

### **Witold Biały**

ORCID ID: 0000-0003-2313-0230  
Silesian University of Technology, **Poland**

### **Tatiana Nikolajevna Ivanova**

ORCID ID: 0000-0003-2284-2949  
Tchaikovsky Branch "Perm National Research Polytechnic Institute", **Russia**  
Federal State Budgetary Institution of Science "Udmurt Federal Research Center of the Ural Branch of the Russian Academy of Sciences", Institute of Mechanics, **Russia**

### **Jozef Žarnovský**

ORCID ID: 0000-0002-5591-8498  
Slovak University of Agriculture, **Slovak Republic**

### **Juraj Ružbarský**

ORCID ID: 0000-0002-7021-5061  
Technical University of Kosice, **Slovak Republic**

## **INTRODUCTION**

A direct influence on the physical and mechanical state of the surface layer of wedge-shaped plates made of 8KHF steel (GOST 5950-2000 Russia, standard PN/H 85023 brand NCV1 Poland) is exerted by heat generation processes developing in the zone of a high-speed thermal process. The degree of their influence is determined by the following factors: the intensity of the impact of the tool on the part, the time of contact between the tool and the part, the elements of the cutting mode, the characteristics of the grinding wheel, the mechanical and thermophysical properties of the material of the part, the properties of the cooling fluid, etc.

In case of a high-speed cutting, the thermal process is characterized by immediate short-term heating ( $10^{-5}$ – $10^{-6}$  s) with a high temperature and a speed of  $10^5$ – $10^8$  deg/s. Immediate heating is followed by an instant removal of heat from the surface layers deep into the metal of the part due to its thermal conductivity with a similar rate. As a result of this high-speed thermal process, non-uniform heating of the surface layer occurs. Then the temperature field damps at a very shallow depth and, thus, a high temperature gradient is created. The high speed of thermal processes leads to structural transformations of the machined material.

High-speed thermal process – sharpening of the cutting edge of the wedge-shaped plate, being the final operation in the technological process, should

provide the necessary physical and mechanical properties of the machined surface. Changes in surface properties during a high-speed thermal process – sharpening of the cutting edge of a wedge-shaped body can lead to deterioration in its functional properties due to structural changes or the propagation of microcracks on the edge. The main factors providing predetermined hardness and strength of the cutting edge of the wedge-shaped body are the martensitic structure, as well as the degree of transformation and dispersion of the decomposition of austenite. The formation of the cutting edge of the wedge-shaped body under a high-speed thermal process occurs under the influence of a thermal factor, which results in changes in the initial structure of the surface layer. Therefore, research on the influence of the parameters of the high-speed thermal process on the change in the structure of 8KHF steel will allow us to study the nature of the change in the microstructure depending on short-term heating to various temperatures and rapid cooling. Also, this study will make it possible to determine critical points of the beginning and the end of structural transformations during heating process (Sipaylov 1978; Fletcher 1991; Ivanova, Dement'ev 2012; Ivanova 2018; Zhukauskas 1982; Zakharov et al. 2016; Toenshoff, Denkena 2013; Zintarsky et al. 2013; Klocke, Kuchle 2011; Jackson, Hitchner 2012).

## METHODOLOGY OF RESEARCH

The most common scheme for machining of flat wedge-shaped parts is sharpening along the edge when the grinding wheel moves parallel to the edge of the created wedge. In this case, the temperature field in the wedge-shaped plate is determined by the following dependence (Sipaylov 1978):

$$T = \int_{-h}^h \frac{q}{2\pi\lambda} \exp\left[-\frac{\vartheta(z-z')}{2a}\right] K_0 \left\{ \frac{\vartheta^2}{4a^2} \left[ r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2 \right] \right\}^{1/2} \times$$

$$\times \left( 1 + \sum_{n=0}^{\frac{\pi}{\alpha} - 1} \frac{\int_0^{\frac{\vartheta}{2a} r \cos(\theta - 2\alpha n)} \frac{\exp\left(-\left\{ \frac{\vartheta^2}{4a^2} \left[ r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2 \right] + \eta^2 \right\}^{1/2}\right) d\eta}{\left\{ \frac{\vartheta^2}{4a^2} \left[ r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2 \right] + \eta^2 \right\}^{1/2}}}{K_0 \left\{ \frac{\vartheta^2}{4a^2} \left[ r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2 \right] + \eta^2 \right\}^{1/2}} \right) dz' \quad (1)$$

where:

