RESEARCH ON THE DURABILITY OF SELECTED CUTTING MATERIALS IN THE PROCESS OF TURNING CARBON STEEL

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Durability of cutting tools represent a large spectral index on the basis of which is characterized by functional work. Every manufacturer of cutting tools before the actual production of these tools during the development make a tests and prescribing them characteristics on which is possible then to predict their behaviour in the actual production process. Durability of cutting tools is often indicated for one tested material of marketing aspect, which is machined and effort of user is to achieve this variable for other machined materials and then is happened problem in the production. The problem is very short lifetime of cutting tool in machining process, where the effect is impossibility to optimize the machining process. The results of this action are excesses time caused by exchanged of cutting plate and then it is make a low production of machining industry by setting of machines, and then the factory has an economical loses. Paper notes that significant differences optimal and feasible achievable durability of the cutting tool in the machining process carbon steel. As the impact on the results of this research is not only technical but also economic and particularly for small and medium manufacturing enterprises, it is examining this issue very important and timely.

KEYWORDS

cutting speed, durability, carbon steel, ISO 3685, sintered carbide

1 INTRODUCTION

Problems of reliability and life tools are in the present very current. A lot of manufacturer of cutting tools determined durability of cutting tool only on the assumption or presumption [Peterka 2014]. Problematic of tool durability and its lifetime is defined in standard ISO 3685. It is defined T-vc dependence for different cutting materials and standard included process evaluation of tool durability for cutting materials made of high speed steel, sintered carbide and cutting ceramic [Gombar 2013].

In turning, there are many types of cutting tools used made from different material. One of these materials is sintered carbide. The initial development of sintered carbides occurred in Germany in the early 20th century. Their commercial use began in 1927 in Germany with a brand called Widia, a name coined from the German phrase "wie Diamant" ("like diamond"), alluding to the material's hardness [Black 2007, Cep 2010 and 2014, Szarkova 2013, Petru 2014].

Figure 1. Sample of tuning process

Sintered carbide is one of the most successful composite engineering materials ever produced. Sintered carbide's unique combination of strength, hardness and toughness satisfies the most demanding applications. A key feature of the sintered carbide is the potential to vary its composition so that the resulting physical and chemical properties ensure maximum resistance to wear, deformation, fracture, corrosion, and oxidation [Isakov 2009, Krenicky 2011, Holesovsky 2012, Hloch 2012, Zelenak 2012, Brezinova 2014].

Figure 2. Cutting plates made of sintered carbide

2 STANDARD ISO 3685

The standard ISO 3685 describes for all cutting materials common T-v_c dependence. Current valid relation of T-v_c dependence is described by Taylor formed basics of standard ISO 3685. T-v_c dependence was designed according to Taylor in logarithmic scale [Duplak 2010, STN ISO 3685 1999].

Very significant problem in standard ISO 3685 is evaluation of results [Janekova 2014]. Characteristics and dependences for all cutting materials are same [Helmi 2008, Neslusan 2007, Michalik 2010].

3 THEORY AND PRACTICE OF T-v_C DEPENDENCE

Graphics dependence $VB=f(\tau_s)$ for different cutting speeds was described with Frederick Winslow Taylor in 1906. Taylor defined that the criterion of blunting was the same for all

curves VB_k. Dependences that are described by Taylor are relevant only for high speed steel, because in that time high speed steel was only available for Taylor experiments. Taylor defined T-v_c dependence according to experiments made with high speed steel [Panda 2011 and 2016, Monkova 2013, Zaborowski 2007]. These tests according to standard ISO 3685 are valid for all cutting materials [Krolczyk 2015, Lattner 2014, Macala 2007, Nagendra 2006].

4 WORKPIECE SPECIFICATION

Workpiece for the experiment is made of steel C45 because this type of steel is heavily used in manufacturing companies around the world and also this type of steel indicates the literature that describes methods for determining the durability of cutting tools [Lesso 2010, Mrkvica 2012, Allo 2013, Ragan 2012]. Material for workpiece is from specific material list with guaranteed chemical structure and mechanical properties [Pandova 2012, Dobransky 2015].

Table 1. Chemical structure of material $100Cr_6$

Chemical structure of C45 [%]	
C	0.42 – 0.50
Mn	0.50 – 0.80
Si	0.17 – 0.37
Cr	max 0.25
Ni	max 0.30
Cu	max 0.30
P	max 0.040
S	max 0.040

Table 2. Mechanical properties of material C45

Mechanical properties of C45	
R_e [MPa]	min 305
R_m [MPa]	min 530
A_5 [%]	16
HB	max 225
E [GPa]	221

Figure 3. Microstructure of C45

5 EXPERIMENTS WITH SINTERED CARBIDE (P20+TIN)

First very important step, before the actual experiments is specification of technological system. In technological system for these experiments were contained machine - tool - workpiece.

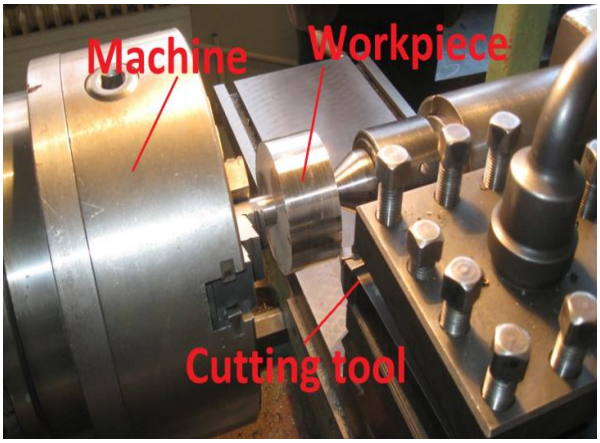

Figure 4. Technological system for experiments

Experiment inputs were workpieces with equal diameters; those were used at turning process. For each cutting speed the diameter should have the same value, because examined material has different consistency in different depth. Experiment was finished once wear criterion was reached.

