RESEARCH OF FLANK WEAR IN TURNING
WITH HARD CUTTING TOOL

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ABSTRACT
In this work are given the researched results of cutting tool flank wear P-30, during the processing with turning of alloyed steel 42 Cr Mo4 which is quite difficult to process.
The experiment is realized with the lathe machine IK62, whereas the measurement V_B is done by microscope type JLC680148. For data process is used a statistic method with five factors. $y=2^k+No$
Key words: Cutting, flank, turning, hard tool

1. INTRODUCTION

The knowledge of mechanism of cutting plate flank wear from the hard metal in the function of the processing material, cutting regimens and means of processing, has an important role during the projection of technological process.

The size of flank wear is a result of reaction of different forms of energy, mainly of mechanical energy, temperature, chemical composition, electric and magnetic conductivity.

The assessment of the size of flank wear of metal-cutting tool is done through these indicators:

- Geometric indicators, which describe stereo metric characteristics of metal-cutting tool.
- Technological indicators, which determine the change in the technological quality of production, mainly the accuracy of obtained parameters, form, position and quality of obtained surface during processing, expressed by parameters of the roughness of processed surface.
- Energy indicators, which pertain to the change of energy relations in decohosation process, which means that the increase of cutting forces requires greater cutting power, which results in the increase of temperature in the cutting process and oscillations of the machine-clamping tool-metal cutting tool- processed particle system.

The size of flank wear and the resistance of metal-cutting tool greatly dependent on the type and characteristics of the cutting-tool material, the processing particle and cutting regimens.

Flank wear of metal-cutting tool is a difficult process accompanied with great physical-chemical changes of cutting surface and cutting edge of the metal-cutting tool which is in friction with splinter and surface of dry or wet particle.

Flank wear changes the geometry and shape of metal-cutting tool, which are closely connected with cutting forces, temperature, plastic deformation and roughness of processed surface.

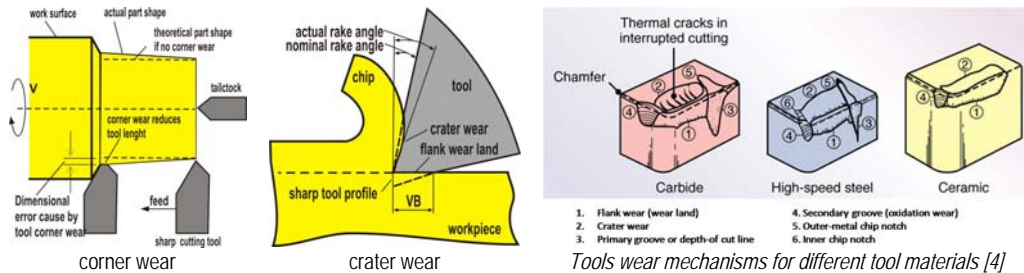Figure 1 shows types of tool wear and tools wear mechanisms for different tool materials [4,5]

corner wear   crater wear   Tools wear mechanisms for different tool materials [4]

Figure 1. Types of tool wear

For cutting regimens and optimum geometry of metal-cutting tool, forms of flank wear depend mainly on the characteristics of the processing material. If the processing material has a high plasticity, the metal-cutting tool wear chiefly on the front layer, whereas if the material has a low plasticity, the flank wear occurs chiefly on the main layer

2. CONDITIONS DURING THE EXPERIMENT

2.1. Machine-Horizontal Lathe IK62, with these characteristics: P=10kW, n=12.5÷2000 rpm, and feed s=0.035÷2.08mm/rev.

2.2. Tool-Cutting plate from the hard metal P30, SINTAL, ISO SNMM120404, SNMM120408, SNMM120412, enforced in the body with sign ISO PSDNN2525P12, outcome 25mm, with cutting geometry: γ=-6^0, α=6^0, λ= -6^0, r_ε=0.4mm, b_f=0.2mm, γ_f=-20^0.

2.3. Researching material–Steel 42CrMo4 in the cylinder shape with dimensions Φ68X750/Φ38.5X750mm.

2.4. Apparatus for wear measurement - digital microscope type JLC680149, with 25 times zoom, with measurement accuracy 0.01 mm. The experiments were conducted with a clamper, with new cutting edge, without cooling tool. As criteria for flank wear measurement was taken the distance of 1 km of circular cutting, where the cutting regimens were increased until the first value of flank wear was obtained.

2.5. Experimental researching plan - Based on scale number achieved by the machine, researched literature, professional experience, dimensions, chemical composition, mechanical characteristics of the processed particle and type of metal-cutting tool, we decided on these cutting regimens: v, s, a, r & χ, tab.1, applying the five-factor experimental plan of the first class (2^k+N_0). A special attention was paid to the manner of clamping the processed particle, since the character of flank wear on the cutting plates from the hard metal requires high rigidity in machine-clamping tool-metal cutting tool-processed particle system.

