Proceedings of XI International Conference on Science and Education, January 4–13, 2018, Hajduszoboszlo, Hungary. ISBN 978-966-330-306-2

MEASURING SYSTEM FOR DETERMINING EFFICIENCY OF PROCESSING AND POSSIBILITY OF CUTTING TOOL

Kostyuk G. I., Matveev A. V., Kostyuk E. G.
National aerospace university «Kharkov aviation institute», Kharkov

At present, the equipment of processing machines is working with high productivity, and it is impossible to trace the exact time of the release of the cutting tool (CT), this leads to:

1. To loss of parts;
2. The loss of information about which cutting modes are most beneficial for a given part from the corresponding material;

Despite the fact that a significant number of studies on effective modes of processing parts is carried out, and they are summarized in many monographs and reference books [1, 2], there is no tool that would not allow for special studies, and on real equipment, without stopping production to ensure receipt rational or even optimal modes of processing these parts with maximum return on CT.

The present development will allow obtaining real-time data on the removed volume of material during the period of resistance of the CT, determining those regimes in which the most favorable processing modes are realized, that is, to ensure the maximum removable volume for the period of durability.

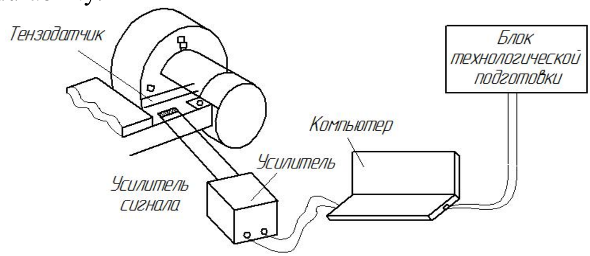


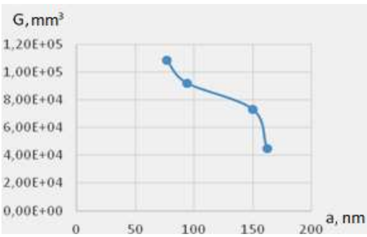
Fig. 1. Scheme of dynamic determination of the efficiency of CT (compressible volume of material for the period of resistance CT)

Coating grain size influence on the material removable volume for the resistance period, the cutting tool durability and the hardened C45 steel machining productivity. Performed investigations of the hard alloy cutting tools performance were also continued for the C45 hardened steel. In this case, as the cutting tool were used 0,18 HfN + 0,82 ZrN coated carbide Sandvik Koromant, two-layer Al_2O_3 + (0,18 HfN + 0,82 ZrN) coated Sandvik Koromant and hard alloys P20, MC22. Compared with the previous variants have been added Al_2O_3 + (0.18 HfN + 0.82 ZrN) coating, for which we have grain sizes from 75.1 to 159 nm, i.e. in this case nano-structured grain was realized, which should provide a high rating.

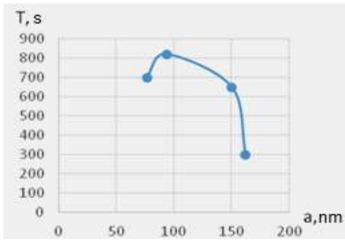
Unfortunately, this coating has fourteenth rating and, in principle, it is don't make sense to use it for the hardened steels processing due to the small Al_2O_3 coating surface layer microhardness. At the same time the 0.18HfN + 0.82 ZrN coating on the Sandvik Koromant plate provides maximum efficiency rating and the maximum cutting tool durability. This suggests that cutting tool operability and efficiency provides not only the minimum grain size, but the cutting tool surface layer microhardness, which is equal 35 GPa for this coating.

For the same coating on the MC221 plate is realized the second mode on the material removable volume for the durability period, although the overall rating based on durability and productivity, takes on the maximum value, and this coated hard alloy can be used in all cases for the C45 processing.

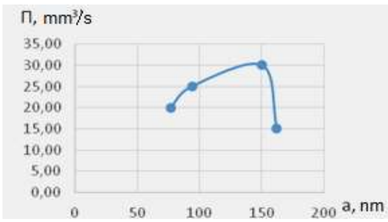
Unfortunately, 0.18HfN + 0.82Zrn coated P20 hard alloy can't be used effectively both for C45 machining, and for 100Cr6 (3505) hardened steel machining.



