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RELATIONSHIP BETWEEN TEMPERATURE AND SPEED OF TURNING PROCESS OF AISI1045 STEEL BY ST3000 ALLOY

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ABSTRACT

Today, mechanical processing is the main method of processing steel and cast iron. Since mechanical processing methods are more accurate than others. Turning is the most basic process in machining, in the turning are used many types of cutting tools are made of different materials. The most important cutting tool property is its durability. The durability of the cutting tool defines the lifetime of this cutting tool and it determines its suitability for select technological operations. Nonetheless, studies show that durability depends on cutting speed and mode. Nowadays, the durability of the cutting tool is determined by a formula in analytical and empirical ways, and also modeling methods are widely used.
In this study, we use AdvantEdge to determine the relationship between the temperature at the cutting zone and cutting speed. The analysis results show that the temperature at the cutting zone (245→239.49→226.2770C) decreases as the cutting speed increases. As researchers, we believe that a large amount of the heat generated with increasing cutting speed was removed from the workpiece by the chip.

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1. Temperature at the cutting zone and influencing factors

During the process of cutting metal, mechanical energy is converted into thermal energy. As a result of generating heat, the temperature at the cutting zone increases. In the cutting process, nearly all of the energy dissipated in plastic deformation is converted into heat that, in turn, raises the temperature in the cutting zone. Because heat generation is closely related to plastic deformation and friction, three main sources of heat can be specified when cutting:

1. Friction or plastic deformation inside the chipboard Q1
2. Friction of slag and inner surface Q2
3. Friction on the back of the instrument and the treated surface Q3

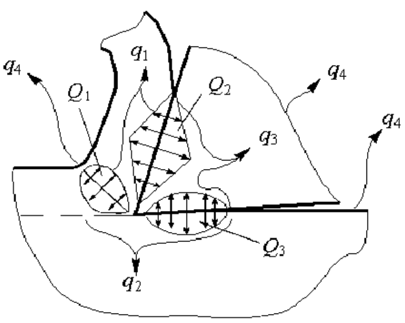

Fig. 1 The balance of heat generation and heat dissipation in the cutting zone

The maximum heat is emitted in the 1-1 zone formed by the chip shown in Figure 1. Firstly, the chip in this zone changes its direction abruptly to the transition zone so there is a lot of internal friction. Secondly, the chip is very strongly compressed and deformed by the action of the cutting tool.

Figure 2 shows a lot of friction in the area enclosed by the dashed lines. As a result of the above two processes, a large amount of heat is generated. In machining processes, cutting tools reach temperatures higher than 900 °C. [1]

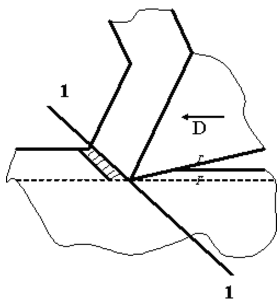

Fig. 2 Deformation zone in metal cutting

During turning processing plastic deformation is occurred before elastic deformation. However plastic deformation region is relatively small, we have to estimate plastic deformation when heat at the cutting zone is determined necessary.

To estimate plastic deformation, measure the microhardness of its surface.

Heat at the turning process can be represented as

$$Q_{ep} = Q_1 + Q_2 + Q_3 \qquad (1.1)$$

The heat generated by the turning process must be dissipated into the environment and it is transferred from a higher temperature to a lower temperature.

The heat generated with increasing cutting speed is dissipated in different proportions into the tool, chip (q_1), tool (q2), workpiece (q3), environment (q_4). (Figure 3)

$$Q_1 + Q_2 + Q_3 = q_1 + q_2 + q_3 + q_4 \qquad (1.2)$$

The generated heat and heat dissipation depend on the physico-mechanical properties of the workpiece material, the cutting mode, the geometric parameters of the cutting tool and the external conditions.

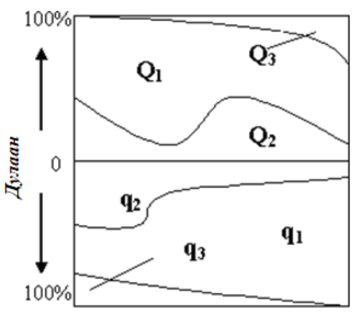

Fig. 3 Causes of Heat Dissipation Paths and Cutting Speed

Starting to cut the temperature in the cutting zone increases and reaches a certain level because the heat generated in a certain time and heat dissipation are balanced. From a practice point of view, special attention should be paid to the temperature of the tool and the workpiece.

Although the heat transferring to the cutting tool is small, it influences the machined parts and the durability of the cutting tool.