$q$  – heat flux density;

$\lambda$  – thermal conductivity coefficient of the material;

$a$  – thermal diffusivity coefficient of the material;

$\alpha$  – number of reflected sources;

$h$  – source half width;

$K_0(u)$  – zero-order Bessel function of the second kind;

$r, \psi, z$  – cylindrical coordinates;

$z'$  – coordinate, considering indefiniteness of the heat source;

$n$  – number of thermal impulses;

$r'$  – current coordinate of considered point;

$$\frac{\vartheta[r' - r \cos(\psi - 2\alpha n)]}{2a} = \eta, \quad \frac{\vartheta}{2a} dr' = d\eta.$$

The integrand of equation (1) describes the temperature field of a linear source moving along the surface of the wedge. The expression before the bracket describes the temperature field of a linear source moving along the surface of a semi-infinite body, while the sum in brackets characterizes the effect of the parts finiteness on the temperature field.

If we denote the sum characterizing the effect of finiteness of part as

$$M(\xi, \rho, \theta, \alpha) > \frac{1}{2} \left( 1 + \sum_{n=0}^{\frac{\pi}{\alpha}-1} \frac{\int_0^{\frac{\vartheta}{2a} r' \cos(\theta - 2\alpha n)} \frac{\exp\left(-\left\{\frac{\vartheta^2}{4a^2} [r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2] + \eta^2\right\}^{1/2}\right)}{\left\{\frac{\vartheta^2}{4a^2} [r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2] + \eta^2\right\}^{1/2}} d\eta}{K_0\left\{\frac{\vartheta^2}{4a^2} [r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2] + \eta^2\right\}^{1/2}} \right)$$

then the general solution for calculation of temperatures in a wedge-shaped plate can be demonstrated as

$$T = \int_{-h}^h M(\xi, \rho, \theta, \alpha) \frac{q}{\pi\lambda} \exp\left[-\frac{\vartheta(z-z')}{2a}\right] \times K_0\left\{\frac{\vartheta^2}{4a^2} [r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2] + \eta^2\right\}^{1/2} dz' \quad (2)$$

The multiplier  $M$  can be calculated for any of the wedge angles. Fig. 1 shows the dependence of the multiplier  $M$  on  $z$  and  $\rho$  for the wedge surface with  $\alpha = 60^\circ$ .

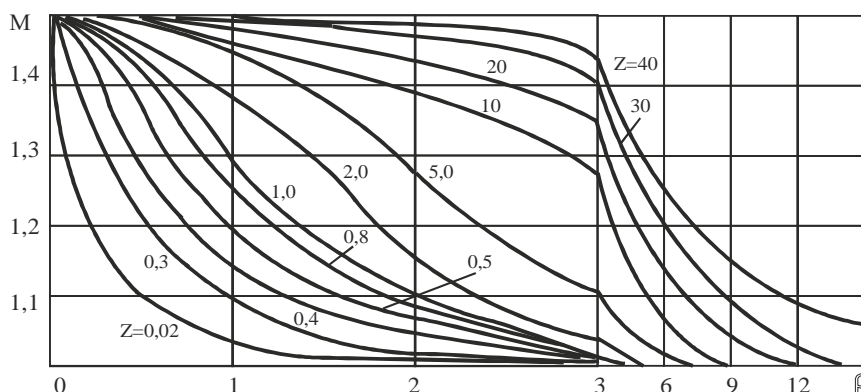


Fig. 1 Dependence of multiplier  $M$  on  $Z$  and  $\rho$  for wedge with  $\alpha = 60^\circ$

