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# STUDY REGARDING THE PRODUCTIVITY AND QUALITY OBTAINED BY MEANS OF VARIOUS PROCESSING METHODS BY MEANS OF ELECTRO-EROSION

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## ABSTRACT

*This paper has the purpose to draw a comparative analysis regarding the processing productivity, the dimensional precision and the surface roughness by (EDM) processing with negative electrode and outlining (EDM) processing. For this purpose there will be used two different technological methods which will be presented in detail in relation to their stages. The experimental part will follow the obtained deviations as a result of the processing of a piece which has the same form and dimension. The main purpose of this paper is to establish the situations in which it is efficient to use one or another of the methods presented here.*

**KEYWORDS:** EDM**,** surface roughnes,

## 1. Introduction

The electric discharge technologies became more and more important among the modern technologies, having the tendency to grow rapidly in the years to come. The important electric discharge machining (EDM) applications are to manufacture dies and tools (plastics moulding, die casting, sheet metal dies etc) [1], [2] and [3].

The processing with electric discharges in pulse are divided in 2 main directions : dimensional processing that have as a principal interest drawing out small parts of the material surface with the object of form and dimension modifying [4,5,6] and formation of deposited layer that has as a main goal the transfer of the draw material from one of the electrode on the other one's surface for modifying its dimensions, properties and the chemical composition of surface layer of the processed material.

When processing the metals by the (EDM) method, the phenomenon of discharging of the electrical power by the impulse between two electrodes (the tool and the part) is used. Between these two electrodes there is a small constant space called the working interstice. During the processing, between the two electrodes there is a dielectric medium (oil, gas, distilled water etc.) which favours a good functioning of the processing. The electric power is sent by the working interstice as impulses of a certain intensity, tension and frequency. The dielectric has the role of creating the medium which favours the (EDM) process and in which there is a rapid series of physical-mechanical, physical-chemical, thermal, hydrodynamic phenomena a.s.o. Thus, in the working space between the two electrodes an electric field is formed, and it produces micro-discharges of a high concentration of power, which is mostly turned into caloric, luminous, sonorous and mechanical energy [7].

The micro-discharge of the power into the working interstice between the anode and cathode, as impulses of various forms leads to the creation of cylindrical micro channels on the top of the micro-irregularities, where the dielectric layer is pierced, as it has a small resistance.

These channels have the diameter between 700 – 900 µm micrometers, and their length also varies between 100-600µm. figure no.1 In these channels, as a consequence of the ionisation phenomenon of the medium the plasma creation takes place, at temperatures of about 50.000 – 87.000K, which

rapidly melt, burn and vaporise a part of the top of the micro-irregularities [8].

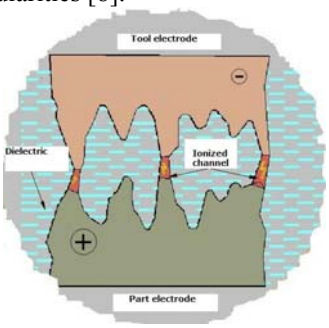


Fig. 1 Representation of the ionised channels [8]

The passing of the materials and of the energy from a physical form into another, produces micro-explosions, which are heard and are visible in some cases. Simultaneously with the electric discharge, mechanical electro shock waves appear which, together with the formed gasses deform the ionised channels as an ellipsoid or spherical form figure no. 2 and in the same time produce electro-erosive products from the formed micro - craters. According to the length of time, the electric energy discharge through the micro-channels goes through the following stages: spark, luminous discharge, arch-spark and electric arch [8].

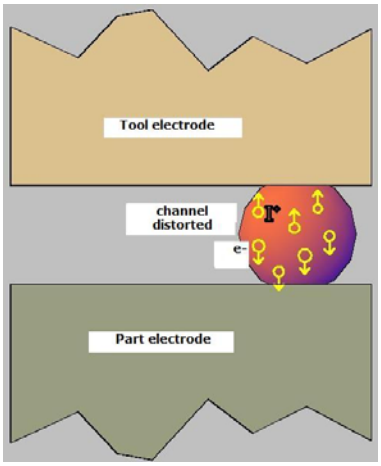


Fig.2 The spherical form of the channel [8]

Generally, it is considered that the electric discharge takes place into two phases:

- The first stage consists of the ionisation of the electric liquid and the formation of a plasma micro-channel.
- The second stage consists of the effective passing of the electric power through the (di-electric) channel and the release of the electric discharge.

