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# INFLUENCE OF Γ-IRRADIATION OF THE TOOL ON SOME PARAMETERS OF THE METAL CUTTING PROCESS

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## ABSTRACT

*In the article by A.V. Khidayatov "Influence of γ-irradiation of the tool on some parameters of the metal cutting process." The article discusses the influence of γ-irradiation of a high-speed tool on wear resistance and on the indication of a natural thermocouple (t.e.f.) when working in gaseous and surface and chemically active media.*

**KEYWORDS:** *Cutting Process, Cutting Fluid, Cutting Tool, Metal Cutting, Machining, CNC Machines*

## INTRODUCTION

One of the main tasks of the science of metal cutting is a qualitatively correct, well-consistent with experiment, the establishment of the basic laws of the cutting process. To successfully solve this problem, it is necessary to pay main attention to understanding the essence of the ongoing processes. It is of great importance to determine the internal interrelationships of cutting processes, between the phenomena in the zone of contact of the chips with the front surface of the tool.

New methods of efficient use of cutting tools are gaining momentum. Especially on CNC mills, automatic machines and automatic lines. In modern automated production, the role of the cutting tool is not limited only to the tool of labor, it largely determines the productivity of the machining process. Improving the wear resistance of cutting tools, where dimensional resistance is required, especially on CNC machines, in automatic machines and automatic lines, plays a huge role, especially in finishing and semi-finishing.

The wear resistance of the cutting tool is mainly determined by the physical and mechanical properties of the cutting tool material.

Along with the development of new grades of tool steels, hard alloys, a very promising way to increase the resistance, the application of wear-resistant layers on the rubbing surfaces of the cutting tool should be recognized.

A similar effect can be achieved by other methods, in particular by magnetizing the cutting tool, irradiation, and others.

Irradiation (in particular, γ-irradiation) affects the physicochemical and mechanical properties of solids: as a result, the nature of the impact on them of external environments also changes, [1].

In this work, the influence of γ-irradiation of a cutting tool on wear resistance and on the magnitude of the thermo electromotive force (t.e.f.) under various cutting conditions is investigated.

Knowing the directional effect of radiation, this can be used for a deeper definition of the essence of the relationship between the phenomena occurring in the chip formation zone. Therefore, the study of the influence of γ-irradiation on the cutting process is of certain scientific and practical interest.

At work [2], experiments were carried out to identify the nature of the action of a chemically active medium on an irradiated and non-irradiated cutter made of high-speed steel R18. It was established that these incisors, which were in an aqueous solution of potassium permanganate, oxidized in different ways: the irradiated incisor was covered with a strong dark brown film when, as unirradiated, it was almost not oxidized.

**Method**

The purpose of this work was to check the effect of γ-irradiation of a high-speed tool in the processing of materials by cutting in some gaseous and surface-chemically active media.

The experimental technique was as follows: tests were carried out with longitudinal turning of steel 40X, on a screw-cutting lathe, model 1K62. The machine was equipped with a main engine system, which provided smooth control of the spindle speed. One-piece high-speed cutter P18. Cutter geometry: $\alpha = \alpha_1 = 8^{\circ}, \lambda = 0^{\circ}, \varphi = \varphi_1 = 45^{\circ}, \gamma = 0^{\circ}$.

**Main part**

The study was carried out at feed rates S = 0.11 mm / rev, S = 0.25 mm / rev and t = 1 mm. Used gas media: a) carbon dioxide; b) argon. For comparison, air cuts (conventional cutting) were performed. The gases were supplied from above to the friction zone of the descending chips along the front surface using a tube with an inner diameter of 6 mm installed in the tool holder; gas consumption is 12-16 l / min. With such a flow rate of gases and a tube diameter, the cooling rate could be neglected.

In [3], the effect of oxygen on the reduction of wear and TEMF when cutting with an irradiated cutter, but compared with cutting with an unirradiated cutter, was found. In the present work, we further test the effect of γ-irradiation of a high-speed tool during the processing of 40X and 50T materials by cutting in $CO_2$ and Ar gaseous media.