For the rib of the wedge ( $\rho = 0$ ) in all cases the factor is  $M = 1.5$ . This means that the temperature at the rib of the wedge is 1.5 times higher than the temperature at the surface of a semi-infinite body under the same conditions. The bigger the distance from the rib of the wedge is, the less values of the multiplier  $M$  are, they tend to unity. In the region directly below the source (for small values of  $z$ ), the multiplier  $M$  quickly tends to unity, which characterizes the weak influence of the part's finiteness on the temperature field directly below the source. The farther from the source, the stronger the effect of the part finiteness, but the value of the temperature far from the source is small. To characterize the influence of the wedge-shaped part finiteness on temperature in points located near top-rib, some average calculated value of  $M$  can be used. In general case, when wedge angle is  $\alpha$ , the value of multiplier  $M$

on the wedge rib can be shown as  $M = \frac{\pi}{2\alpha}$ . Therefore the solution for calculation of temperature at the wedge rib will be

$$T = \frac{\pi}{2\alpha} \int_{-h}^h \frac{q}{2\pi\lambda} \exp\left[-\frac{\vartheta(z-z')}{2a}\right] K_0 \left\{ \frac{\vartheta^2}{4a^2} \left[ r^2 \sin^2(\theta - 2\alpha n) + (z - z')^2 \right] \right\}^{1/2} dz' \tag{3}$$

If we introduce notations

$$\frac{\vartheta(z-z')}{2a} = \zeta, \quad \frac{\vartheta}{2a} z = Z, \quad \frac{\vartheta}{2a} h = H, \quad \frac{\vartheta}{2a} r = \rho,$$

the temperature can be represented in a dimensionless form

$$\theta = \frac{\pi}{2\alpha} \int_{Z-H}^{Z+H} \exp(-\zeta) K_0[\rho^2 \sin^2 \theta + \zeta^2]^{1/2} d\zeta \tag{4}$$

when:

$\rho \rightarrow \infty$ , i.e. at points of machined surface, located enough far from wedge rib, the influence of finiteness of part size decreases, and for  $\rho = \infty$  for all  $\zeta$  the multiplier  $M = 1$ .

Fig. 2 demonstrates the calculation of the temperature distribution on the wedge surface with an angle at the top being  $\alpha = 60^\circ$  for surface points corresponding to different  $\rho$ . When  $\rho = 6.25$  the temperature corresponds to the temperature on the surface of a semi-infinite body; when  $\rho = 0$  (the rib of the wedge), it is 1.5 times larger at all points than on the surface areas remote from the edge. If the same assumption is used for a wedge with an opening angle  $\alpha$ , then the temperature on the edge will accordingly exceed the temperature of sufficiently remote points by a factor of  $\frac{\pi}{2\alpha}$ .

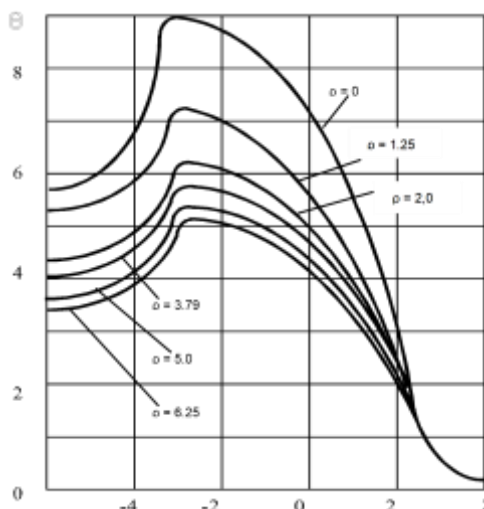


Fig. 2 Temperature distribution along wedge surface with  $\alpha = 60^\circ$

When plates are grinded along the cutting edge, the presence of a second free surface (other than the machined one) washed by the coolant can significantly affect the temperature distribution in the region of greatest heating, i.e. near the rib of the wedge.

