12th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

EDM PROCESS IN THE MODERN TECHNOLOGIES

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ABSTRACT
The study of unconventional manufacturing methods technologies, mainly Electric Discharge Machining (EDM) has been performed for over 20 years within the Faculty of Machine Building from Technical University of Cluj-Napoca, Romania. During the time, this process was more and more used in Machine Building. Some traditional processes were replaced with EDM and in most of the cases the results were satisfying. Some materials with special mechanical properties can be manufactured only by EDM process. The traditional processes can not be replaced totally, but EDM process can complete the technology making it cheaper and giving better result.
The article presents some possibilities to optimize the EDM technologies and the importance of technological parameters that combines traditional methods and unconventional EDM method of manufacturing.
Keywords: Unconventional, technology, discharge, machine, building

1. INTRODUCTION
The manufacturing of complex surfaces by electro erosion is one of the most used methods, especially because it can generate practically surfaces as complicated as it needs, and not depending on the durity of the hardness of the material. The process is used mainly in the work tools departments and also for the large series of machining. The main advantage is that the work tool is performed from materials that are easy to process and the conditions of working don't depend on the hardness of the material. Concerning the fact that the finishing works of the surfaces occur after the process thermal treatment, the process is difficult and expensive process. Electric Discharge machining becomes very efficient. Without a contact between tool and work piece, it avoids the appearance of the distortion in the work piece and of the internal stress in the superficial layer of the manufactured surface.
Today, the machining by electro erosion can practically realized any kind of manufacturing that is made with classic methods: drill, saw, turn, mill, ream, grind, hone, etc. [1]
This machining can be classified in two groups: EDM (machining with massive electrode), WEDM (machining with wire electrode).

2. MANUFACTURING PRINCIPLES
The EDM machines can be separated in two types: universal and special machines. The physic process of material machining and the evacuation of the processed material from the spark take place in the interstice between work piece and tool. In the process of electro erosion, the electric parameters have the main importance.
The productivity of manufacturing by an impulse is directly dependent on the energy of the impulse:

$$Q_i = c\,\eta W_i \qquad \ldots(1)$$

In which Qi is the volume of the material that was sampled/impulse; c- adequacy coefficient; η – efficiency coefficient; Wi – the energy of a singular impulse[3].
The warming of the surface of the two electrodes and the existence of the electric field determines the appearance of the thermoelectric and thermion emissions. The particles accelerated in the electric field, arrive to the electronic spots, where takes place the energy transfer. It suppose that most of the energy is transformed in thermal energy, developing temperatures between 4000º - 50000º C. It takes place melting, boiling off, thermal influence, structural changes of the peripheral zones of the electrodes, forming of micro fissures, forming of erosion craters. [2]

3. WIRE ELECTRIC DISCHARGE MACHINING

The process can be compared with the classic process of sawing or cutting with diamond wire, but the particular characteristic of not stressing the workpiece and the wire that don't gets in contact with.
Comparing with the classic machines, the workpiece flows forward and the wire rolls only.

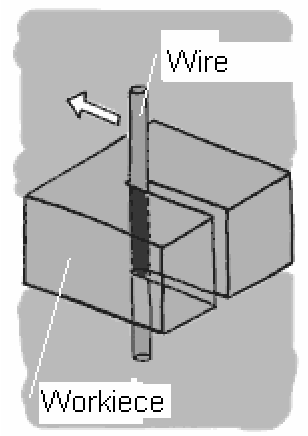

Figure 1. WEDM machining

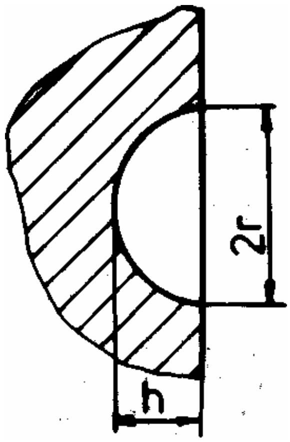

Figure 2: Crater dimension

One of the parameters that are followed to be obtained after machining is the roughness of the surface. Machining with this method can be obtained very good surfaces with roughness that can arrive till 0,2µm, but only in finishing mode. In the industry is not always necessarily such a good surface. So in the industry, is important to anticipate the roughness of the surface to be able to prepare a technology for a workpiece that is economic. Obtaining a roughness that is wanted by the client, it avoids an additional machining which would require an additional time and cost.
The roughness depends on the parameters that are set by the technician.
For practical applications it considers:

$$h = C_H \cdot E_i^{\,p} \qquad (2)$$

where:
CH – material coeficient;
p – exponent p=0.33-0.4
CH=190 for steel and steel alloyed with Cr;
CH=67 for hard alloys;
Expresing the energy Ei

$$E_i = \frac{U_m \cdot I_m}{f} \qquad (3)$$

it obtains:

$$h = C_H \left(\frac{I_m \cdot U_m}{f} \right)^p \qquad (4)$$

where:
Im – medium value of the intensity;
Um – medium value of the tension on the interstice;
f - frequency.
The roughness is increasing when the intensity of the current is growing and when the frequency is decreasing.
The process can be compared with sawing or cutting with diamond wire. The texture of the surface is not the same on the entire surface of the work piece. This phenomena is due to the dielectric that don't wash equable the processed material. As in the conventional processes, the EDM can also do rough, finishing or super finishing works.
With the new machines of EDM, the roughness R_a that is obtained on the existing machines that work in the industry is between 0,2 ÷ 6,3 μm. In some cases, because of the aspect that must be obtained on the surface, the work pieces are processed with very high roughness, over 12,5 μm. The productivity that is obtained in this case is very high because of the very high energy that is used. For the very high precision processes, it can be obtained in special conitions a roughness of 0,05 ÷ 0,1 μm.[2]

4. EXPERIMENTAL RESULTS

Because usualy, the process is used in industry after a termic threatment of the workpiece, we used hard steel.