The dependences of the wear of the cutter along the flank surface on the cutting speeds when cutting steel 40X were measured at the beginning by unirradiated, and then by the same

irradiated (with an irradiation power of 200 R / sec, for 384 hours, the source of irradiation was Co 60), the cutter in (normal conditions), i.e. air and carbon dioxide. The results show that the effectiveness of the action of external media for an irradiated cutter is higher than for an unirradiated one. Figure 1 shows the results of experiments when working in a carbon dioxide environment and under normal conditions. It can be seen from the graph that at S = 0.11 mm / rev, the irradiation of the cutter when working in $CO_2$ and "air" environments reduces the wear of the cutter

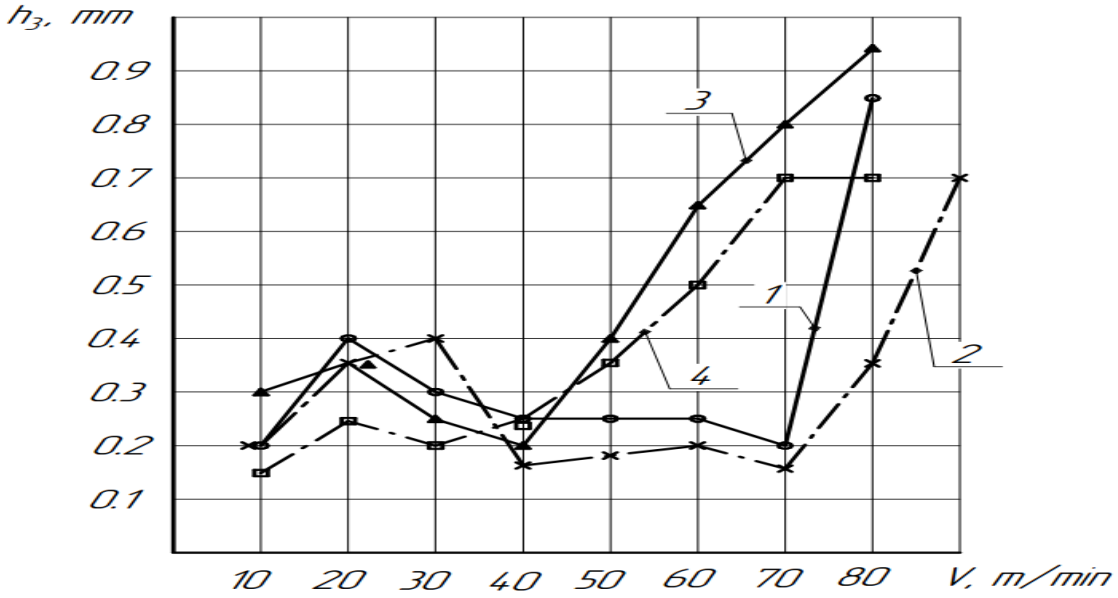


Fig. 1. Influence of irradiation of the cutter on wear in air and carbon dioxide

at S = 0.11 mm / rev

1-Non-irradiated cutter with "Air" medium, 2- Irradiated cutter with "Air" medium

3- Unirradiated cutter medium, "CO2" 4- Irradiated cutter medium "CO2"

When working with irradiated and non-irradiated cutters in the specified media ("$CO_2$" - carbon dioxide and in "air"), the cutting temperature was measured depending on the cutting speed, using the natural thermocouple method, at feed rates S = 0.11 mm / rev and S = 0,25 mm / rev. The results show the indication of the TEMF of a natural thermocouple in all cases when working with an irradiated nix cutter than when working with an unirradiated one.

Figure 2 shows the results of cutting with irradiated and non-irradiated cutters in "argon" and "air" environments for wear of the cutting tool. Figure 3. shows the results of the TEMF reading of a natural thermocouple during operation (cutting) in the "Argon" and "Air" environments. From the graph it is noticeable that for an irradiated cutter up to a cutting speed of V = 40 m / min, the TEMF reading is lower, and at high cutting speeds, V> 40 m / min, no noticeable effect is observed.

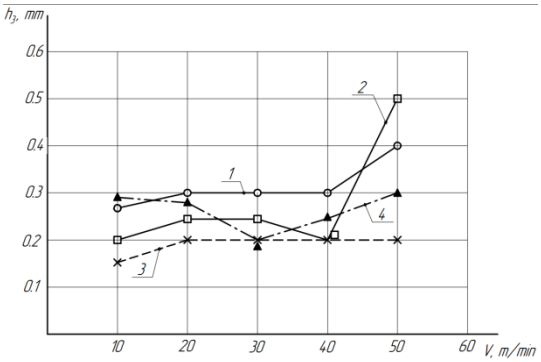


Fig. 2. Influence of tool learning on wear in air and argon at S = 0.25 mm / rev

1-Unirradiated cutter medium "Air"

2- Non-irradiated cutter "Argon"

3- Irradiated cutter medium "Air"

4- Irradiated cutter medium "Argon"