Fundamental solution for this case can be written the following way (Sipaylov 1978):

$$\theta = \exp(-Z) K_0(\sqrt{X^2 + Z^2}) - \beta \exp(\beta X - Z) \times$$

$$\int_x^\infty \exp(-\beta X) K_0(\sqrt{X^2 + Z^2}) dX - \int_0^\infty \left\{ \beta \exp \beta Y \left[ \int_Y^\infty \frac{2}{R} \exp(-(Z + R)) \right] - \right. \\ \left. - 2\beta \exp(\beta X - Z) \int_X^\infty \frac{dX}{R} \exp(-(\beta X + R)) \right\} dY' dY' \quad (5)$$

Equation (5) describes temperature field of linear source moving along wedge surface, the both faces of which are cooled. The first summand of this expression describes the temperature field on the surface of the wedge without heat transfer. The second summand characterizes heat transfer only on the plane of the wedge along which the source moves. The third summand reflects the impact from the heat exchange of the free surface.

The farther from the rib of the wedge, the more rapidly the effect of heat transfer decreases. The greatest influence of the free surface will be when the third summand of equation (5) is the biggest.

Equation (6) is a solution for a strip source moving along one of the faces of the plate wedge with heat transfer occurring on both faces and under the source.

$$\theta = \int_{Z-H}^{Z+H} \exp(-\xi) K_0(\sqrt{X^2 + \xi^2}) d\xi - \beta \int_{Z-H}^{Z+H} \exp(\beta X - \xi) K_0(\sqrt{X^2 + \xi^2}) dX d\xi - \\ - \int_{Z-H}^{Z+H} 1 \int_0^\infty \left\{ \beta \exp Y \int_Y^\infty \left[ \frac{2}{R} \exp(-(\xi + R)) - 2\beta \exp(\beta X - \xi) \right. \right. \\ \left. \left. \int_X^\infty \frac{dX}{R} \exp(-(\beta X + R)) \right] dY' \right\} dY' d\xi \quad (6)$$

Complete general solution for rib temperature calculation considering the action of coolant can be demonstrated as the next dependence

$$T = \frac{2qa}{\pi\lambda \cdot v_d} M_{cp}(\rho, \alpha, \phi) B(\beta, \chi) \cdot \theta \quad (7)$$

where:

$$\theta = \int_{Z-H}^{Z+H} \exp(\zeta) K_0 \cdot (\sqrt{\rho^2 \sin^2 \phi + \zeta^2}) d\zeta$$

To ensure guaranteed heat transfer during the high-speed thermal process of the wedge-shaped plate, it is necessary to take into account the heat transfer coefficient  $\alpha$ , the thermophysical properties of the coolant and the processed material.

In this work, we confine to considering a method for determining the heat transfer coefficient  $\alpha$  under conditions of convective heat transfer in unlimited space to apply this for solving the problems of determining the temperature fields of machined parts.

Convective heat transfer occurs when the fluid moves. In this case, heat transfer is carried out simultaneously by molecular conduction and macroparticles, which are mixed in a fluid moving from a region with one temperature to a region with a different temperature. It should be noted that convection can occur only in the moving fluid, while the heat transfer is directly connected with the transfer of the fluid itself.

The heat exchange between the fluid flow and the machined surface is directly proportional to the heat transfer coefficient  $\alpha$ , contact area  $F$  and the temperature difference between the temperature of the machined surface  $T_n$  and

the temperature of the liquid  $T_q$ . The relationship under consideration is based on Newton's law

$$Q = \alpha(T_n - T_q)F \text{ or } \alpha = \frac{Q}{(T_n - T_q)F} \quad (8)$$

From the other hand, the density of heat flux on the machined surface (heat removal) can be found according Fourier equation

$$q_n = -\lambda \left( \frac{\partial T}{\partial n} \right)_{n=0}$$

where:

$n$  – normal line to machined surface

or

$$\alpha = -\frac{\lambda}{T_n - T_q} \left( \frac{\partial T}{\partial n} \right)_{n=0} \quad (9)$$

Thus, heat transfer coefficient is amount of heat received from moving fluid by machined surface and vice versa from machined surface by the moving fluid through the unit of machined surface, which is divided by temperature difference between machined surface and fluid.