- OLC 45
- 42MoCr11
- OSC7

The experiments for this work were made on a Wire Electric Discharge Machine model MAKIO EE3. For a higher hardness, the test pieces were thermal treated.

Table 2: Roughness values

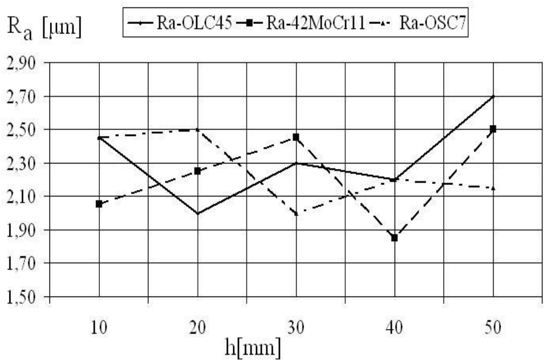

Figure 3 : Roughness variation depending on the material

Surface roughness Ra[μm] after machining OLC45, 42MoCr11 and OSC7			
	Material		
	OLC45	42MoCr11	OSC7
h=10mm	2.45	2.05	2.45
h=20mm	2.00	2.25	2.50
h=30mm	2.30	2.45	2.00
h=40mm	2.20	1.85	2.20
h=50mm	2.70	2.50	2.15

The dimensions of the test pieces are:
- length L= 80mm;
- width l= 20mm;
- height h= 10÷50mm;

The roughness of the surface was measured on the midle of the height. The obtained values are listed in the table 2.
From the figure 3 can be observed that for the same thickness of the work pieces the value of the roughness are oscillating between 1, 85 μm and 2, 70 μm.
But after a thickness of 70 mm the roughness changes from the bottom and the upper part of the work piece to the centre as it can be seen in the fig. 4. This phenomenon takes place because the nozzles are placed at the top and at the bottom of the work piece and the pressure is not big enough to be able to wash all the particles.
On a work piece with a thickness of 110 mm, the measurements were made from the bottom to the middle of the work piece and the roughness grows from 2, 7 μm up to 5, 5 μm as it can be seen in fig. 4.

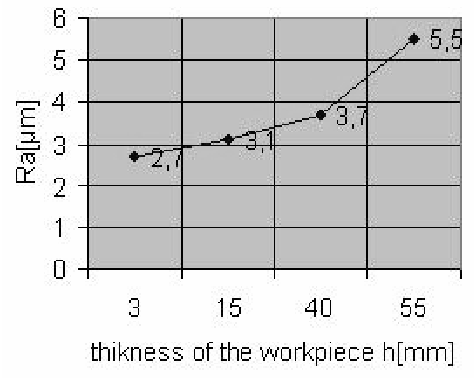

Figure 4. The diagram of roughness variation depending on the thickness of the work piece

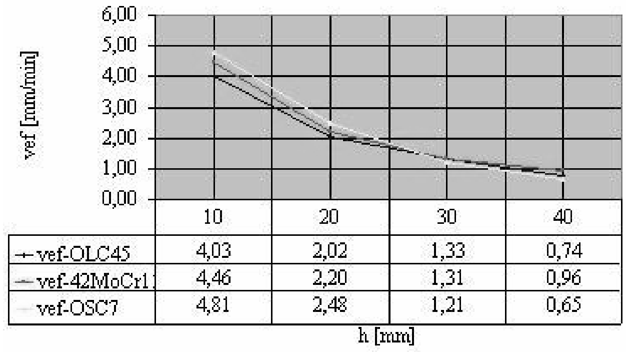

Figure 5. The cutting speed variation depending on the thickness of the work piece and on the material

In the industry the roughness that is obtained is very important. On this parameter depends the quality and the aspect of the product.

Today the new machines with the command and control system that assist the process make the work of the operator easier.

In the fig. 5 can be observed that the cutting speed depends on the material that is processed. Even if the difference is not big between the three material, it can be important if the work piece is produced in large series.

5. CONCLUSIONS

What is important to be known in the industry for this technological method of machining is expanding in the industry more and more. To be mentioned is that it begins to be used in micromachining. Considering this, it must be very good known to be able to establish a technological itinerary and after this a price for a work piece or for a large series of production. The operator is using the CAD/CAM programs that write the CNC program but the parameters of the machine must be set concerning the material, the thickness of the work piece, the roughness that must be obtained and the tool material. For a better planning of the technology, it’s necessary to build a bibliotheca with most common materials that are to be used in a factory. For example for the same kind of machining(roughing or finishing), in the tables of the machine-tools, the parameters are optimized but it is not specified the quality of the surface that can be obtained. of the the work presents only one parameter that influence the quality of the machined surface. For example for the same kind of machining(roughing or finishing), in the tables of the machine-tools, the parameters are optimized but it is not specified the quality of the surface that can be obtained.

6. REFERENCES

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