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ESTIMATION OF INFLUENCE OF THE INITIAL DATA ON RESULTS OF CALCULATION OF TEMPERATURE IN A CUTTING ZONE

V.A. Pushnykh, V.L. Bibik

Tomsk polytechnic university
E-mail: bibik@yrg.kuzbass.net

Influence of the initial data for calculation of temperatures in a cutting zone on average cutting temperature is considered. The factors rendering the most essential influence on cutting temperature value are determined on the basis of computer simulation.

Forecasting and calculation of cutting tool wear is one of primary goals of the theory of processing of materials by cutting. As the major factor determining wear is, the cutting temperature the given article is devoted to attempt to analyze influence of the initial data for calculation of cutting temperature on this temperature value.

Comparison of two methods for calculation of cutting temperature by A.N. Reznikov's theory and S.S. Silin's theory is made in work [1] and it is established, that both methods can be used for calculation of cutting temperature, however they have some limitations, in particular A.N. Reznikov's theory is applicable for the materials giving a flow chip.

Calculation of temperature was carried out by A.N. Reznikov's theory [2] with the help of developed Windows appendices in the programming media Delphi [1]. Comparison of calculated values of the temperatures obtained by means of the given program, with experimental data is presented in Tabl. 1. A processable material – ШХ15, cutting material – Т14К8, γ=0°, α=12°, φ=φ_1=45°, t=4,1 mm, S=0,5 mm/rev. As one can see from the Table, calculated values of cutting temperature are well fitted with experimental data.

Table 1. *Results of comparison of calculated cutting temperature with experiment*

Cutting velocity, m/s	Temperature, °C			
	Cuttings		On a front cutter surface	On a back cutter surface
	Experiment	Calculation	Calculation	Calculation
0,17	400	368	377	227
0,50	560	563	581	301
0,67	610	629	650	323
1,00	700	736	762	358
1,33	790	825	854	386

To estimate influence of the initial data on cutting temperature the data from A.N. Reznikov's work [2] have been used and changed on ±50; ±25; ±10, ±5 %, accordingly. For an example results of calculation of cutting temperature at change of the front angle in the main secant plane (γ) are presented in Tabl. 2.

The diagrams have been built with use of the average cutting temperature since character of cutting temperature change in dependence on change of argument is similar to character of change of average temperatures on contact platforms on front and back surfaces of the tool. The initial data which are applied at calculation of cutting temperature are accepted as arguments. Diagrams are united on groups for reasons of compactness.

Table 2. *Results of calculation of cutting temperature ? at change of the front angle ? in the main secant plane*

γ, grad.	7,5	11,3	13,5	14,3	15,8	16,5	18,8	22,5
Θ, °C	847	898	926	936	954	962	989	1030

The diagram of dependence of cutting temperature Θ on coefficient of thermal diffusivity (ω), heat conductivity (λ) and processable material strength (σ_v) is presented on fig. 1. Strength of a processable material practically does not influence cutting temperature. The given parameter influences the forces working on a contact site, and on a back surface of the tool. The contact length on this site as a rule, is small and, hence, the share of strength in change of cutting temperature is insignificant. Coefficients of heat conductivity and thermal diffusivity are used at calculation of deformation temperature, average temperatures of a chip and a product [2]. With increase of coefficient of heat conductivity the cutting temperature is reduced, it is connected with growth of the final thermal stream directed through a contact site on the back surface of the tool in a product. At increase of coefficient of thermal diffusivity inverse relationship is observed.

Influence of coefficient of heat conductivity of a tool material (λ_p), the main angle in the plan (φ) and a front angle in the main secant plane (γ) are shown on Fig. 2. The coefficient of heat conductivity of the tool material is used to calculate average values of temperatures on contact sites of front and back surfaces of the tool. Reduction of coefficient of heat conductivity of a tool material results in increase of average values of temperatures at contact sites and therefore will lead to growth of cutting temperature. From the physical point of view increase of a front angle value in the main secant has to result in reduction of cutting temperature (cutting forces components are decreased), however on Fig. 2. inverse relationship is presented. The increase of front angle value in the main secant plane reduces tool section in this connection heat removal in tool carrier is found difficult. All this results in growth of cutting temperature values. The main angle in the plan is used at calculation of width and thickness of a cut. At increase of the main angle in the plan cut thickness and thermal flow intensity on overcutter side of a chip are increased. All this leads to growth of temperature.

