The Monitoring of Machining Inherent

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Abstract: *A contribution discusses about an analysis of the physical effects and geometric accuracy, as well as the roughness of a machined surface during the cutting process with use of replaceable cutting blades. We study achieved parameters at lathe-cutting of steel category 14 220. Chosen material is characterized in high hardness which causes problems at its machining.*

Surfaces are hardened and carbonized that affect the usage of chosen method in terms of defined parameters such as cutting depth and also feed. Evaluation of cutting blades is dependent on specified parameters to be achieved at the material machining.

Keywords: *physical effect, accuracy, surface roughness, hardness, cutting parameters*

1. Introduction

Objective of the study is an evaluation of the surface quality, dimensional accuracy, and hardness, reached temperatures at changing feed. Achieved results of each replaceable cutting plate in laboratory conditions are also evaluated. The environmentally friendly and efficient manufacturing process is required. Suitable cutting insert has to be selected along with appropriate conditions for the cutting depth a_p = 0.5 mm.

An experiment deals with the assessment of cutting process at machining, particularly at lathe-turning using various cutting inserts which are recommended by different manufacturers. Selection of material is based on the materials suitable for shifts´ production, exposed to shear stress. Samples are made from the steel category 14 220 which is carbonized and hardened to 55±2 HRC at functional surfaces.

2. Methodology

Characteristics and preparation of samples

The sample is made from steel 14 220 which is superior, low alloyed steel suitable for carbonizing with very hard carbon layer, with high strength in core. The material is in form of cylindrical bar. The chemical composition is determined in Slovak standard STN 41 4220, with following elements´ content:

- C = 0.14 – 0.19 %,
- Si = 0.8 – 1.1 %,
- S = max 0.035 %,
- Mn = 1.1 – 1.4 %,
- P = max 0.035 %.

Cutting inserts

Characteristics of cutting insert CNMG 120412 ER 6630

Cutting insert CNMG 120412 ER 6630 (Pramet) is universal material that is used for steel lathe-turning. It can be also used for machining of cast iron and stainless steel. It is characterized in good wear resistance and high toughness. The cemented-carbide compositions coated at middle temperature MT CVD process is marked by four-digital code.

Characteristics of cutting insert DNGA 150616 T03020 N DISAL 210

Cutting insert DNGA 150616 T03020 N DISAL 210 is a cutting ceramics which is based on the oxide base Al2O3+TiC. Cemented corundum is characterized in high hardness compared to cemented-carbide compositions, high wear resistance at high temperatures (up to 1 200°C) and high cutting speeds up to 400 m.min^{-1}.

Measurement of the dimensional accuracy

Dimensional accuracy along with the surface roughness is the basic characteristics of the surface quality. A digital micrometer MITUTOYO was used for the dimensional accuracy´s measurement. The digital device´s measuring range is 25-50 mm and measurement accuracy 0.001 mm. Resulted diameters were measured three times for each sample after lathe-turning. Presented value is the arithmetic mean of all three measured values.

Temperature measurement

The main element for temperature measurements is a thermocouple, working on a principle of the thermoelectric effect. The voltage is generated at the ends of conductors when two conductors of different metals are heated. The voltage is directly proportional to the average temperature at the contact point of those conductors. The generated thermoelectric force is proportional to average temperature at contact point of machined and cutting material.

Measurement of hardness

Measurement of the hardness is performed according to the standard STN ISO 6058. This standard specifies the technique of Rockwell hardness´s measurement. A principle of the method is to force a diamond cone with the apical angle 120 ° into a surface of tested material. Then a pressure mark *e* left on surface is measured. Testing body is weighted down by the static force F_0 = 98.07 N before the measurements. So it enters into depth h_0 of tested material. It thereby eliminates the effect of surface which is exposed to a previous processing.

Measurement of roughness

A device SURFTEST 301 was used for measurements. Following roughness was measured by the device:

Ra – arithmetical average deviation from a mean line, μm

3. Results

Feed of machined material had been changed at each experiment on the basis of the decided method. Values of feed are shown in table 1.

Table 1 Values of feed for each sample

Sample	Feed (mm)
Sample No. 1	0.7 mm
Sample No. 2	0.4 mm
Sample No. 3	0.2 mm
Sample No. 4	0.1 mm
Sample No. 5	0.05 mm

Other defined parameters:

- cutting depth a_p 0.5 mm
- diameter of the sample D 40.5 mm
- spindle rev. 710 min^{-1}
- cutting speed v_c 89 $m.min^{-1}$

Measured values of dimensional accuracy at lathe-turning at cutting depth a_p = 0.5 mm and cutting speed v_c = 89 $m.min^{-1}$ are shown in the table 2.

