ASPECTS REGARDING THE WIDIA PLATES BEHAVIOUR COVERED WITH TiN DURING THE CUTTING PROCESS

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ABSTRACT

The microscopic property that depends on the interfacial structure and on the tension to which the interface is submitted is called adherence. The strong connection in the interfacial area, low tension gradients, the absence of cracks and of degradation in the course of time are properties that define a good adherence at the layer-underlayer interface. The good adherence of the thin layer to the underwear implies the non- deterioration in normal conditions or while tensions application of the interfacial area. In order to establish the degree of adherence of the tin titanium – nitride layers deposed on the widia plates, there were researches made about the behaviour of the covered plates during the cutting process. In this way the dependence between the durability (T) of the widia plates and the cutting speed (v) was determined as a result of experiments.

KEYWORDS: widia plates, thin layer, cutting

1. Introduction

The durability of the widia plates is measured in minutes, is noted "T" and depends on the following factors:

- the tool material
- the quality of the worked material
- the cooling and the greased liquids
- the tool geometry
- the cutting depth "t"
- the tool advance in the material

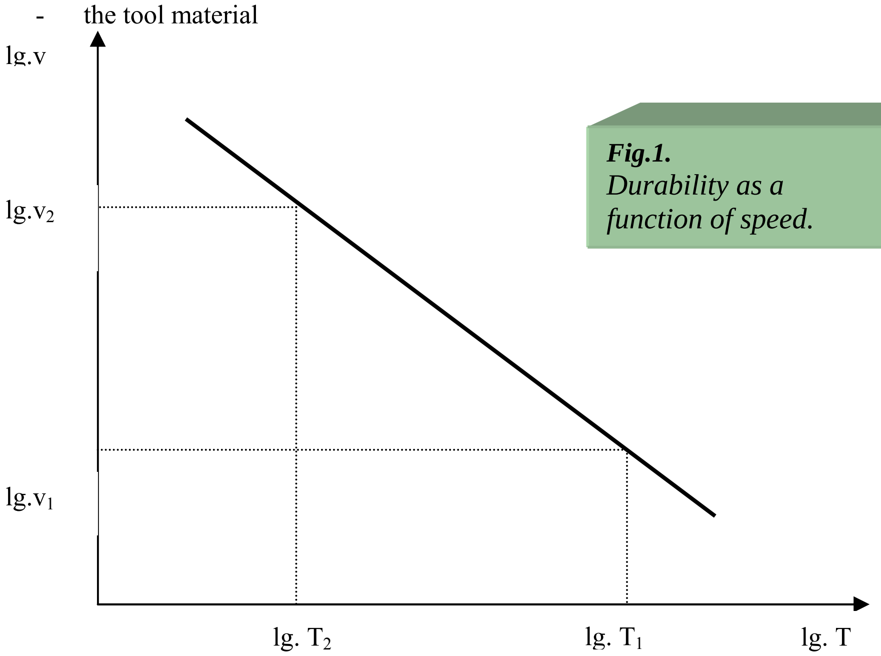

Fig.1.
Durability as a function of speed.

The greatest influence on the durability comes from the cutting speed which is mathematically defined by Taylor relation:

$$v = \frac{C}{T^m} \quad [\text{m/min}]$$

where “m” is the durability index and “C” is a constant that depends on the worked material properties, on the cutting depth “t” and the advance “s”.

For a limited area of speed variation, the”m” index can be considered a constant value although this is not a constant size but dependent on factors that influence the cutting wear.

When m=constant, in double logarithimic co-ordinates, the equation (1) represents a straight line under the following form:

$$\log v = -m \log T + \log C \qquad [1]$$

where: $m = tg\ \alpha$

The smaller the “m”, is the nearer to the horizontal line the straight line is and to a small variation of the cutting speed “v” corresponds a big variation of the durability.

The dependence of the durability as a function of the speed T=F (v) is shown in fig.1.

