

METHODS OF IMPROVING THE EFFICIENCY OF THE EDM-WIRE CUTTING

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Abstract: The paper presents research and case studies undertaken in order to improve the EDM-wire cutting. Both, the draft cutting and the finishing cutting are discussed within this paper, in order to increase the dimensional accuracy of the part and to keep a high material removal rate.

1. INTRODUCTION

Electrical discharge machining, used from 1943 is an important non-traditional machining process, widely used in aerospace, nuclear, automotive, electronics, medical and other industries. EDM wire cutting process could be considered complementary to conventional machining methods, because it is possible to produce accurate parts with complex shapes, which are more difficult to be made by conventional methods. EDM wire cutting process has the ability to cut delicate shapes from any conductive material, including hard materials, titanium, zirconium, etc.

It was determined that the processing of materials with good thermal conductivity decreased cutting efficiency, as well as materials with high melting point.

EDM wire-cutting is commonly used when low residual stresses are required. Wire EDM has no added residual stress because there are no cutting forces and dielectric coolant keeps the parts at reasonable temperatures.

To obtain a better surface roughness, it is important to set suitable machining parameters. Such parameters are: electrical parameters, dielectric fluid, work piece materials, etc.

Most related research found that the roughness of the surfaces increased, when using higher discharge energy [Ahmet H], since greater discharge energy would produce larger craters, thus causing a larger surface roughness value on the work piece [Rebelo JC]. Furthermore, related research has indicated that the dominant factor affecting surface roughness was pulse duration, because the surface roughness depends upon the size of the spark crater. Shallow craters together with larger diameters lead to better work piece surface roughness. To obtain flat craters, it is important to control the electrical discharge energy at a lower level by setting a short pulse duration [Bâlc].

2. EXPERIMENTAL RESEARCH

According to the cutting precision and surface roughness, machining of the work piece is made by one or more cuts; by repeating the finish cut, we obtained an improved cutting accuracy and better surface roughness.

For all the operations we used pre-established working conditions, depending on the material type, his thickness and the cutting wire diameter.

The parameters we worked with in order to optimize the draft cut are pulse frequency and advance speed, while the voltage – A_j parameter – is the same. For high values of A_j advance speed is decreasing. F – pulse frequency doesn't have an influence in surface quality, but higher value of F is increasing a little the cutting speed; a pulse frequency to high leads to the wire breakage.

The finish cutting optimization is realized with A_j and S (maximum advancing speed) parameters, while F stays generally unchangeable. If we increase A_j – medium reference voltage, the rate of material removal is increasing and the cutting speed is decreasing. When S is increased, the rate of material removal is decreasing and the cutting speed is increasing.

In order to improve the process results we implemented the following algorithm:

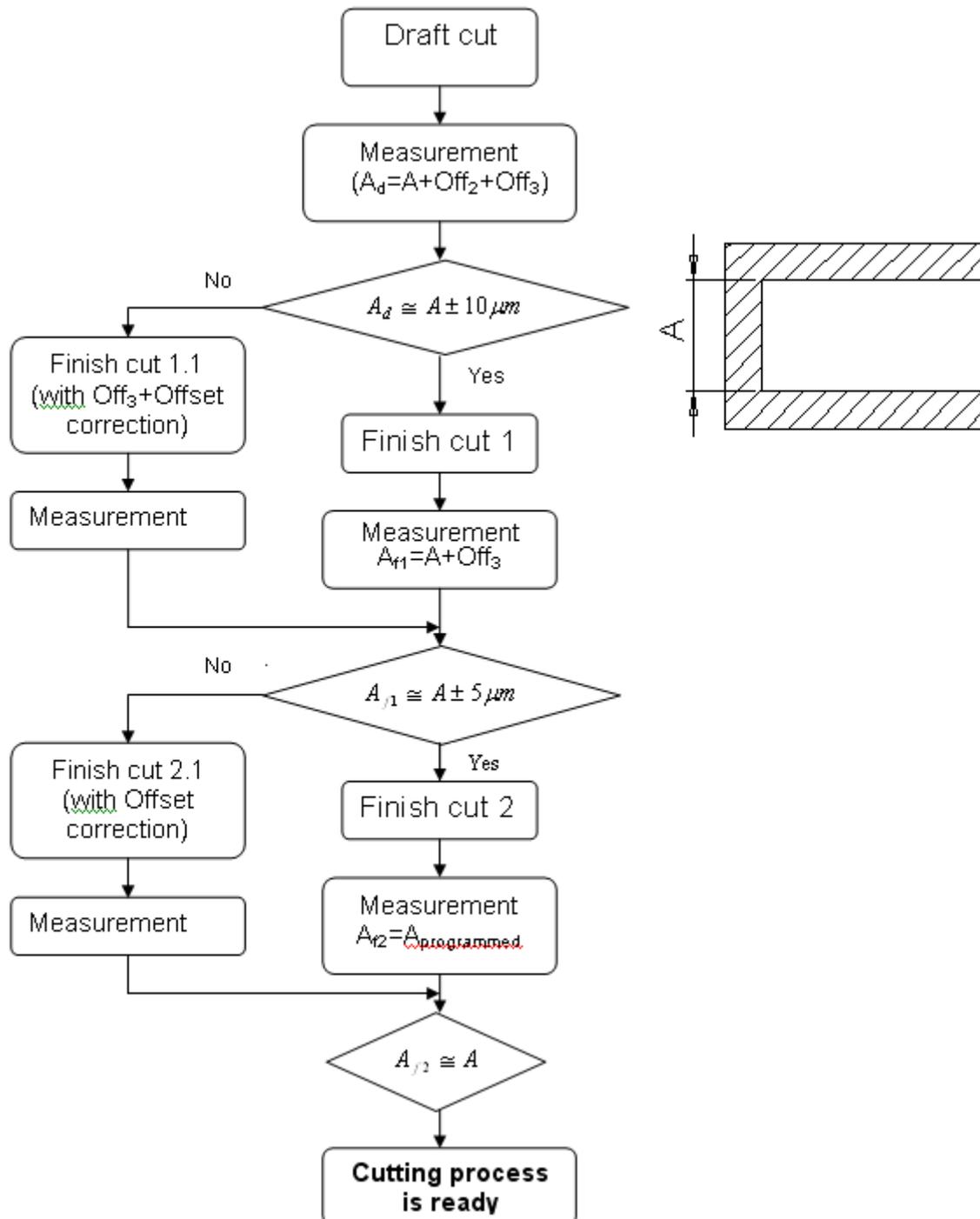


Fig 1. The algorithm for improving EDM-wire cutting process

At the first measurement the difference between A and the programmed dimension corresponds to finishing allowance, meaning $2x$ (material to be removed at the drill cut + material to be removed at the finish cut)

At the second measurement the difference between A and the programmed dimension corresponds to finishing allowance 2, meaning $2x$ materials to be removed at the finish cutting.

3. CASE STUDY

The purpose of this study was to find better EDM cutting procedures and methods, in order to improve the accuracy and surface roughness of the parts with complex shapes and to put into practice the experimental research.

The studies were performed on a SP-640P machine tool, produced by SEOUL PRECISION MACHINE, South Korea, with a hard brass wire electrode, uncovered with paraffin, having 0.25 mm thickness and 900 N/mm^2 breaking strength.

For all the operations we used pre-established working conditions, depending on the material type, his thickness and the cutting wire diameter.

The machine uses the SPM EzCut Ver 5.021 software. The drawing of the necessary contour can be made in any CAD program.

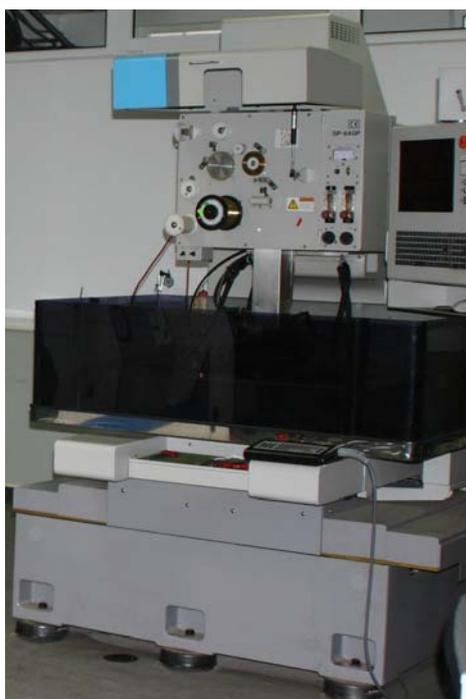


Fig 2. SP-640P machine, TUCN

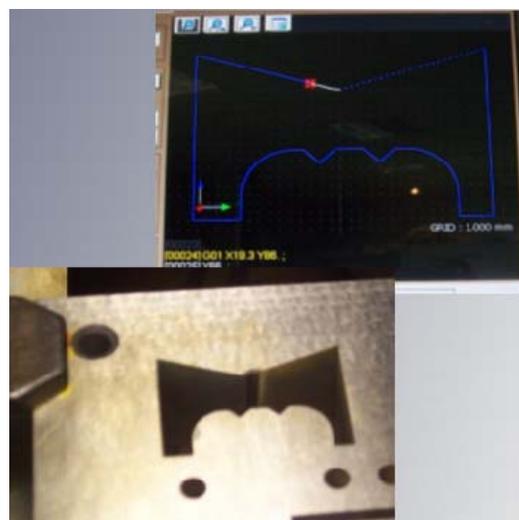


Fig.3 Case study part

The case study part was cut from a C120 steel work piece (30 mm thickness) and the machining was made in two stages, draft and finish cutting. The obtained dimensional accuracy of this machined profile was measured using the Werth VideoCheck IP 400 machine and the results are presented in table 1.

Table 1. Results for case study 1

Dimension Nr.	Measured dimension	Requested dimension	Resulted deviation
Dimension 1	30.0571	30.06	0.0029
Dimension 2	20.0274	20.03	0.0026
Dimension 3	20.9415	20.94	-0.0015
Dimension 4	7.9874	8	0.0126
Dimension 5	4.9096	5	0.0904
Dimension 6	3.8579	3.86	0.0021
Dimension 7	5.2541	5.26	0.0059
Average deviation= 0.016429			

4. CONCLUSIONS

The EDM wire cutting process performance can be improved and measured with dimensional accuracy, surface roughness and the rate of material removal. If we want to obtain a very good surface roughness, the electrical current and the pulse duration should be decreased, so that the electrical discharges between the wire electrode and the work piece are smaller, with a higher frequency.

The improved procedures used by the authors allowed the obtaining of good results during the experimental research. The cutting accuracy in case study 3 was 0.08 mm, when we used a single cut machining. Within the case studies 1 and 2 the dimensional accuracy was 0.01 – 0.03 mm, when the machining was made in two cuts.

5. REFERENCES

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