2. Relationship between cutting procedure and temperature

Many researchers who study influencing factors on heat generated in the cutting process noted that the temperature in the cutting zone is influenced by the workpiece material, cutting procedure, geometric parameters of the cutting tool, and other factors.

While cutting speed influences extremely and data influences small, depth of cutting does not influence cutting temperature. The influence of the cutting parameters on the tool temperature was studied among other research by Chu and Wallbank in 1998, where a relationship between the cutting parameters and the cutting temperature for a specific range of cutting speed and feed was established.

Also, researchers Saglam, Unsacar, and Yaldiz in 2006 studied the influence of cutting parameters and the tool's geometry on the cutting temperature and the cutting forces during the turning of carbon steels. The results of this study suggest that tools approaching and rake angle have a considerable effect on the cutting forces and on the tool-chip interface temperature.

Many researchers have defined analytical and empirical formulas for estimating the temperature in the cutting zone.

Analytical formulas are complex and contain a large number of unknown variables.

The empirical formula is simple but has the disadvantage that it is only suitable for experimental conditions. The following formula is quite common. These include: $\theta = C_\theta \cdot t^{x\theta} \cdot s^{y\theta} \cdot v^{z\theta}$ (2.1)

Where:

θ is the temperature in cutting zone, C;

t – cutting depth, mm;

s - feedrate, mm/pr ;

v – cutting speed, m/min;

C_θ is the coefficient taking into account the condition of the target

x_θ, y_θ, z_θ - an indicator of the degree to which a factor affects the target area

Exponents usually are the following ranges

x_θ=0.1-0.2; y_θ=0.2-0.25; z_θ=0.4-0.6;

The exponents show that the cutting speed has the greatest impact on the cutting temperature. [1,2]

3. Modelling of heat generated in the cutting zone and cutting speed

The generated heat at the cutting zone is mainly governed by elastic-plastic strain energy dissipated at the primary, secondary and tertiary deformation zones and friction between the chip and insert on the secondary deformation zone.

AdvantEdge is a 2d and 3d modeling software. The software is capable of analyzing the endurance parameters (temperature, load) of the sawing tool and the factors influencing the sawing. High-precision results can be obtained without physical testing. [3]

Using this program, we determined the relationship between the temperature and the cutting speed of turning AISI-1045 steel by CT3000 alloy.

Adjust at the beginning of the model. Modeling settings:

Units = SI

Process Type = turning

Workpiece length = 5.0 mm

Workpiece height = 2.0 mm

Material = AISI-1045

Rake angle = 6.0 deg

Rake length = 2.0 mm

Relief angle = 6.0 deg
Relief length = 2.0 mm
Cutting Edge Radius = 0.4 mm
Tool Material = Carbide-Grade-P
Mesh Grading = 0.4
Feed = 0.33 mm
Cutting speed = 157.0 m/min
Depth of cut = 3.0 mm
Length of cut = 3.0 mm
Initial temperature = 20.0 degC
The settings are shown in Figures 3, 4, and 5.

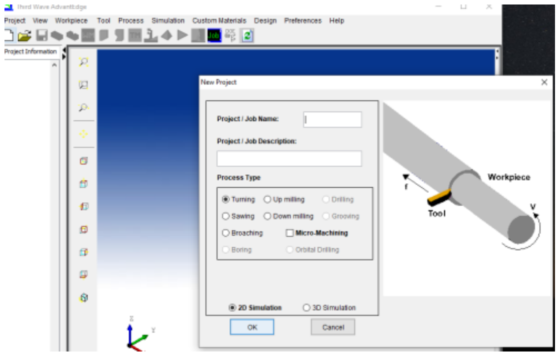

Fig. 3 Selection of turning lathe in 2D or x, y plane

The 2D lathe is designed to flatten the rotating body

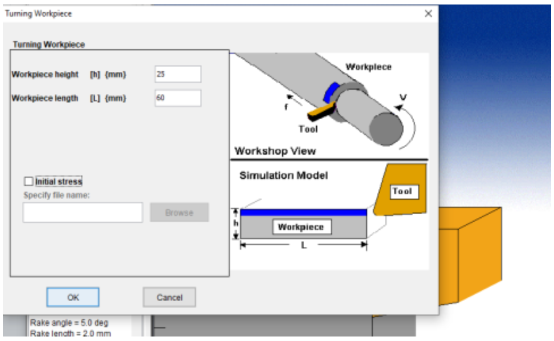

Fig. 4 Workpiece dimensions

In this study, the machining process was performed using a DTGNR2020K16 tool holder and a TNGG160404 R cutting insert. The workpiece material was an AISI 1045 alloy steel. AdvantEdge program does not include 40X grade material, we chose AISI-1045 200HB hardness material with similar chemical composition and physical and mechanical properties.