From relation 1 we get $T_1^m \cdot v_1 = T_2^m \cdot v_2$ and the gradient “m” in double logarithms coordinates can be determined by the following relation:

$$m = tg\ \alpha = \frac{\lg v_2 - \lg v_1}{\lg T_1 - \lg T_2};$$

2. Experimental conditions

For the experiments plates from P30, CNMG 12-04-08-PN group were used, covered and uncovered with TiN.

The table 1 shows the cover process manner and both the constructive and active geometry of the plates used.

Table 1. *The constructive and active geometry of the plates*

Plate type	The worked material	The plate geometry [º]							
		Constructive				Active			
		α	γ	χ	λ	α	γ	χ	λ
CNMG 12-04-08-PN	Oțel OLC45	0	12	40	0	8	-6	45	0

2.1.Worked materials

At the CROMSTEEL INDUSTRIES firm Târgovişte, the CNMG 12-04-08-PN plates type are used for working the steels.

The chemical composition of OLC45 steel used for test was shown in table 2 and the mechanical properties in table 3..

The samples used for the tests were OLC45 bar shape, 40 mm diameter and 200 mm length for CNMG 12-04-08-PN plates (microstructure is presented in figure 2).

Table 2. *Chemical composition*

C	S	Mn	Si	P
[%]				
0.46	0.014	0.65	0.27	0.016

Table 3. *Mechanical properties*

Flowing limit	Tensile resistant	Elongation	Resilience	Hardness (in normalized state)
$R_{p0,2}$ [N/mm²]	R_m [N/mm²]	A_5 [%]	KCU [J/cm²]	[HB]
480	690-840	14	60	235

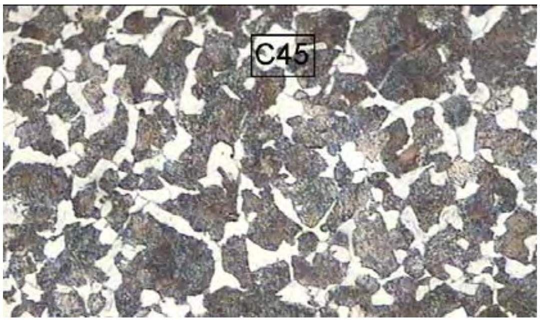

Fig.2. *Microstructure of the OLC 45 samples (x50) .*

2.3. Experiments

There were made experiments on a lathe with numerical control MAZAK.

The working operations consisted in longitudinal turning under the conditions of the cutting process (t, s, v_1). Keeping unchanged the working conditions for all the tests it is determined the wear dependence as function of the tool working time.

The tool wear measurement is made at equal intervals (at every passing). The experiment is repeated for a new value of the cutting speed v_2, maintaining the other parameters constant.

In order to eliminate the faults due to the thermal deformation of the tool, this one is cooled at the medium surrounding temperature before making the measurement. The measurement of the tool wear is made with the measurement accuracy of 1 micrometer on the microscope from the Technic alQuality Control laboratory.

In order to establish the characteristic points the dependence curve depending on time is marked out. (fig. 3, 4, 5 and 6).

The standard representation of the wear dependence depending on time is shown in figure 3 and points out three characteristic areas: OA - the initial wear; AB - the proportional wear; BC - the catastrophic wear.

The cutting conditions parameters are chosen in the domain of the values used on the working machines from CROMSTEEL Targoviste. In the table 4 there are some examples of using the CNMG 120408 PN plates.