The modern production need high productivity, low manufacturing time and low production costs. For this, some modern machine tool are included over modules, as rotation table, precise high rotation spindle, bar magazine, tools magazine, workpiece magazine, laser zero point measurement system, cutting forces dynamometers for diagnostic of process, frequencies sensor, acoustic sensors etc [9].


Fig. 3. The FEM 110 CNC electric discharging machine

The used electrodes during the (EDM) process are made of copper, graphite, brass, aluminium, steel, titan, etc.

The copper electrodes are used for the steel processing, allowing high speed erosion and regimes, as their wear is relatively small; the electrolytic copper is the most used. The processing was performed on a FEM 110 CNC (computer numerical control) electric discharging machine with digital panel, figure no. 3.

This paper aims to be a comparative study of processing the injection matrixes, vulcanization, deep drawing and so on by two methods: massive electrode processing and simple electrode processing by linear and circular interpolation.

The first method is a very simple one, but it demands the previous processing of the electrode by lathing, milling and other types of processing, which takes a lot of processing time and leads to the increase of the electrode cost. For the second case one can use a simple electrode obtained by lathing and milling within minimal costs. In the second case, one can also easier control and modify the dimension aimed to be obtained and the roughness of the processed surface.

## 2. The presentation of the electro-erosion processing works

Two methods of processing an example marker were used:

- A first processing method was performed by classical negative electrode erosion, using just a piercing advance, the descending was done on the Z axis of the machine, as it is represented in figure no.4. This electrode was obtained by milling and turning. The final quota of the electrode must be also corrected with the value of the sparkling interstice.

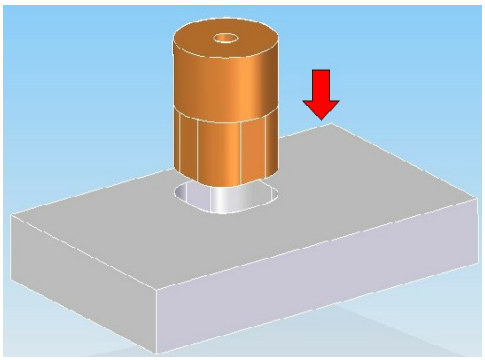

Fig.4 Representation of the classical erosion

- The second processing method was done by the CNC erosion, using a negative cylindrical electrode, performing both a piercing advance and a longitudinal advance, the descent was done on the Z axis while the movement was performed on the XY axis, as shown in figure no. 5. The electrode was obtained very easily and with cheap costs by milling. The finite dimension of the processed surface can be obtained by the programming of the tool trajectory and not by the modification of the electrode dimensions, as in the first case.

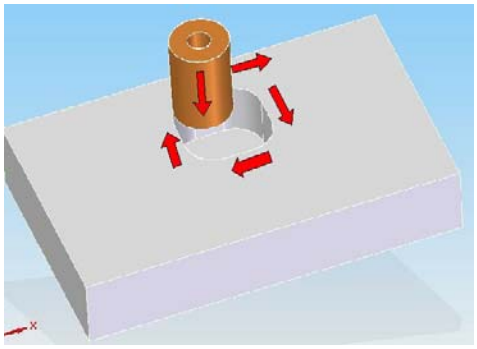

Fig.5 Electro-erosion by linear interpolation

## 3. Experimental data

The experimental determinations were done in the non-conventional laboratory of the University of Bacau.

Two different technologies were used in order to obtain the two tools (electrodes). The processing of the cylindrical electrode of electrolytic copper is done by lathing to Φ 20 mm, the whole is performed on a lathe and is screw-cut by a screw tap, figure no. 6.

