of density of a thermal flow and length of contact of a shaving with a forward surface of an edge. On the basis of the received results the recommendations at the choice of a tool material and rational parameters of the tool are developed.

Reference:

1. ***Резников А.Н., Резников Л.А.*** *Тепловые процессы в технологических системах. - М.: Машиностроение, 1990. – 288с.*