Dependence of cutting temperature on cutting mode elements is presented on Fig. 3. Cutting velocity (V) are used to calculate thermal flows intensity on overcutter side of a chip, on the back surface of a cutter. The increase of cutting velocity and accordingly the given thermal flows will result in increase of deformation, average temperatures of a chip and a product, that in turn will increase average cutting temperature. The increase of feed (S) causes increase of cut thickness, reduction of deformation heat and deformation temperature, that in turn through average temperatures of a chip and a product reduces cutting temperature. The increase of cutting depth (t) results in increase of cut width, reduction of thermal flows intensity on overcutter side of a chip and deformation heat, that in turn through average temperatures of a chip and a product reduces cutting temperature.

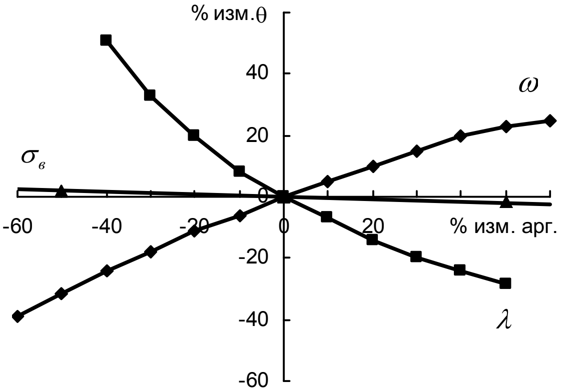

Fig. 1. *Influence of coefficient of thermal diffusivity (ω), heat conductivity (λ) and strength of a processable material (σ_v) on cutting temperature*

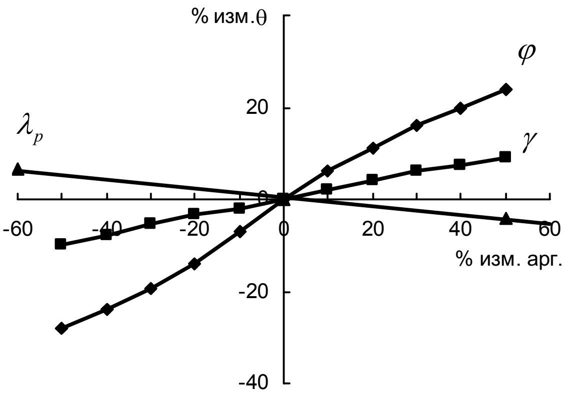

Fig. 2. *Influence of coefficient of heat conductivity of a tool material (λ_p), the main angle in the plan (φ) and a front angle in the in main secant plane (γ) on cutting temperature*