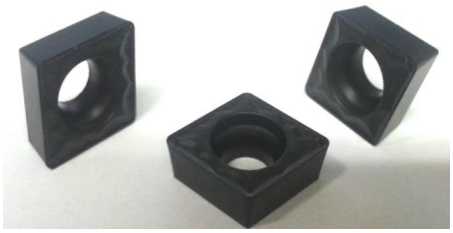

Figure 5. Sintered carbide plates used in experiment

Figure 6. Photo from experiments

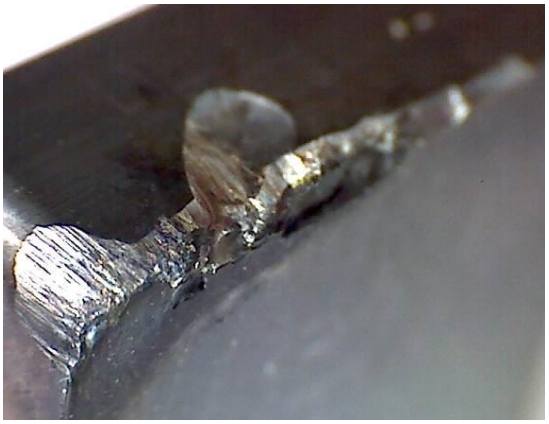

Figure 7. Wear of cutting plate

6 TECHNOLOGICAL CONDITIONS AND RESULTS OF EXPERIMENTS

v_c = 5 – 350 m.min^{-1}; a_p = 0.2 mm; f = 0.3 mm ; r_ε= 0.8mm; k_r=80°; k'_r=10°; VB = 0.3 mm;

Table 3. Results of T-v_c dependence for P20+TiN

v_c [m.min^{-1}]	T [min]	v_c [m.min^{-1}]	T [min]	v_c [m.min^{-1}]	T [min]
5	250	46	130	125	148
8	210	65	180	137	64
10	125	72	205	205	42
13	86	93	230	250	23
25	70	105	215	310	15
39	118	112	204	350	13

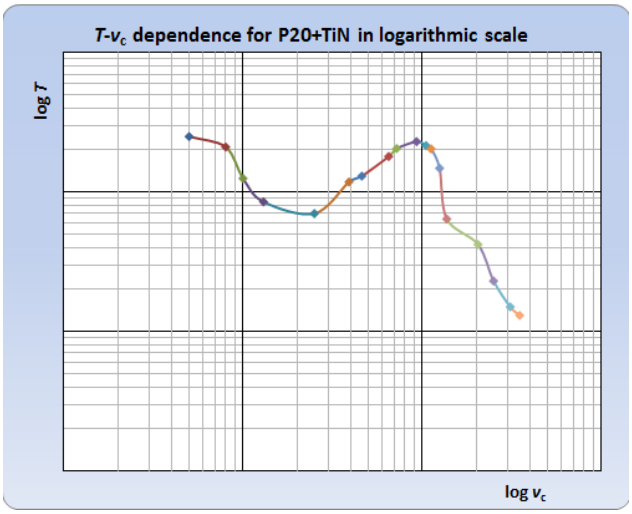

Figure 8. T-v_c dependence for P20+TiN in logarithmic scale

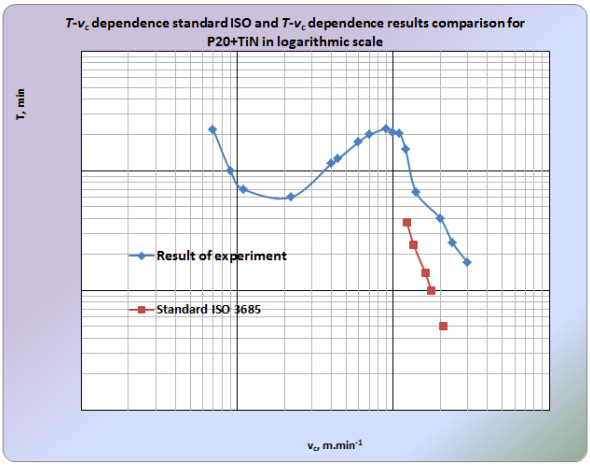

Figure 9. Standard ISO and experiment results comparison for P20+TiN

7 CONCLUSION

Primary factor of each new discovery or piece of knowledge is experiment. Very important part of quality production in engineering companies is quality tool [Cacko 2014, Jurko 2016]. Tools with listed and described properties are indispensable in the production. Material for cutting tools defines their machining properties. Testing properties of those materials are very important, because their properties may be different than properties defined in standards ISO [Vasilko 2009, Panda 2013]. Within this article there was tested cutting material made of sintered carbide (P20+TiN) of which cutting properties are defined in standard ISO 3685. Cutting plates made of sintered carbide were used for experiment, which was necessary for creation of T-vc dependence for this cutting material. Graph process shows differences between standard ISO T-vc dependence and T-vc dependence as results from experiments. There is no linear dependence for sintered carbide as it is presented in standard ISO 3685. On the base of following instructions described in standard ISO 3685, that was defined according to Taylor there was created graph of T-vc dependence in logarithmic scale.

Issue cutting tools durability is very topical for small and medium-sized enterprises, because cutting tools durability significantly influences economics of these enterprises [Prislupcak 2016]. Deeper exploration of these problems is very important. Experiments need to be repeated with accurately defined technological parameters throughout available range of cutting speeds and analyzed through valid standard ISO 3685.

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