Heat transfer coefficient  $\alpha$  depends on different factors and huge number of variable arguments providing heat transfer process in general. They include geometric dimensions, shape and temperature of heat transfer surface, hydrodynamics, moving mode, speed and temperature of coolant as well as physical properties of fluid. The speed of flux and flow conditions of coolant exert the main impact on heat transfer intensity. The nature of the flow around the wedge-shaped body is expressed in the power-law distribution of velocity at the outer boundary of the shear layer (Fletcher 1991).

$$v = cx^{m_1} \quad (10)$$

With an accelerating or decelerating flow, this flow around will be entailed by the occurrence of a pressure gradient  $dp/dx$ . Only in case of  $m_1 = 0$  the flow around the wedge-shaped body will become gradient less, i.e. it will correspond to the flow around the plate. Fig. 3 demonstrates the most likely cases of flow around the wedge-shaped bodies.

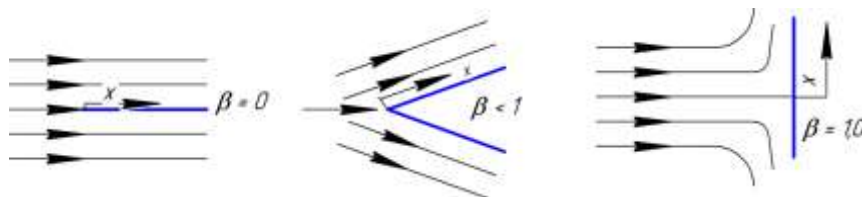


Fig. 3 Schemes of flow around the wedge-shaped bodies

The exponent  $m_1$  can be expressed in through the opening angle  $m_1 = \frac{\beta}{2-\beta}$ .

When  $\beta = 0$  and  $\beta = 1$  the flow around the wedges is similar to the longitudinal or transverse flow around the plate.

The temperature distribution in the contact zone of grinding wheel – part – cooling fluid will be (Zhakauskas et al. 1982):

$$\frac{T_n - T}{T_n - T_q} = \theta = c_2 \int_0^{\eta_1} \exp(-Pr \int_0^{\eta_1} f_1 d\eta_1) d\eta_1 \quad (11)$$

where:

$T$  – temperature in the contact zone of the grinding wheel – the wedge being machined – cooling fluid;

$T_n$  – temperature of the machined surface;

$T_q$  – cooling fluid temperature;

$C_2$  – constant of integration, which depends on boundary conditions;

$Pr$  – Prandtl number for fluid;

$\eta_1$  – flow function.

By substituting various values of  $Pr$  and  $\beta$ , we can determine the temperature distribution in the boundary layer, which is shown graphically (Fig. 4).

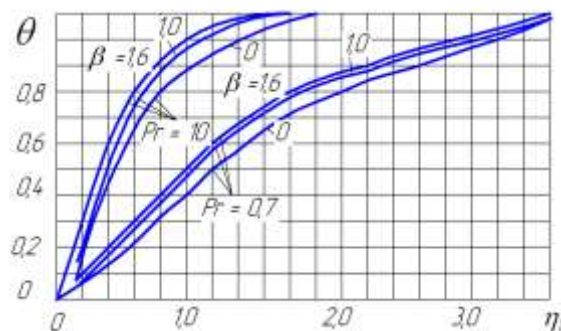


Fig. 4 Temperature distribution in the thermal boundary layer of wedge-shaped bodies at various values  $Pr$  and  $\beta$

## RESULTS

By using Nusselt criterion for flow around wedge-shaped body (Zhakauskas et al. 1982):

$$Nu = \frac{\alpha \cdot x}{\lambda} = \frac{c_2}{\sqrt{2-\beta}} \sqrt{Re} \quad \text{or} \quad Nu = 0,56 \frac{(\beta+0,2)^{0,1}}{\sqrt{2-\beta}} Re^{0,5} Pr^{0,333+0,067\beta-0,026\beta^2}$$

and temperature gradient on the surface, we find heat transfer coefficient

$$\alpha = \frac{\lambda}{\sqrt{2-\beta}} \sqrt{\frac{v_x}{v \cdot x}} c_2 = \frac{\lambda \cdot 0,56 (\beta+0,2)^{0,1} Pr^{0,333+0,067\beta-0,026\beta^2}}{\sqrt{2-\beta}} \sqrt{\frac{v_x}{v \cdot x}} \quad (12)$$

where:

$x$  – linear size of the machined surface.