Table.1. Conditions for experiment realization

Independent variables with levels and coding identification					
Nr	Note	Level Code	Maximal 1	Average 0	Minimal -1
1	v m/min]	X_1	67.000	53.000	42.000
2	s [mm/rev]	X_2	0.042	0.038	0.035
3	a [mm]	X_3	1.000	0.707	0.500
4	r [mm]	X_4	1.200	0.800	0.400
5	κ [⁰]	X_5	60.000	51.961	45.000

Table 2. Derived results during experiment realization

Nr	Design cutting condition					Results	
	v[m/min]	s[mm/rev]	a[mm]	r[mm]	κ[°]	$V_B[\mu m]$	$Y=lnV_B[\mu m]$
1	42	0.035	0.5	0.4	45	3.825	1.342
2	67	0.035	0.5	0.4	45	5.270	1.662
3	42	0.042	0.5	0.4	45	4.080	1.406
4	67	0.042	0.5	0.4	45	7.182	1.972
5	42	0.035	1.0	04	45	3.952	1.374
6	67	0.035	1.0	0.4	45	5.567	1.717
7	42	0.042	1.0	0.4	45	4.845	1.578
8	67	0.042	1.0	0.4	45	7.582	2.026
9	42	0.035	0.5	1.2	45	3.578	1.275
10	67	0.035	0.5	1.2	45	5.788	1.756
11	42	0.042	0.5	1.2	45	4.522	1.509
12	67	0.042	0.5	1.2	45	5.967	1.786
13	42	0.035	1.0	1.2	45	3.952	1.374
14	67	0.035	1.0	1.2	45	6.222	1.828
15	42	0.042	1.0	1.2	45	5.865	1.769
16	67	0.042	1.0	1.2	45	6.188	1.823
17	42	0.035	0.5	0.4	60	4.522	1.509
18	67	0.035	0.5	0.4	60	6.115	1.810
19	42	0.042	0.5	0.4	60	5.049	1.619
20	67	0.042	0.5	0.4	60	6.570	1.883
21	42	0.035	1.0	0.4	60	5.278	1.664
22	67	0.035	1.0	0.4	60	6.825	1.921
23	42	0.042	1.0	0.4	60	6.630	1.892
24	67	0.042	1.0	0.4	60	7.301	1.988
25	42	0.035	0.5	1.2	60	4.743	1.557
26	67	0.035	0.5	1.2	60	6.273	1.836
27	42	0.042	0.5	1.2	60	6.740	1.908
28	67	0.042	0.5	1.2	60	7.072	1.956
29	42	0.035	1.0	1.2	60	7.216	1.976
30	67	0.035	1.0	1.2	60	7.548	2.021
31	42	0.042	1.0	1.2	60	7.463	2.010
32	67	0.042	1.0	1.2	60	8.066	2.088
33	53	0.038	0.7	0.8	51	5.049	1.619
34	53	0.038	0.7	0.8	51	5.049	1.619
35	53	0.038	0.7	0.8	51	5.066	1.623
36	53	0.038	0.7	0.8	51	5.066	1.623
37	53	0.038	0.7	0.8	51	5.066	1.623
38	53	0.038	0.7	0.8	51	5.066	1.623

The exponential model for tool flank wear are given.

$$V_B = 0.589 \cdot v^{0.572} \cdot s^{0.888} \cdot a^{0.204} \cdot r^{0.063} \chi^{0.750} \quad .... 1$$
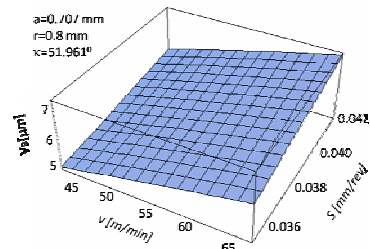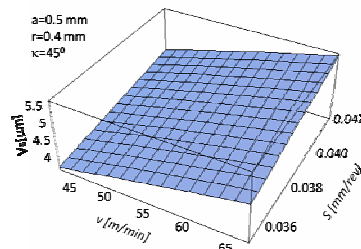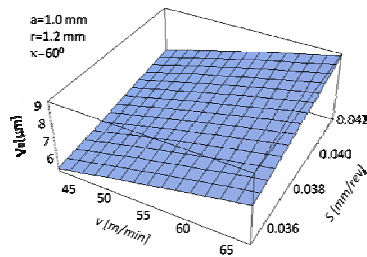
Figure 2. Graphic interpretation of mathematic model (1)

3. THE ANALYSIS OF OBTAINED RESULTS

Upon defining the inlet and outlet parameters, selection of appropriate method for measurement and measuring apparatus, analysis of independent changeable inlet parameters, selection of form of function for defining the scope of experiment, implementation of experiment, statistical processing of researched parameters and verification of mathematical models, the impact of obtained parameters (v, s, a, r & χ) on the parameter of back layer flank wear of metal-cutting tool is defined.

With the increase of cutting speed, the conditions in the cutting area change, splinter is quickly removed from the cutting area, decreasing the plastic deformation in the splinter deformation area and in the area where surface layer is created, which has an impact on the reduction of roughness.

This transfers the mechanical impact and the heat towards the cutting edge, causing greater specific pressures and speed gradients, which results in the reduction of friction coefficient between splinter and front surface, as well as reduction of coefficient of splinter compression and cutting forces. The increase of cutting pace results in the increase of thickness of the cut layer, which requires increase of energy for its transformation into splinter, which further results in increase of cutting forces and heat. The cutting depth and the circulation radius of cutting edge have a little impact on flank size. With the increase of circulation radius of cutting edge and rake angle, the quality of processed surface is increased, as well as the cutting forces, heat and the oscillations which result in the increase of flank wear of metal-cutting tool.

4. CONCLUSION

With mathematical processing of results obtained during the research, tab. 2 was obtained the mathematical model (1), and graphical interpretation was presented in fig.2. From the analysis of the mathematical model (1) and its graphical interpretation, we can conclude that:

- With the increase of cutting speed the flank wear of metal-cutting tool increases, whereas its resistance decreases.
- Cutting pace and depth have less impact on the size of flank wear.
- If a clean surface and high resistance of metal-cutting tool is required against flank wear, it is preferable that the processing with cutting be done with rake angle $\chi=45 \div 60^0$ and greater radius of the top of cutting edge.

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