Table 2 Dimensional accuracy at lathe-turning

No. of the sample	Cutting speed, $m.min^{-1}$	Feed, mm	Lathe diameter, mm	Reached diameter, mm		Deviation from the lathe diameter, mm	
				Cutting plate DNGA 150616 T03020 N	Cutting plate CNMG 120412 ER 6630	Cutting plate DNGA 150616 T03020 N	Cutting plate CNMG 120412 ER 6630
1.	89	0.7	40.5	40.083	40.063	0.417	0.437
2.		0.4	40.5	40.071	40.051	0.429	0.449
3.		0.2	40.5	40.052	40.037	0.448	0.463
4.		0.1	40.5	40.046	40.026	0.454	0.474
5.		0.05	40.5	40.033	40.015	0.467	0.485

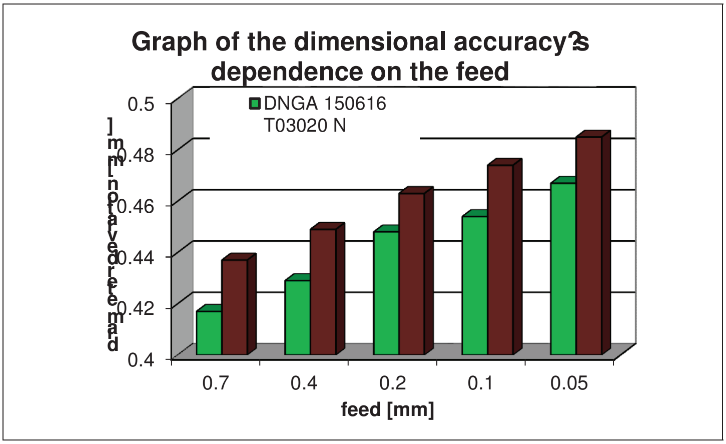

Figure 1 Graph of the dimensional accuracy´s dependence on the feed

Measured values of temperature at lathe-turning at cutting depth a_p = 0.5 mm and cutting speed v_c = 89 m.min^{-1} are shown in the table 3.

Table 3 Temperature at lathe-turning

No. of the sample	Cutting speed, m.min^{-1}	Feed, mm	**Reached temperature [°C]**	
			Cutting plate DNGA 150616 T03020 N	Cutting plate CNMG 120412 ER 6630
1.	89	0.7	270	255
2.		0.4	225	230
3.		0.2	195	185
4.		0.1	180	170
5.		0.05	165	125

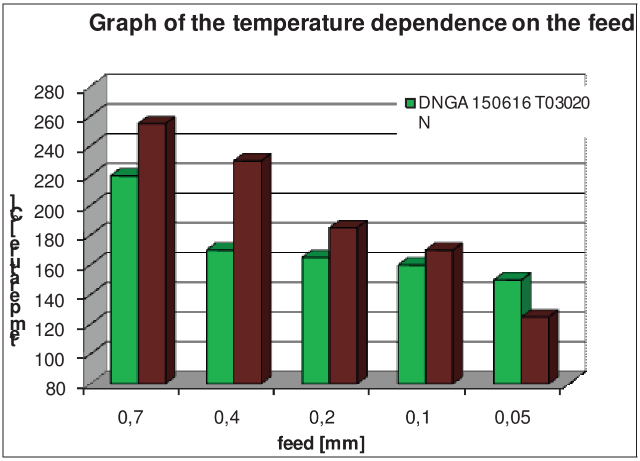

Figure 2 Graph of the temperature dependence on the feed

Measured values of roughness at lathe-turning at cutting depth a_p = 0.5 mm and cutting speed v_c = 89 m.min^{-1} are shown in the table 4.