Equation (12) gives the dynamics of change in heat transfer coefficient on the surface of wedge-shaped bodies depending on their wedge angle  $\beta$ .

Research on heat transfer coefficient during high-speed thermal process – sharpening of wedge surface allowed us to make the following conclusions:

1. The most important element affecting the heat transfer coefficient is the wedge angle  $\beta$ . With increasing wedge angle  $\beta$ , the heat transfer coefficient grows.
2. To ensure guaranteed heat transfer, the wedge angle should be at least  $7^\circ$  and not exceed  $114^\circ$ .
3. The thermophysical properties of the cooling fluid exert ambiguous influence on the heat transfer coefficient. With an increase in the thermal conductivity  $\lambda$ , the heat transfer coefficient  $\alpha$  increases in direct proportion. The heat

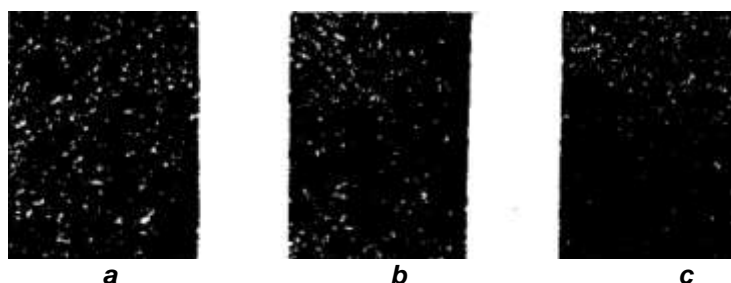
transfer coefficient decreases sharply with increasing kinematic viscosity of the liquid  $\nu$  and thermal diffusivity coefficient  $a$ .

4. The temperature distribution in the boundary layer depends on the Prandtl number  $Pr$  and the wedge angle  $\beta$ . With their growth there is an increase in temperature in the contact zone of the grinding wheel – the wedge-shaped surface being machined – the cooling fluid.

Research on thermal processes in a high-speed thermal process made it possible to establish regularities of influence of cutting speed, source speed, contact area, coolant properties and heat transfer coefficient on the temperature and rate of thermal processes in surface layers, as well as their impact on the depth of heating to a certain temperature. The study also allowed us to show the relationship between temperature and rates of heating and cooling. The solution to this problem, taking into account the action of the cooling fluid, gives the opportunity to bring the picture of the development of thermal processes closer to real conditions and makes it possible to reasonably predict the structural state of the surface layer of wedge-shaped parts made of 8KHF steel under various conditions of a high-speed thermal process.

The nature of the change in the microstructure of 8KHF steel and its hardness depending on the rapid heating of the samples was studied at temperatures of 200, 300, 400, 500, 600, 700, 800, 850°C. The samples had been heated in a special furnace with an air atmosphere for 10 minutes, and then they were cooled in water. For each heating temperature, 5 wedge-shaped samples of 20 × 40 mm were provided.

The hardness of samples was measured applying Rockwell method. The microstructure of samples was studied by means of transverse microsections, which were made in places of spark cutting. All samples had the same microstructure, which was uniform along the section. It consisted of fine grain perlite and carbides. The microstructure is shown on the photograph, Fig. 5. According to the degree of dispersion of cementite grains in perlite, this microstructure corresponds to 4 points of scale 2. No changes in the microstructure at the surface of the decarburized layer were observed on all samples of the part.



**Fig. 5 Microstructure of steel 8KHF: a – after quenching (initial), b – after quenching and tempering, c – after secondary quenching ×200**

During research spectral and chemical analyses were fulfilled. Their results show that wedge-shaped bodies made of steel grade 8KHF meet the



requirements of GOST 5950-2000. They contain the next chemical elements in %:

C	Mn	Si	P	S	Cr	V
0.76	0.33	0.24	0.021	0.008	0.65	0.22

The change in hardness of samples according to temperature of secondary heating is demonstrated on Fig. 6. Data analysis shows that heating up to temperature 350°C doesn't change the hardness of the samples. When they are heated to temperatures in the range between 400 to 700÷750°C, it causes decrease in hardness HRC from 51÷52 to 20÷25. In case of heating up to 400°C, the microstructure of metal samples consists of troostite and carbides. With temperature increase to 600°C the microstructure gets bigger and turns to sorbite and carbides. When the samples are heated to 800÷850°C and then rapidly cooled, secondary quenching occurs, hardness HRC increases to 60÷65. Checking by means of a magnetic flaw detector shows the presence of cracks on samples that were secondary quenched after heating to temperatures of 800÷850°C and then rapidly cooled.