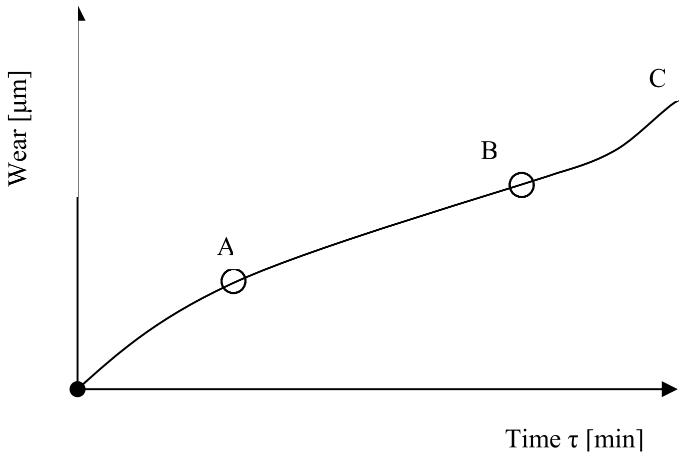

Fig. 3. *Wear depending on time.*

Table 4. *Cutting conditions*

Plate type	Processing type	Processed material	Cutting conditions		
			V_{max} [m/min]	s [mm/rot]	t [mm]
CNMG 12-04-08-PN	Turning	OLC45 Steel	200	0,060	1,0
			314	0,060	1,0
			314	0,048	0,8

The cutting speeds were calculated by means of the following relation:

$$V = \frac{\pi \cdot D \cdot n}{1000} \text{ [m/min]},$$

where: D – bar diameter [mm]
n – rotation speed [rot/min]

For the OLC45 steel bars:

$$V_1 = \frac{\pi \cdot 40 \cdot 2228}{1000} = 280 \, {}^{m}\!/\!{}_{\min};$$

$$V_2 = \frac{\pi \cdot 40 \cdot 2500}{1000} = 314 \, {}^{m}\!/\!{}_{\min}.$$

In the table 5 the domains of the parameters values of the cutting conditions are shown.

Table 5. *Domains of the parameters values of the cutting conditions*

Plate type	Processed material	Conditions	n [rot/min]	v [m/min]	s [mm/rot]	t [mm]
CNMG 12-04-08-PN	OLC45	1	1592	200	0,060	1,0
		2	1751	220	0,060	1,0
		3	1910	240	0,060	1,0
		4	2069	260	0,060	1,0
		5	2228	280	0,060	1,0
		6	2500	314	0,060	1,0

4.The experimental results

After making the experiments, the wear values (VB) of the CNMG 12-04-08-PN plates were established. These values resulted from some periods of time, corresponding to one, two, respectively to three turning passings of the sample.

The calculus of the passing period is made by means of the relation:

$$\tau = \frac{L}{n \cdot s} \cdot i \text{ [min]};$$

where: L-the length of the bar
n-the rotation speed
………s-forward flow
………i-number of successive passings
For the OLC45 bars:

$$\tau_1 = \frac{200}{2228 \cdot 0{,}06} \cdot 3 = 4{,}50 \text{ min}$$

$$\tau_2 = \frac{200}{2500 \cdot 0{,}06} \cdot 3 = 3{,}00 \text{ min}$$

The experimental data were centralized in table table 6:

Table 6. *The experimental data.*

Plate type	Processed material	Cutting speed [m/min]	Passing number	Wear VB [µm]		Time [min]
				Plate covered with TiN of 8µm PN/CG4015	Plate uncovered PN/GC4035	
CNMG 12-04-08-PN	OLC45	280	1	1,73	4,30	4,50
			2	2,32	5,60	9,00
			3	2,88	12,93	13,50
			4	4,84	-	18,00
		314	1	1,92	5,99	3,00
			2	2,61	7,84	6,00
			3	3,46	14,48	9,00
			4	5,62	-	12,00