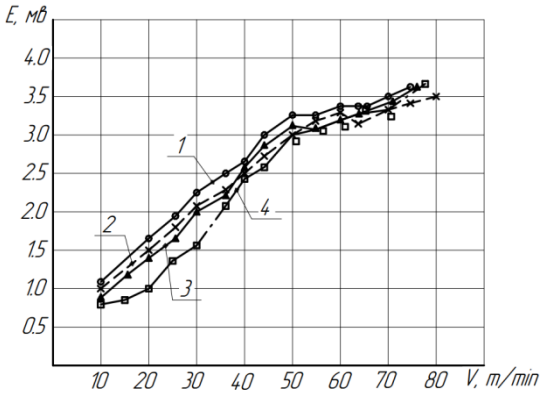


Fig. 3. Dependence E = f (v) when cutting in the "Ar" medium S = 0.11 mm / rev

1- Unirradiated cutter medium "Air"

2- Irradiated cutter medium "Air"

3- Unirradiated incisor medium "Ar"

1- 4- Irradiated incisor medium "Ar"

In the process of cutting, lubricating and cooling technological means are widely used. One of the ways to increase the durability of the cutting tool is to increase the activity of lubricating-cooling fluids (coolant). It is of interest to study the effect of γ-irradiation of a cutting tool on its wear and on the TEMF of a natural thermocouple when operating in surface chemically active media.The experiments were carried out on a 1K62 lathe with stepless speed control, with longitudinal turning of 50G steel, and a one-piece P18 high-speed cutter. (Cutter geometry$\alpha = \alpha_1 = 8^\circ$ , $\lambda = 0^\circ$,$\varphi = \varphi_1 = 45^\circ$, $\gamma = 0^\circ$).. The study was carried out in aqueous solutions of three ethanolamine a, carbon tetrachloride and barium chloride.

When working with irradiated and non-irradiated cutters in the specified media, the cutting temperature was measured depending on the cutting speed, using the natural thermocouple method, at feed rates: S = 0.11 mm / rev and S = 0.25 mm / rev and t = 1 mm.

The results of the experiments show that the reading of the natural thermocouple in all cases when operating in surfactant and HAV media with an irradiated cutter is higher than when operating with an unirradiated cutter (Fig. 4).

Under the same conditions, the amount of wear along the flank surface was measured in Fig. 5. The results of experiments when working in an environment of carbon tetrachloride are presented. The graph shows that at S = 0.25 mm / rev, the influence of irradiation of the cutter on its wear is positive. For feed S = 0.11 mm / rev up to speed V = 45 m / min, the effect of irradiation on wear is insignificant, and at high speeds V> 40 m / min, wear on the flank surface for the irradiated cutter is lower.

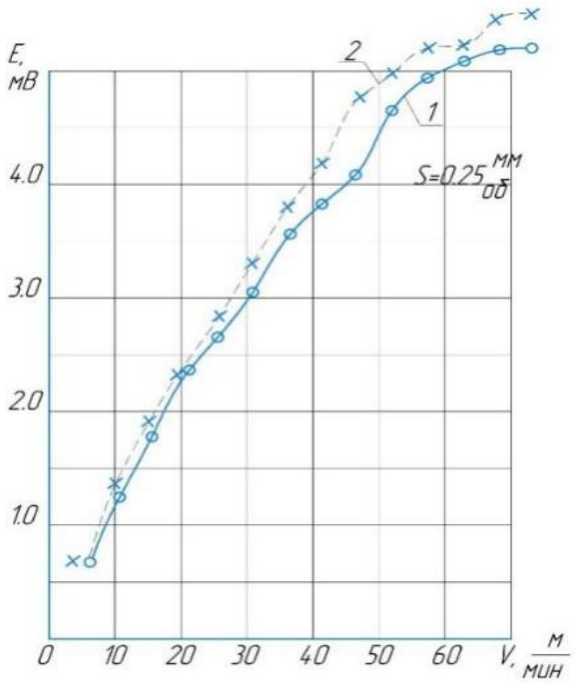


Fig. 4. Dependence E = f (v) when cutting in the Ccl4 environment.

1-unirradiated incisor; 2-irradiated cutter.

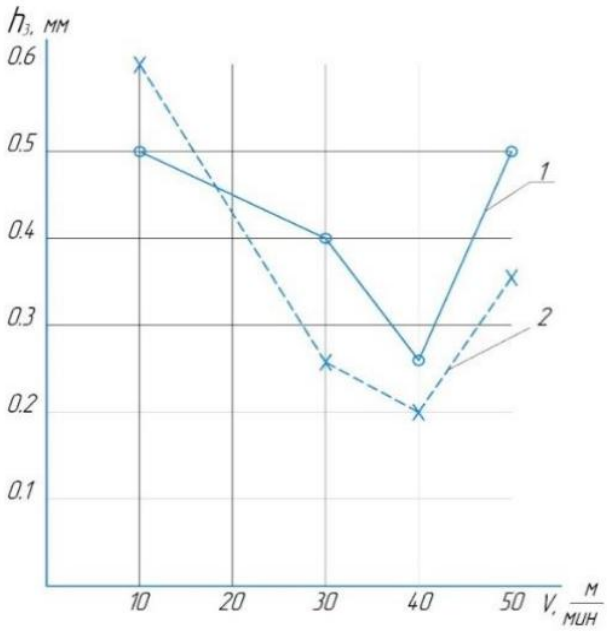


Fig. 5. Dependence *h*3 = f (v) when cutting in a medium of 2.5% carbon tetrachloride Ccl4.

