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STABILITY ANALYSIS OF ELECTRICAL DISCHARGE MACHINING WITH BRASS WIRE

***Abstract**: Changing analysis of instantaneous speed of machining, voltage between a tool and a workpiece, current of machining and a ratio of working pulses of technological current to a number of pulses applied to interelectrode gap during electrical discharge machining with brass wire of five shaped holes in bearing steel 1.3505 (EN) was performed in the article.*

***Key words**: wire, electrical discharge machining, a workpiece, a parameter.*

***Language**: English*

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Introduction

Machine parts are made of various structural materials (metals, plastics and etc.). The some parts are made of special superhard and wear-resistant steels for increasing of the physical and mechanical, technological, operational and other properties. Machining of such materials by traditional methods is difficult.

Electrical discharge machining allows to remove volumes of conductive material from the workpiece. Electrical discharge machining can be performed by electrodes or wire, which are most often made of copper or brass. Any profile on the workpiece can be cut with wire. There are no standards for wear of tools for electrical discharge machining, so attention is paid to stability of the process [1-10]. The process stability of cutting of the complex profiles with wire is ensured by installation of optimal machining modes and correction of the tool movement on the appropriate technological equipment with numerical control.

Materials and methods

Electrical discharge machining of the steel workpiece was carried out on the CUT 20 (GF AgieCharmilles) special wire electrical discharge machine. The general view and the technical characteristics of the CUT 20 electrical discharge machine are presented in the Fig. 1.

The machine dimensions – 2500/2500/2200 mm
The maximum dimensions of the workpiece – 900/680/250 mm
Air pressure – 6-9 bar
Travel X/Y/Z – 350/250/250 mm
Travel U/V – 90/90 mm
The maximum taper angle – ±25 degrees
Minimum travel X/Y/Z/U/V – 0.125 µm
Working fluid – Deionized water
The size of filtered particles – 5 µm
Standard guides of the dies – Ø 0.2/0.25/0.3 mm
Programmable tension of the wire-electrode – 3-320 N
Programmable winding speed – 30-270 mm/s
Total load current – 13 A
Maximum current – 35 A

Figure 1 – The general view and the technical characteristics of the CUT 20 (GF AgieCharmilles) electrical discharge machine.

Five profile holes were cut on the workpiece ("Ring"). Bearing steel 1.3505 (EN) was accepted as material of the workpiece. The machined contours (the Fig. 2) were built in the PEPS software environment. The outer diameter of the ring was $110_{-0.14}$ mm, the diameter of the central hole was $40^{+0.02}_{+0.01}$ mm, the radii of the semicircles in the central hole was 6 mm, the length of four grooves was 30 mm, the width of the grooves was 9 mm, the minimum distance between the grooves was 10 mm, the maximum distance between the grooves was 30 mm, the diameter of the circle passing through the centers of the grooves was 66±0.06 mm, the width of the ring was $12^{-0.01}_{-0.05}$ mm, the surface roughness of the center hole was 0.16 µm, roughness of the other surfaces was 3.2 µm.

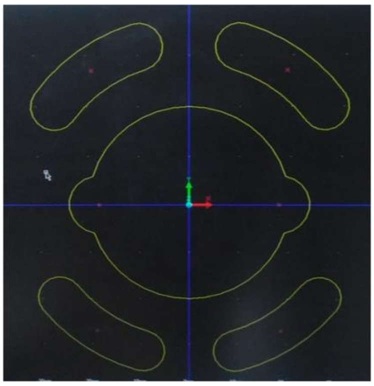

Figure 2 – The machined contours on the workpiece, built in the PEPS software environment.

Basing and fixing of the workpiece are carried out on the machine. The center of the workpiece is defined and origin of the coordinate system is specified. The created control program for electrical discharge machining is transferred to the machine. Cutting is carried out in several steps with brass wire with the diameter of 0.25 mm.