a



b

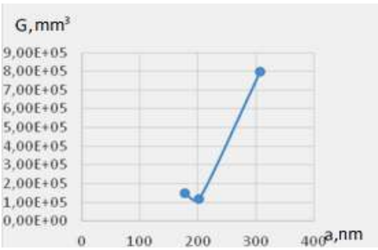


c

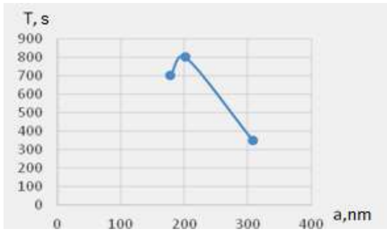
Fig. 2. Dependencies of the manufacturable C45 removable volume for durability period (*a*), the 0.18HfN + 0.82ZrN coated MC222 cutting tool durability (*b*) and processing performance (*c*) from the grain size

Analysis of the 0.18HfN + 0.82ZrN coated MC222 cutting tool research results showed that the maximum removable material volume (C45) for the durability period $G = 1.1 \cdot 10^5$ mm^3 at the $a = 70$ nm, the maximum durability $T = 800$ sec at the $a = 95$ nm and the productivity $P = 30$ mm^3/s at the $a = 150$ nm. This suggests that each of the productivity and efficiency criteria has own grain size (Fig. 2).

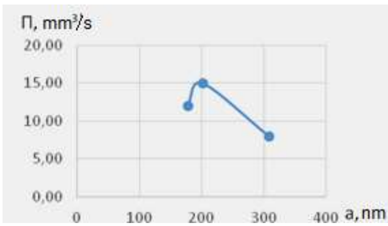
Similar investigations were carried out for the MC221cutting tool with the same coating (Fig. 3). The maximum value are realized for $G = 1{,}05 \cdot 10^5$ mm^3 at the $a = 123$ nm, for $T = 850$ sec at the $a = 123$ nm and for $P = 40$ mm^3/s at the $a = 210$ nm. For the same MC221 coated cutting tool are realized more efficient modes $G_1 = 7{,}2 \cdot 10^5$ mm^3 at the $a = 105$ nm (Fig. 4) and $G_2 = 5{,}7 \cdot 10^5$ mm^3 for the a = 73 nm (Fig. 5) and $G_3 = 8 \cdot 10^5$ mm^3 (Fig. 3), $T_1 = 2500$ sec, $T_2 = 1900$ sec and $T_3 = 800$ sec, and $P_1 = 400$ mm^3/sec, $P_2 = 30$ mm^3/sec and $P_3 = 15$ mm^3/s, respectively. It can be seen that the first mode is more preferred, then the second mode can be used for employment.



a



b

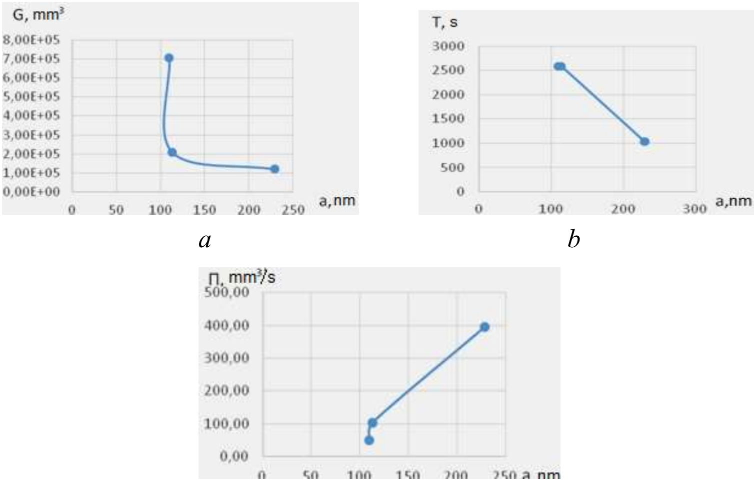


c

Fig. 3. Dependencies of the manufacturable C45 removable volume for durability period (*a*), the 0.2HfN + 0.8ZrN coated MC221 cutting tool durability (*b*) and processing performance (*c*) from the grain size

For 0.18HfN + 0.82ZrN coated Sandvik Koromant cutting tool results of the C45 turning are shown on the Fig. 6 and 7. It was found that $G_1 = 1{,}27 \cdot 10^5$ mm^3 is realized at the $a = 110$ nm, the $G_2 = 5 \cdot 10^5$ mm^3 for $a = 300$ nm; $T_1 = 4500$ sec, $T_2 = 4000$ sec, and $P_1 = 50$ mm^3/sec and $P_2 = 70$ mm^3/sec. It is evident that with the grain size growth all parameters, except P, are reduced, and P increases and reaches a maximum at the $a = 560$ nm.