1 - unirradiated incisor; 2 - irradiated cutter (S = 0.25 mm / rev).

Similar results were obtained (Fig. 6.) and when working in the medium of trietonolamine. For feed S = 0.25 mm / rev, the influence of irradiation of the cutter on its wear is positive, and for feed S = 0.11 mm / rev, the transition speed is V = 33 ÷ 36 m / min, vistula V = 35 m / min, wear for irradiated cutter is lower.

Figure 7. the results of experiments when working in a barium chloride medium are presented. It can be seen from the graph that when the feed S = 0.25 mm / rev, the irradiation of the cutter during operation up to V = 40 ÷ 44 m / min reduces the wear of the cutter, and at a speed above V = 45 m / min, the wear of the cutter increases. At S = 0.11 mm / rev up to a cutting speed V = 45 m / min for an irradiated cutter, the wear is higher, and starting from V = 45 m / min for an irradiated cutter its wear is lower.

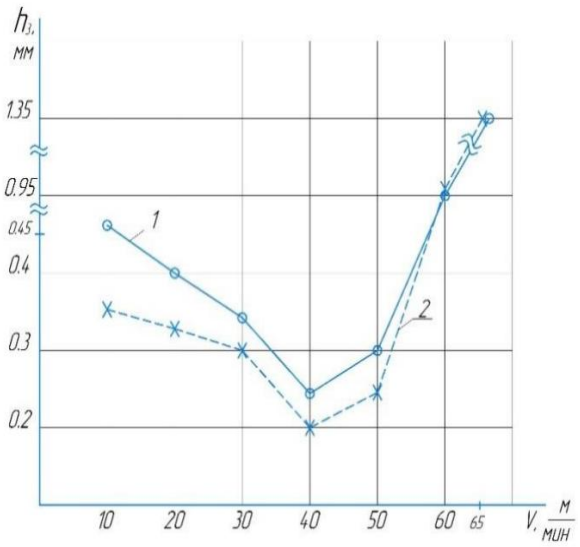


Fig. 6. Dependence *h*3 = f (v) when cutting in a medium of 1% triethonalamine.

1 - unirradiated incisor; 2 - irradiated cutter (S = 0.11 mm / rev).

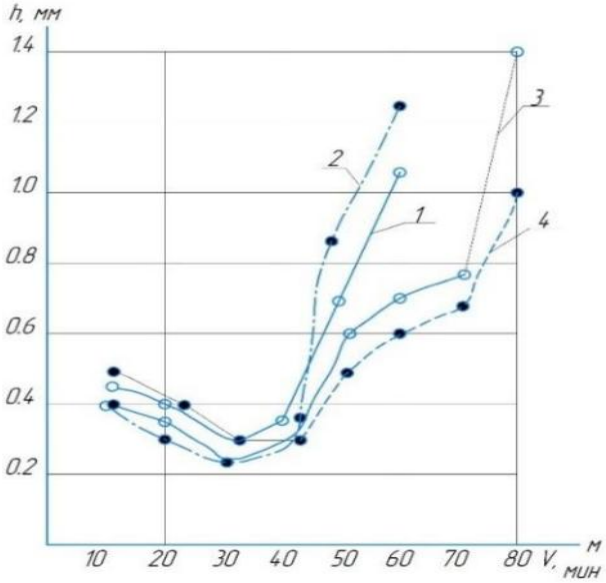


Fig. 7. Dependence h3 = f (v) when cutting in a medium of 5% barium chloride.

1-unirradiated cutter, 2- irradiated cutter at S = 0.25 mm / rev,

3- unirradiated incisor, 4- irradiated incisor at S = 0.11 mm / rev.

γ- Irradiation of the cutter has a significant effect on the effectiveness of the action of surface and chemically active media.

**CONCLUSIONS**

1. Irradiation of the cutting tool increases the activity of the influence of the external gas environment ($CO_2$ and Ar).
2. The nature of the influence of γ irradiation of the tool depends on the combination of temperature and cutting speed.
3. γ- Irradiation of the cutting tool affects the reading of the natural thermocouple and depends on the type (gases and cutting fluids) of the external environment.
4. The nature of the influence of γ irradiation of the cutter on the action of surface-chemically active media depends on the processing modes.

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