The following technological parameters were adopted for implementation of the process of electrical discharge machining:

The pulses parameters of technological current:

1. The type of the plug-in modules-boards of the generator output stages (Module) – 0;
2. Discharge current (I) – 17;
3. Voltage without load (UHP) – 0;
4. Short circuit current (ISH) – -2;
5. Processing energy (P) – 27;
6. Pulse duration (Ton) – 32;
7. Limitation of short circuit pulses (SPL) – 5;
8. The number of positive pulses (Ppos) – 0;
9. The number of negative pulses (Pneg) – 1.

The feed adjustment parameters:

1. The read mode of the values for the servo (Smode) – 0;
2. The specified value for the servo (Ssoll) – 5;
3. The type of adjustment of the servo system (REG) – 0.

The general parameters of the generator:

1. The type of the working step (WTy) – Main;
2. Strategy (STR) – 0.

The pumping parameters:

1. Pumping pressure (P) – 8 bar;
2. The coefficient of conductivity (K) – 5 uS.

The parameters of wire:

1. Tension force of wire (F_W) – 12 N;
2. Winding speed of wire (A_W) – 30 m/s.

The geometry parameter:

1. Correction of equidistant displacement (Ofs) – 0.15.

Results and discussion

The machined contours on the workpiece are presented in the Fig. 3. The contours dimensions and the surfaces roughness after electrical discharge machining were sustained.

Figure 3 – The machined contours on the workpiece.

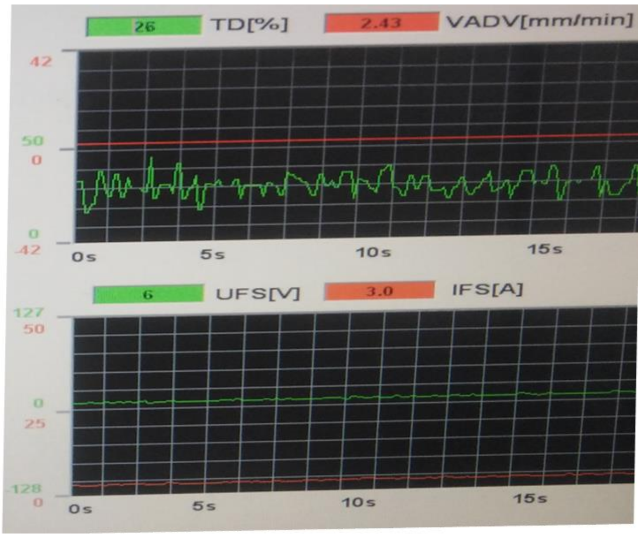

Figure 4 – The dependencies characterizing stability of electrical discharge machining.

Stability of machining was determined on the basis of the technological parameters indications of the process in real time. The dependencies of the current value of the ratio of working pulses of technological current to the number of pulses applied to interelectrode gap (TD), instantaneous speed of machining (VADV), voltage between wire and the workpiece (UFS) and current of machining (IFS) from time of electrical discharge machining of five through holes are presented in the Fig. 4. The considered time range of machining was taken 20 s. Instantaneous speed of machining on the all accepted time range does not change and is 2.43 mm/min. The ratio of working pulses of technological current to the number of pulses applied to interelectrode gap does not exceed 50%. Two pulses are generated per second of machining. The parameter values increase and decrease on short intervals of the all time range of electrical discharge machining. The average value of the parameter changing is 26%. Voltage between wire and the workpiece and current of machining in the process of the profiles cutting change slightly and are 6 V and 3 A, respectively. Thus, the small values of voltage and current are optimal for electrical discharge machining of bearing steel with brass wire.

Conclusion

Based on the process analysis of cutting of the profile holes in the workpiece of bearing steel with brass wire we can draw the following conclusions:

1. The process of electrical discharge machining proceeds stably with minimal deviations from the dimensions accuracy and the surfaces quality of the cut elements in the workpiece on the proposed modes.

2. Electrical discharge machining of bearing steels can be carried out at voltage between wire and the workpiece of 6 V and current of 3 A.

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