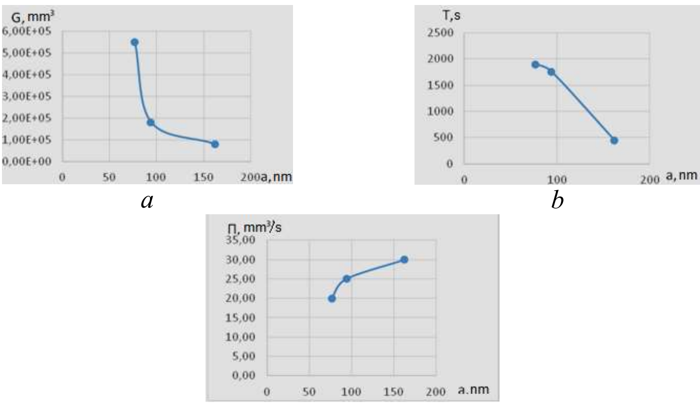
All this suggests that, despite the fact that the first mode for Sandvik Koromant cutting tool is successful on the removable volume for the durability period and cutting tool durability, but the mode with 560 nm large grain size is more rational on the productivity.



a *b*

c

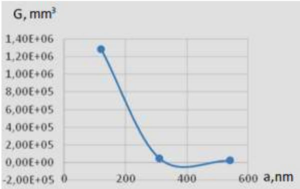
Fig. 4. Dependencies of the manufacturable C45 removable volume for durability period (*a*), the 0.2HfN + 0.8ZrN coated MC221 cutting tool durability (*b*) and processing performance (*c*) from the grain size



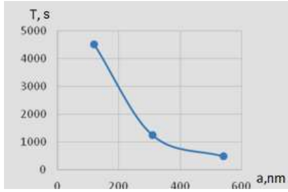
a *b*

c

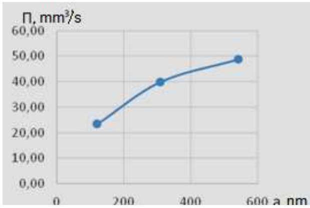
Fig. 5. Dependencies of the manufacturable C45 removable volume for durability period (*a*), the 0.2HfN + 0.8ZrN coated MC221 cutting tool durability (*b*) and processing performance (*c*) from the grain size



a

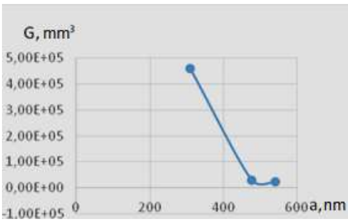


b

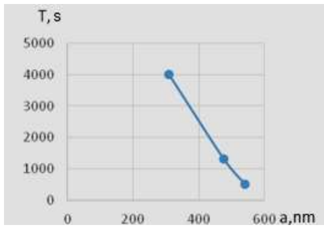


c

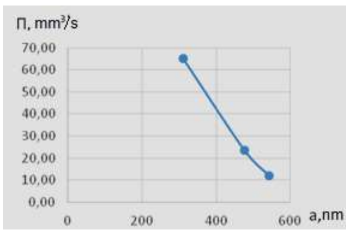
Fig. 6. Dependencies of the manufacturable C45 removable volume for durability period (*a*), the 0.2HfN + 0.8ZrN coated Sandvik Koromant cutting tool durability (*b*) and processing performance (*c*) from the grain size



a



b



c

Fig. 7. Dependencies of the manufacturable C45 removable volume for durability period (*a*), the 0.2HfN + 0.8ZrN coated Sandvik Koromant cutting tool durability (*b*) and processing performance (*c*) from the grain size

Conclusions. A system for measuring the resistance of a cutting tool in real time has been created, which makes it possible to find the amount of material to be removed during the durability period and processing capacity.

Given this information, it is possible to find modes with maximum stability, maximum removable volume and maximum processing performance.

This system was tested under severe processing conditions of C45 when machining them with plates of hard alloys K40, Sandvik Koromant and MC221 with 0.2HfN + 0.8ZrN coating and without it. Rational processing modes are obtained, which ensure maximum durability, a removable volume of material during the period of durability and processing capacity.

References

1. Kostyuk G. I. Efficient cutter with nano-coating and nanostructured modified layers : monograph-reference book : 2 books / G. I. Kostyuk. – Publishing House of the International Academy of Science and innovative technologies, 2017. – Bk. 1. Plasma-ion and ion-beam technology. – 735 p.

2. Kostyuk G. I. Efficient cutter with nano-coating and nanostructured modified layers : monograph-reference book : 2 books / G. I. Kostyuk. – Publishing House of the International Academy of Science and innovative technologies, 2017. – Bk. 2. Laser technology. – 507 p.