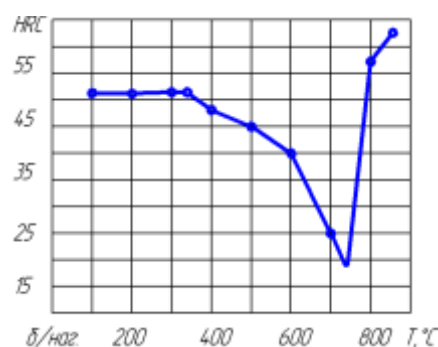


Fig. 6 Changes in hardness depending of temperature of heating and rapid cooling

The critical points of the phase transformations were determined by the dilatometric method, the application of which is based on the fact that heating causes a violation of continuity in the change in the length of the test sample during phase transformations. To determine the critical points, a Chevenar dilatometer was used. Specially made samples were heated in the dilatometer furnace to 900°C. The heating rate was 200 deg/h. During heating, the elongation of the sample and the reference were recorded on a photographic plate using a light point (during heating of the sample and the reference, the light point will follow the resultant of two paths). The structure and hardness of 8KHF material, depending on the heating mode, is presented in Table 1.

Table 1 Structure and hardness of 8KHF material depending on heating mode

Heating temperature, °C	Initial hardness HRC	Hardness after heating HRC	Microstructure after heating
200, 300, 350	52...51	51...50.5	Troostite+carbides
400, 500	51...50	48...46	Troostite+carbides
600, 700	52...50	25...35	Sorbite+carbides
800, 850	51.5...50	56...63	Martensite+carbides

The temperature of the beginning and the end of transformations occurring in steels 8KHF during heating was established by bends on the graph temperature – elongation. Point  $Ac_1$  on the Fig. 7 corresponds to the start of transformations, while point  $Ac_3$  shows the end of transformation of initial structures into austenite. The transformations begin at temperature 741°C, and they end when it reaches 772°C.

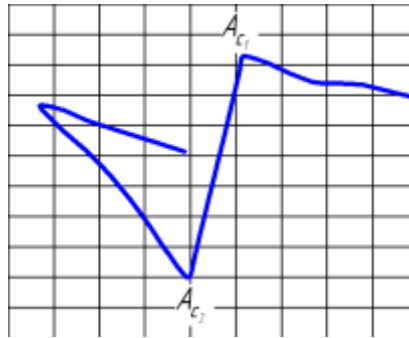


Fig. 7 Oscillogram for identifying critical points of structural transformations

Thus, microstructure analysis of steel 8KHF depending on heating temperature showed that heating over critical points  $Ac_1$  and  $Ac_2$  causes secondary quenching of metal, while heating to temperatures in the range between 500 to 700°C results in tempering.

To establish possible structural changes during a high-speed thermal process – sharpening of wedge-shaped bodies along the cutting edge, analytical studies were carried out to determine the temperature in the cutting zone, depending on the machining conditions for various grinding schemes. The results of the calculations fulfilled according to the dependencies mentioned above are given in Table 2.

