CONTENTS AUTHORS

15th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2011, Prague, Czech Republic, 12-18 September 2011

THE TEMPERATURE RESEARCH IN INCREASED SPEED PROCESSING BY TURNING

Avdi Salihu, Faculty of Applied Technical Sciences Mitrovica, Fabrika e akumulatorëve Mitrovicë, Kosovë.
avdi.salihu@uni-pr.edu

Nexhat Qehaja, Mechanical Engineering Faculty, Prishtina
Kodra e dielli, pn Prishtinë 10000, Kosovë, nexhatq @yahoo.com

Hakif Zeqir, Faculty of Applied Technical Sciences in Mitrovica, Fabrika e akumulatorëve Mitrovicë, Kosovë,
kifa.z@hotmail.com

Azem Kyqyku Engineering Faculty, Prishtina, Kodra e diellit, pn. Prishtinë 10000, Kosovë
nexhatq@gmail.com

Avdyl Bunjaku, Mechanical Engineering Faculty, Prishtina
Kodra e dielli, pn Prishtine, Kosovë,
avdylbunjaku@hotmail.com.

Fitim Zeqiri, Faculty of Applied Technical Sciences in Mitrovica, Fabrika e akumulatorëve Mitrovicë, Kosovë.
Fitim.zeqiri@uni-pr.edu

ABSTRACT:
In this paper are introduced research results of the temperature using the thermocouple method during the turning. The research is done in numerical lathe GILDEMESTER MD 5S on material C 45 (according to DIN) with the cutter plates MC2 of the HERTEL Company. The processing is implemented by changing the various independent sizes: cutting velocity (v), cutting feed (s), cutting depth (a) and nose radius (r) using the first row four factor plan (2^4+4).
***Keywords**. Temperature, cutting velocity, cutting plates, thermocouple.*

1. INTRODUCTION

During machining heat is generated at the cutting point from three sources, as indicated in fig. 1. Those sources and causes of development of cutting temperature are:

- Primary shear zone (1) where the major part of the energy is converted into heat
- Secondary deformation zone (2)at the chip –tool interface where further heat is generated due to rubbing and/or shear
- At the worn out flanks (3) due to rubbing between the tool and the finished surfaces

Regarding to the average temperature during cutting, many scientific studies are published. Research have been conducted in order to establish the influence of processing parameters in temperature distribution, in the processing part and the cutting edge.

Former researches for temperature measurement are done by Savin(1909), Brokemberg Mayer (1919), that have measured temperature using the calorimetric method during the cutting process. Usachev in 1915 applied the thermocouple which he placed on a tool and measured the temperature directly. At the same time, Shore (1924) in the USA, Getwin (1925) in Germany and Herbert in England, have developed temperature measurement through natural thermocouple that is made up from the cutting tool and the processing part.

CONTENTS AUTHORS

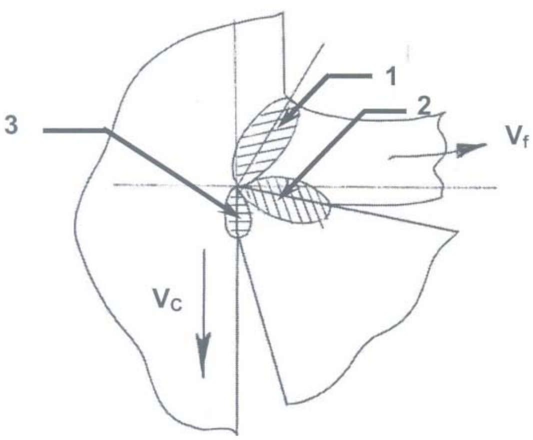

Figure 1. Sources of heat generation in machining

In this paper are introduced the research and experimental results of temperature measurement through the method of thermocouple

2. CONDITIONS FOR EXPERIMENT REALIZATION

Material: Steel C 45 has been used (according to DIN) product of smelter Ravne from Koroshka's Ravne, Republic of Slovenia.

Machine: The experiment for measuring the average temperature is done in numerical control turning type GILDEMEISTER MD 5S P = 1.85 – 25 KW number of rotations n=100–4000 rot/min and cutting feed s = 0.001–39.99 mm/rev.

Metal cutting tool: Ceramic cutting plates MC2 have been used 120712-120716-120720 product of HERTEL.