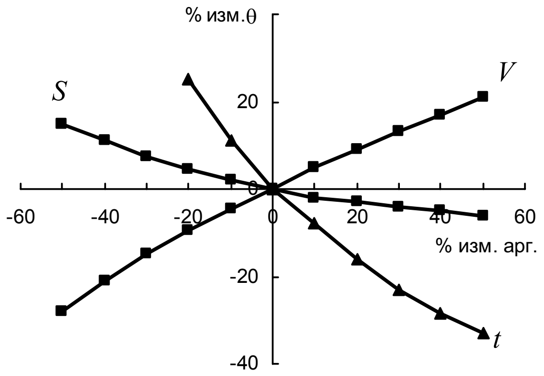

Fig. 3. *Influence of cutting mode elements of on cutting temperature*

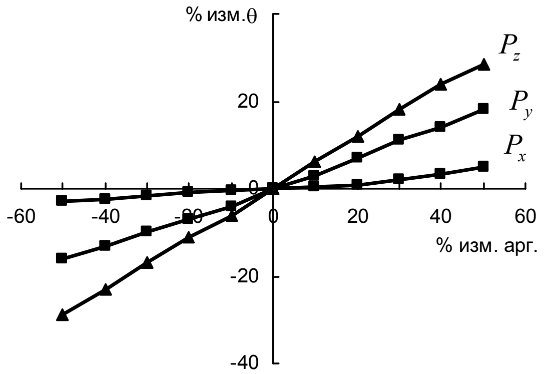

Fig. 4. *Influence of cutting force components on cutting temperature*

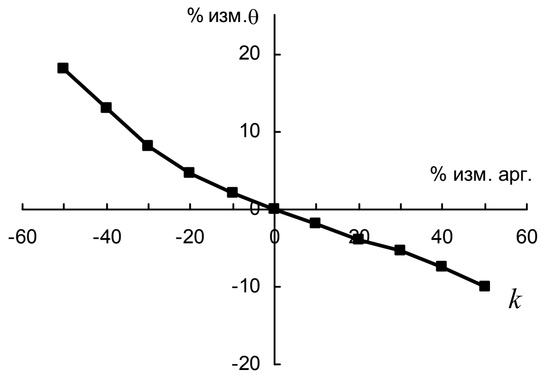

Fig. 5. *Influence of shrinkage of a chip k on cutting temperature*

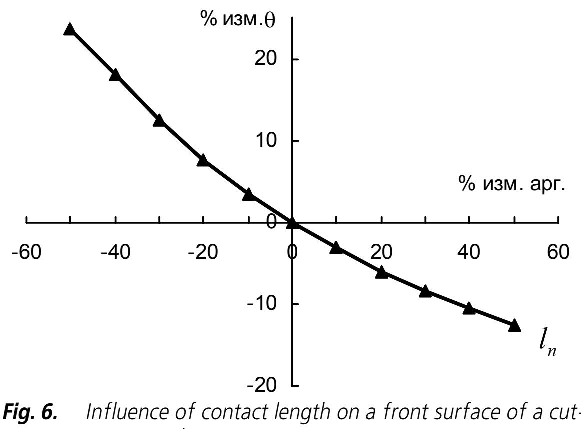

Fig. 6. *Influence of contact length on a front surface of a cutter on cutting temperature*

Influence of cutting force components P_x, P_y, P_z on cutting temperature is shown on Fig. 4. Growth of cutting forces results in growth of thermal flow intensity on overcutter side of a chip and deformation heat. It leads to growth of deformation temperature, average temperatures of a chip, a product and, accordingly, cutting temperatures.

Dependence of cutting temperature from shrinkage of a chip is given on Fig. 5. The increase of shrinkage of a chip results in reduction of deformation heat, therefore the deformation temperature, average temperatures of a chip, a product, and cutting temperature decrease.

Influence of contact length l_n on a front surface of a cutter on cutting temperature is presented on Fig. 6. As one can see from the diagram at increase of contact length of a chip at a front surface of the tool the cutting temperature decreases.

Conclusions

As results of computer simulation have shown, the greatest influence on temperature in a cutting zone is rendered by the following factors: cutting mode elements (V, t), thermal physical characteristics of a processable material (ω, λ), the main angle in the plan φ, tangential and radial components of cutting force (P_z, P_y). At change of cutting velocity twice the cutting temperature changes on 49 %; similar change of cutting depth gives the temperature response of 98 %. At change of factors of thermal diffusivity and heat conductivity of a processable material twice the cutting temperature changes on 55 and 98 %, accordingly. Change on 100 % of tangential and radial components of cutting force cause the temperature response of 58 and 34 %, accordingly. Change of an angle in the plan twice results in change of cutting temperature on 52 %.

The least influence from researched parameters is rendered by strength of a processable material (σ_v) and axial component of cutting force (P_x), temperature response is 4 and 8 % accordingly, at change of the given parameters twice. At change of other parameters (λ_p, γ, S, k, l_n) on 100 % the cutting temperature varies within the limits of 10...28 %.

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Literature

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TECHNIQUE OF DEFINITION OF CRACKING RESISTANCE CHARACTERISTICS OF METAL PLATES AND ENVELOPES OF SMALL THICKNESS

A.S. Solyanik, K.V. Shchedrivy

Tomsk Polytechnic University
E-mail: Kosimm@mail.ru

The technique of cracking resistance tests of metal plates of small thickness is given. Features of such tests, among which are occurrence of warp in the places of fastening of plates, occurrence of waves because of loss of stability at out-centre loading are shown. Ways to eliminate these shortcomings with the help of special equipment are specified. Tests by the proposed methods allow to make recommendations for technology and choice of steels at creation of valve tapes.

Problems in mechanics of destruction of metal products at presence of cracks till now are not solved up to the end. The greatest interest of domestic researchers to this problem has fallen to 70–80 years of the last century [1–3]. Intensive searches of the answer to behavior of cracks in metal by foreign researchers have resulted in occurrence of American and British standards for cracking resistance tests. In the USSR such result was occurrence of the method of destruction ductility tests (cracking resistance) at static [4] and dynamic [5] loading. However in 2005 they were cancelled without replacement [6]. In engineering practice and in research purposes it is remained necessity to estimate strength and durability of products at presence of cracks. Therefore the further making of experience of mechanical tests on cracking resistance, their perfection are actual.

At experimental definition of cracking resistance characteristics it is necessary to provide the decision of several problems:

1. To choose the most rational form of a sample.
2. To create an artificial fatigue crack.
3. To provide necessary accuracy of registration of fatigue crack lengths and loadings during test.
4. To carry out tests for destruction ductility with record of the loading diagram.
5. Using the diagram to define values of calculated parameters and to compute cracking resistance characteristics by authentic quantitative way.

The choice of the sample form is frequently predetermined by initial assortment of researched metal (a bar, a plate, a sheet, a strip etc.). The present methods are intended to define cracking resistance characteristics conformably to sheet metal, tapes, envelopes of small thickness. Catering for a valve tape, the flat sample with the central holes with length of 250 mm of the corresponding cross sizes with preliminary cut on the one side and artificially grown fatigue crack, Fig. 1, has been chosen.