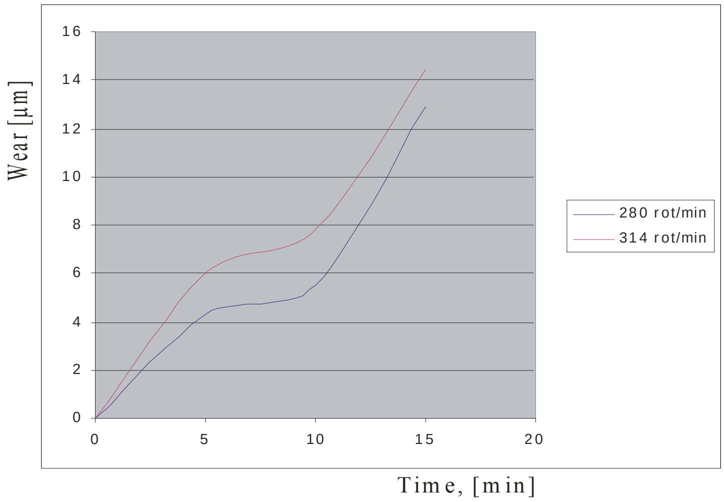

Fig.4. *The wear of the uncovered plates, during the turning of the OLC45 steel.*

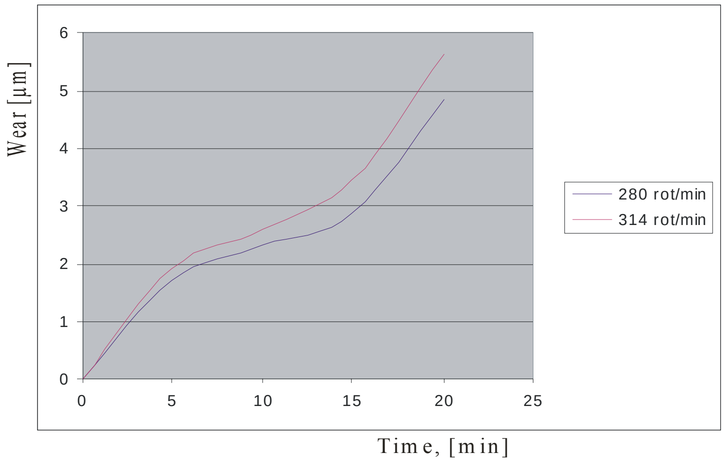

Fig.5. *The wear of the plates covered with TiN, during the turning of the OLC45 steel.*

5.Conclusion

Examining the shape of the durability curves depending on the cutting speed T = f(v) (figure 6) one can notice the fact that at the same time with the cutting speed growing the same durability of the layers during the working period deceases. This aspect is valuable both in the case of the covered plates and in that of the uncovered plates.

One can notice from the covered plates. The plates covered with titanium nitride behave better during the steel processing with a low content of carbon.

The durability of the covered plate is 2.3 bigger at low speeds and 3.1 times bigger at high speeds, compared with the uncovered plates, fact that indicates that the covered plates are more resistant to higher cutting speeds. When the covered plate wear with TiN gets the shape corresponding to the catastrofic wear, a sudden rise of this one takes place during a very short cutting period.

One can notice that when the wear of the TiN covered plate gets the shape corresponding to the catastrophic wear, a sudden rise of this one takes place in a very short cutting time.

This behaviour can be explained by the fact that in the limits of the rational wear. The hand layer resulted from coating surphasses and gets to the base material that does not resist any more to the high cutting speeds with which it had been worked.

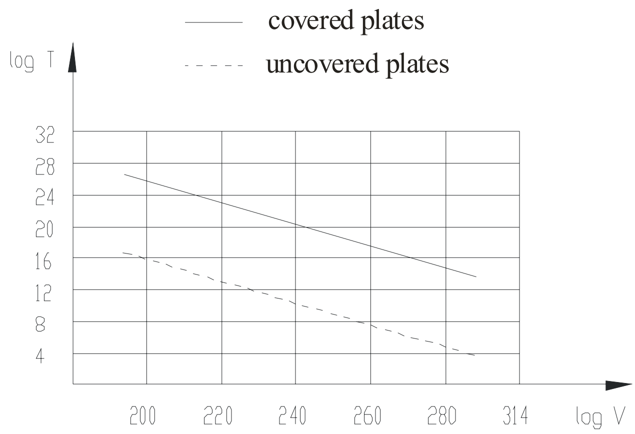

Fig. 6. *The durability T=f(V) for the TiN covered and uncovered plates during the turning of the OLC45 steel; s= 0,060 mm/rot; t=1,0 mm.*

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