Holder IK.KS2NR-064 25x25 mm was used- product of KENNAMETAL Company (original χ=85 ^{0} turned 10 ^{0}) with the following geometry:: $\chi = 75^{o}$, $\chi_{1} = 15^{o}$, $\gamma = -6^{o}$, , $\lambda = -6^{o}$, $r_{\varepsilon} = 1.2 - 1.6mm$, $\gamma_{f} = -20^{o}$, $b_{f} = 0.2mm$ VB=0.00 mm.

Cutting plate holder is adjusted to the conditions for transporting thermo-electrical signal from the cutting plate. fig. 2.

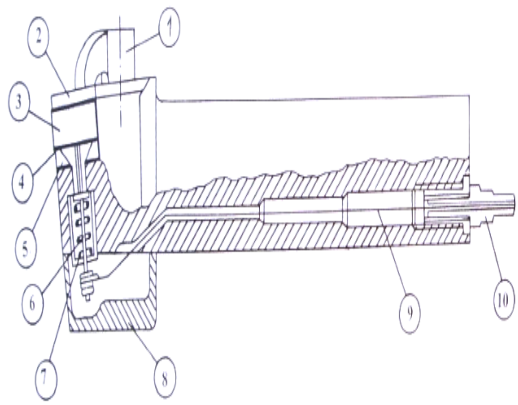

Figure 2. The cutting tool prepared for temperature measurement;

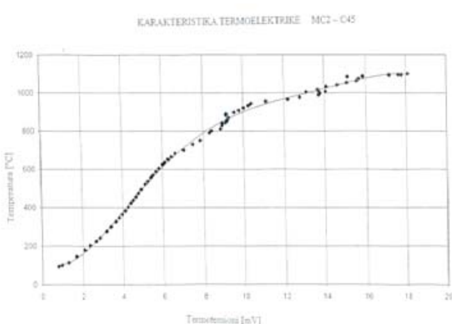

Figure 3. Dependency between temperature and thermo-tension

The equipment for registration of signals from the working material: HOTINGER'S Head [1]. Installation for the calibration of natural thermocouple C45-MC2, based on results, gave dependence between temperature and thermo voltage, as a fifth-order polynomial presented in 2.1.

Using regressive analysis from obtained results as per paper [1] it has been obtain dependency between temperature and thermo-tension as polynomial of fifth grade of forms:

$$T= 118.68-64.105\ u + 55.038u^{2} -7,0719u^{3} +0.368u^{4} -0.007u^{5} \qquad (2.1)$$

Graphic interpretation of polynomial 2.1 is presented in fig. 3.

Research apparatus In order to set the average temperature during the cutting process, the measuring apparatus was used as presented at [1].

Rings: Made of the following dimensions Ǿ 170 x 80 x 25 mm[1]. The processing was executed by changing the various independent sizes: cutting velocity (*v*), *cutting* feed *(s)*, cutting depth *(a)* and the nose radius (*r*) as shown on Table 1, using the first row four factor plan (2^4+4) [1,3].

T*able 1. Conditions for experiment realization*

CHARACTERISTICS OF INDPENDENT VARIOUS SIZES					
Nr	Note	Level Code	Maximal 1	Average 0	Minimal -1
1	v (m/min)	X1	700,000	458,258	300,000
2	s (mm/rev)	X2	0.320	0,226	0,160
3	a (mm)	X3	1,600	0,894	0,500
4	r (mm)	X4	2,000	1,549	1.200

3. ANALYSIS OF THE RESEARCH RESULTS

The obtained results out of the experiment realization are presented on Table 2 and based on the data processing, the mathematical model 3.1 was gained. The graphical interpretation of the model 3.1. is presented in fig 4.

$$T = 364.194 \cdot v^{0.188} \cdot s^{0.102} \cdot a^{0.0341} \cdot r^{-0.0865} \qquad (3.1)$$

By analyzing the mathematical model and the graphic interpretations we can conclude as follows:

- the highest temperature will be at the chip's contact zone with the front surface because the largest amount of heat is concentrated there as a result of deformation and friction.
- in the cutting temperature influences except the cutting speed, that has a greater influence, also cutting feed. If the cutting feed is increases, the chip pressure on the tool will increase; along with it the work too which is necessary for deformation. But as it is known, the coefficient of chip contraction decreases, and therefore the required work for deforming a 1 mm^3 chip decreases. On the other hand, the friction of the back surface with the work piece does not change. Consequently, the cutting temperature increases when the cutting feed is increased but at a slower rate than to the velocity [5]
- when the cutting feed is increased, the contact of chip with the front face is improved the heating declines.
- it can be stated that the increase of the average temperature is a result of the increase of temperature on the back surface of the cutting tool because of the increased friction between the procesed surface and the tool's back surface.
- the cutting depth influences in the cutting temperature and this is seen from mathematical models and their graphical interpretation, because the pressure on the cutting edge length unit does not change. With the increase of the cutting depth the length of the edge that takes part in the cutting process is increased, and thereby the heat removes from the cutting zone. [2].
- the geometry of tool influences on the cutting temperature, with the increase of the cutting angle the cutting forces increase and consequently the quantity of heat that is created at the cutting zone increases – that is the temperature increases.

Table 3. Show of the obtained results of the experimental realization

	REAL PLAN OF MATRICA				RESULT S
Nr	v (m/min)	s (mm/rrot)	a (mm)	r (mm)	T (ºC)
1	300.000	0.160	0.500	1.200	850.600
2	700.000	0.160	0.500	1.200	1020.700
3	300.000	0.320	0.500	1.200	905.600
4	700.000	0.320	0.500	1.200	1050.900
5	300.000	0.160	1.600	1.200	890.600
6	700.000	0.160	1.600	1.200	1070.800
7	300.000	0.320	1.600	1.200	942.300
8	700.000	0.320	1.600	1.200	1102.750
9	300.000	0.160	0.500	2.000	805.600
10	700.000	0.160	0.500	2.000	940.010
11	300.000	0.320	0.500	2.000	890.600
12	700.000	0.320	0.500	2.000	1050.400
13	300.000	0.160	1.600	2.000	840.700
14	700.000	0.160	1.600	2.000	980.400
15	300.000	0.320	1.600	2.000	930.010
16	700.000	0.320	1.600	2.000	1058.600
17	458.258	0.226	0.894	1.549	940.800
18	458,258	0.226	0.894	1.549	930.300
19	458.258	0.226	0.894	1.549	945.700
20	458.258	0.226	0.894	1.549	927.200

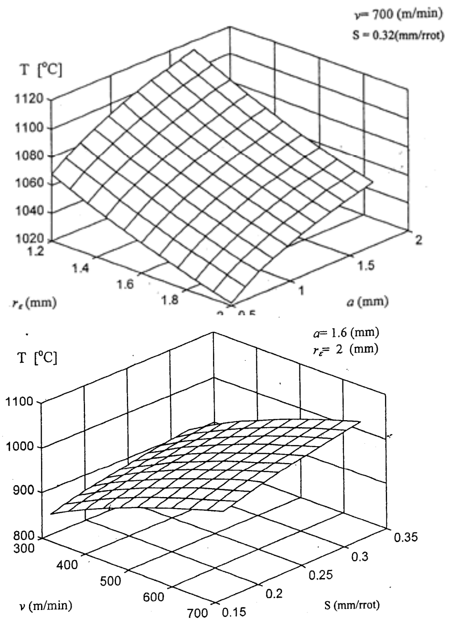

Figure 4. Graphic interpretation of the mathematical model 3.1

- tools material influences one the cutting temperature by starting off from two directions; first –the coefficient of its friction with the work piece and second from thermal conductivity [5]

4. CONCLUSION

Out of the mathematical models' analysis and graphical interpretations we can conclude:

- the change of average temperature during the cutting process in the function of cutting parameters can be presented through gradual function
- the largest affect on average temperature is made by the cutting velocity and cutting feed where during the research the maximal temperature value was 1102.75 ^{0} C.
- the influence of cutting depth in temperature is smaller during the cutting process.
- when the nose radius of the top of the cutting plate is increased, the temperature is decreased.

5. REFERENCES

[1] Salihu, A,: Hulumtimi i perpunueshmerise se materialit me prerje me shpejtesi te rritura, punim i doktoratës, Fakulteti i Makinerisë Prishtine. 2001.
[2] Milton C Shaw, :Metal cutting principles, Arizona State University, Oxford New New York, 2005.
[3] Stankov ,J.: Osnove merne tehnike,metode planiranja eksperimenata, FTN, Novi Sad,1982.
[4] Pantelic,I,: Primena statistickih metoda i istrazivanjima i procesima proizvodnje, FTN, Novi Sad, 1984.
[5] Aleksander B.: Mechanicl tehnology, volume I (Teknologjia mekanike ,volumi I). Faculty of Mechanical Engineering, Tirane. 1976.