Fig.6 Cylindrical electrode

The electrode with a negative form of the part is obtained by the milling of the outline on a CNC milling machine, and it is pierced and afterwards screw-cut. Figure no.7

Fig. 7 The electrode with a negative form of the part

In figure no. 8 the form of the part processed by two methods is presented.

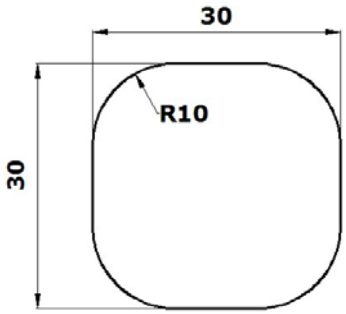


Fig. 8 The form of the part proposed to be studied

Where:
L = 30 mm
R = 10 mm

The form of the part was first milled figure no. 9, and the shape of the part was to be given by electro-erosion. The productivity of the two operations of electro-erosion is different, the obtained timings are displayed in table no. 1.

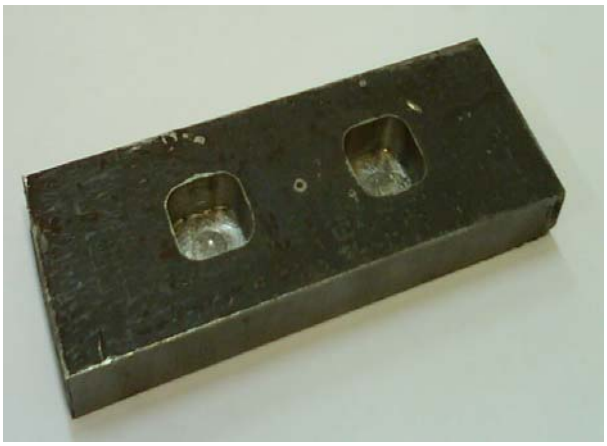

Fig. 9 The part after the milling processing

Table 1. The obtained processing timing.

| Operation | Timing |
|---|---|
| | HH:MM:SS |
| Classical electro erosion | 51:23 |
| Linear interpolation | 1:47:15 |

The processing accuracy is better by linear interpolation, one can do the correction of the tool, it does not depend upon the accuracy of the tool processing. In the other case, a highly accurate precision is necessary when the tool is processed, as the precision of the processed tool depends on it. In table no. 2 the obtained values are presented, after having done the measurements with the TESA MICRO - HITE 3D apparatus.

Table 2. The values obtained as a consequence of the measurements

| Operation | L | R |
|---|---|---|
| | mm | mm |
| Classical electro-erosion | 30,03 | 10,01 |
| Linear interpolation | 30,01 | 10 |

The values of the processed surface roughness are presented in table no. 3. The linear interpolation has a better roughness even if the productivity is lower.

Table. 3 The values of the roughness

| Operation | Roughness |
|---|---|
| | Ra [μm] |
| Classical electro-erosion | 15,56 |
| Linear interpolation | 13,23 |

The structure of the surface processed by electro – erosion, shown in figure no. 10, presents only micro-pinches of spherical forms.

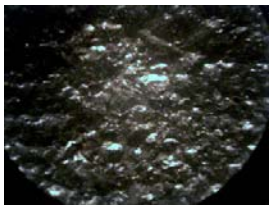

Fig. 10 Structure of the surface processed by (EDM).

## 4. Conclusions

As a consequence of the study we can deduce the following advantages:

For the classical erosion we can mention:

- A good productivity:
- Precision mostly depends on the precision of the electrode and on the chosen regime;

a. For the electro-erosion by linear interpolation we can mention:

As we deal with a simple electrode, it is easy to obtain;

A better roughness as the contact time with the processed surface is lower.

- The processing precision can be corrected by programming of the working regime and by the tool correction no need to modify the electrode. We can also deduce the following disadvantages :

a. In the case of the classical electro-erosion we deduce that:

- The electrode is more complicated to obtain and the process takes more time;
- The material consumption for the electrode is greater;
- The correction or the correction of the quota in case of mistaken dimensions is impossible.

b.– Productivity is lower;

-The form must be obtained by programming.

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