Table 4 Roughness at lathe-turning

No. of the sample	Cutting speed, $m.min^{-1}$	Feed, mm	Reached roughness Ra [µm]	
			Sandvik – Coromant Cutting plate DNGA 150616 T03020 N	Pramet Tools Cutting plate CNMG 120412 ER 6630
1.	89	0.7	1.41	1.27
2.		0.4	1.38	1.08
3.		0.2	1.25	0.83
4.		0.1	0.85	0.48
5.		0.05	0.35	0.24

Graph of the roughness?s dependence on the feed

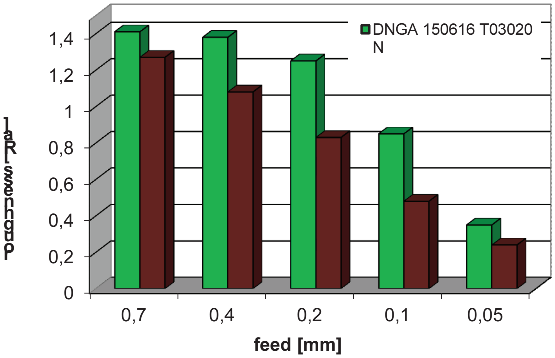

Figure 3 Graph of the roughness´s dependence on the feed

Measured values of hardness at lathe-turning at cutting depth a_p = 0.5 mm and cutting speed v_c = 89 $m.min^{-1}$ are shown in the table 5.

Table 5 Values of hardness HRC after lathe-turning

No. of the sample	Cutting speed, $m.min^{-1}$	Feed, mm	Reached hardness [HRC]	
			Cutting plate DNGA 150616 T03020 N	Cutting plate CNMG 120412 ER 6630
1.	89	0.7	61	59
2.		0.4	60	58
3.		0.2	58	56
4.		0.1	57	55
5.		0.05	56	54

4. Conclusion

The object of the experiment was to analyse replaceable cutting plates CNMG 120412 ER 6630 and DNGA 150616 T03020 N, and also the reached parameters at lathe-turning of the material - steel of category 14 220. Selected material is characterized in high hardness which is one of the difficulties at its machining. The surfaces were carburized and hardened that influences the method of lathe-turning in terms of defined parameters such as the cutting depth and feed. Evaluation of those cutting plates depends on defined parameters which had to be reached at material machining. Assessed criterion can be the roughness as well as the dimensional accuracy. Effect of the temperature and hardness must also be considered. Detected quality of each surface shows that some operation will be replaced in the future. Reduction of these operations will result in lower costs for machining. An application of manufacturing methods will eliminate the time lost that is caused by a product transfer between devices, and also the time lost caused by a clamping.

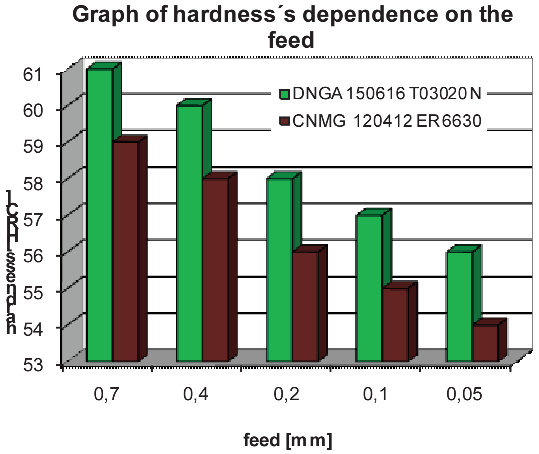

Figure 4 Graph of hardness´s dependence on the feed

REFERENCE

[1] BÁTORA,B-VASILKO,K.: Obrobené povrchy, Trenčianska univerzita, Trenčín 2000, str. 10-21, str. 131-145.

[2] BÁTORA, B. 1995. Strojárenská technológia II. časť, Nitra : SPU 1995, 39-166 s.

[3] KREIDL, M. 2005.: Měření teploty – senzory a měřicí obvody. 1. vydání.Praha: Marten 2005, 240 s. ISBN 80-7300-145-4

[4] KROČKO, V. – TOMÁŠ, J. 1999. Smery vývoja technológie obrábania z hľadiska ekológie. „Medzinárodná vedecká konferencia MF SPU“. Nitra 1999, 123 s.

[5] TOMÁŠ, J. – KROČKO, V. – DRLIČKA, R. 1999. Technológiou tvrdého sústruženia k zvýšeniu ekologizácie výrobného procesu. „Nové smery vo výrobných technológiách“. Prešov 1999, 35 – 40 s.

[6] TOMÁŠ, J. – KROČKO, V. – DRLIČKA, R. 1999. Suché sústruženie ako ekologická technológia obrábania tvrdých materiálov. „Technológia ´99“. Bratislava 1999, 607 – 609 s.

[7] Krastev G., Kangalov Pl., Research on the rate of coating iron with Hull cell, Ruse: PB at Ruse University “A. Kanchev”, 2006, Vol. 45 p. 45-48

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