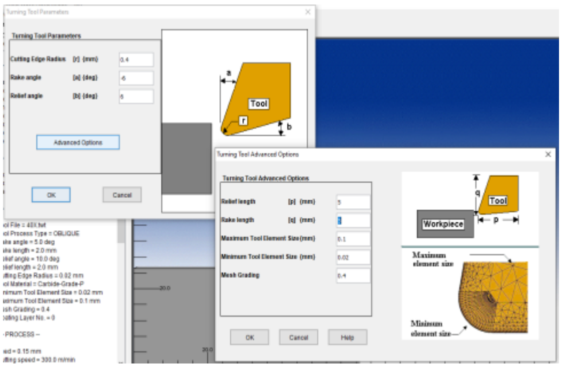

Fig. 5. Geometrical parameters of the cutting

For modeling, the maximum depth of the cutting procedure is t = 3 mm, the yield is s = 0.33 mm / turn, the cutting length is l = 60 mm, the cutting speed is 157 m / min, and the pre-cutting temperature is 20 ° C.

We can change the cutting length depending on the highest temperature at the cutting zone and simulation time.

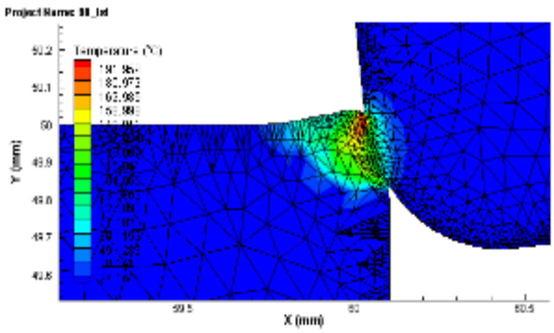

Fig. 6. Heat dissipation during cutting /0.33 mm / rpm, t = 3 mm, v = 98 m / min /

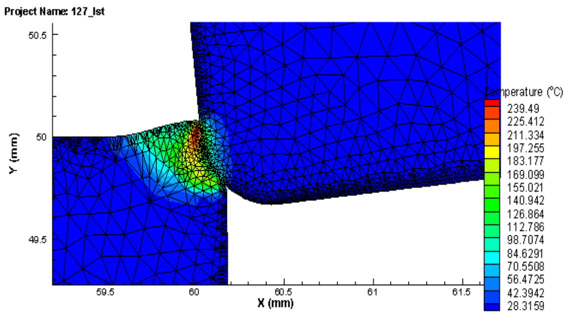

Fig. 7. Heat dissipation during cutting /0.33 mm / rpm, t = 3 mm, v = 127 m / min /

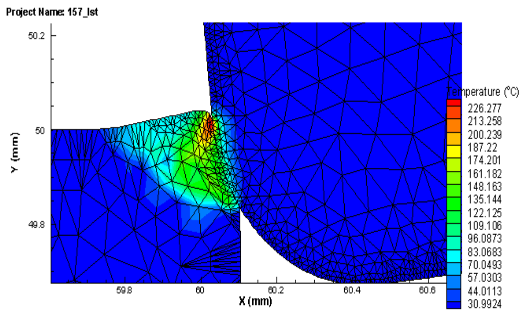

Fig. 8. Heat dissipation during cutting (0.33 mm / rpm, t = 3 mm, v = 157 m / min)

The modeling results (Figures 6, 7, and 8) show that the temperature in the cutting zone (245 -> 239.49 -> 226.2770C) decreases while the cutting speed increases. This is due to the fact that most of the heat generated by the increase in velocity is rapidly dissipated with the particle. We noted that a large amount of the heat generated with increasing cutting speed was removed from the workpiece by the chip.

Conclusions.

1. Although the heat transferring to the cutting tool is small, it influences the machined parts and the durability of the cutting tool.
2. The empirical formula is simple but it has the disadvantage to be suitable for experimental conditions. The exponents show that the cutting speed has the greatest impact on the cutting temperature.
3. The modeling results obtained by AdvantEdge show that the temperature in the cutting zone (245 -> 239.49 -> 226.2770C) decreases while the cutting speed increases. We concluded that a large amount of the heat generated with increasing cutting speed was removed from the workpiece by the chip.

REFERENCES

1. https://studme.org/274290/tehnika/eksperimentalnye_metody_opredeleniya_temperatury_rezaniya_tochenii
2. https://ozlib.com/811630/tehnika/temperatura_rezaniya_sposoby_izmereniya_vliyanie_temperaturu_rezhimov_rezaniya
3. https://www.thirdwavesys.com/advantedge/