Table 2 Maximum temperature on the cutting edge of wedge-shaped body depending on scheme of high-speed thermal process – sharpening and machining modes

Scheme of heat source movement	Abrasive tool	Cooling	Cutter power kW	Sharpening modes			Temperature $T_{max}$ , °C
				$U_w$ , m/s	$U_p$ , m/min	$t$ mm	
Along cutting edge of "wedge"	AC4MO13 100/80 100 %	+	0.18	25	0.05	0.35	280
			0.22	25	0.10	0.40	310
			0.25	25	0.15	0.42	355
			0.63	25	0.25	0.40	510
Across cutting edge of "wedge"	AC2K1 125/100 100 %	+	0.25	25	0.02	0.41	220
			0.48	25	0.05	0.38	340
			0.96	25	0.15	0.40	490

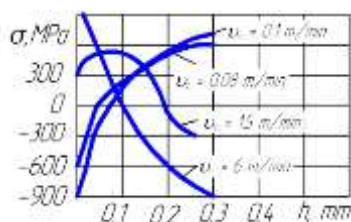
Analytical calculations of maximum temperature of surface to be sharpened under high-speed thermal process demonstrated that during intensive machining modes ( $U_p = 0.20$  m/min and higher) it can exceed the temperature

of structural changes. The results of calculation are proved by studies of microstructure of machined material of cutting edge of wedge-shaped body, which showed the presence of microcracks and phase transformations, corresponding to conditions of secondary quenching (Fig. 8).



**Fig. 8 Microstructure of material after sharpening of cutting edge of wedge-shaped body with longitudinal feed  $u_p = 0,25$  m/min,  $t = 0.4$  mm,  $u_{kp} = 20$  m/s**

We conducted experimental research to determine the stresses occurring in the surface layer of samples of steel 8KHF after various conditions of a high-speed thermal process. Stresses were determined by the method of N.N. Davidenkov (Ivanova, Dement'ev 2012). On the base of the results of the experiments, graphical dependences of the stresses on the machining modes were drawn (Fig. 9).



**Fig. 9 Dependence of residual stresses in surface layer on speed of part during grinding of steel 8KHF,  $u_w = 25$  m/s,  $t = 0.5$  mm**

The analysis of graphical dependences (Fig. 9) shows that with an increase in the speed of movement of a part, residual tensile stresses of a larger value are formed in the surface layer. If the gradient drops and the contact temperature increases, the surface layers heat up deeper and have time to get rest, i.e. stress relaxation occurs, reducing the tensile stress on the surface to zero.

## CONCLUSION

During the studies not only a decrease in tensile residual stresses was recorded, but also their transition to compressive ones, which cannot be explained just by the influence of a temperature gradient. In this range of parameters of the grinding mode, the action time of the heat source  $\tau$  becomes longer, the surface layer warms up deeper and the stress redistribution over time occurs. When depth of heating increases, the surface layer does not cool simultaneously over the entire cross section. In the cooling process, there comes a moment when the outer layer contracts the surface layer, causing the maximum tensile stresses to displace from the surface deeper into the metal. Therefore, to prevent dangerous tensile stresses from happening, it is necessary to reduce

the longitudinal feed (part speed), which will cause a decrease in the productivity of the high-speed thermal process. It was established that it is necessary to increase the machining depth at the optimum cutting speed to compensate for the loss of productivity.

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**Abstract:** A direct influence on the physical and mechanical state of the surface layer of wedge-shaped plates made of 8KHF steel is exerted by heat generation processes developing in the zone of a high-speed thermal process. Research on the influence of the parameters of a high-speed thermal process on the change in the structure of 8KHF steel (GOST 5950-2000 Russia, standard PN/H 85023 brand NCV1 Poland) was fulfilled. It allowed studying the nature of the change in the microstructure depending on short-term heating to various temperatures and rapid cooling. As a result, critical points of the beginning and the end of structural transformations during heating were determined. Research on thermal processes in a high-speed thermal process made it possible to establish regularities of influence of cutting speed, source speed, contact area, coolant properties and heat transfer coefficient on the temperature and rate of thermal processes in surface layers, as well as their impact on the depth of heating to a certain temperature. The study also allowed us to show the relationship between temperature and rates of heating and cooling. The solution to this problem, taking into account the action of the cooling fluid, gives the opportunity to bring the picture of the development of thermal processes closer to real conditions and makes it possible to reasonably predict the structural state of the surface layer of wedge-shaped parts made of 8KHF steel under various conditions of a high-speed thermal process.

**Keywords:** steel 8KHF, cutting edge sharpening, thermal deformation, depth and nature of structural transformations, high-speed thermal process