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AN ELECTRODE WEAR COMPENSATION MODEL REGARDING THE EDM PROCESS

TIRLA, A[ndrei]; POPA, M[arcel] S[abin]; POP, G[rigore] M[arian]; CHETREANU - DON, C[amil] O[ctav]; OLTEAN, A[ndrei] I[oan] & PREJA, D[an]

Abstract: *Electro-discharge machining (EDM) is an important manufacture technology in machining difficult-to-cut materials and to shape complicated contours and profiles with high material removal rate, low tool wear and good tolerances. However, this capability could be deteriorated due to electrode wear leading to decrease of process productivity. Studying the electrode wear and related significant factors would be effective to enhance the machining productivity and process reliability. In this research, an experimental study is conducted to investigate the electrode wear in die-sinking EDM and to build a tool wear compensation model.*
Key words: *EDM, RSM, wear, compensation*

1. INTRODUCTION

For a long time now in other words from the beginning of industrial usage of EDM in 1950, it was admited that this procedure, due to it's capacities of eroding through electric sparks in any spacial directions is kinematically very flexible (Popa et al.,2009). 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 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. Electric discharge machining becomes very efficient. Without a contact between tool and work piece, it is avoided the appearance of the distortion in the work piece and of the internal stress in the superficial layer of the manufactured surface (Nichici & Achimescu, 1983). The major advantage of EDM in comparison with other manufacturing processes is represented by the fact that the hardness of material is not important, the only necessary condition is that the processed material must be electro conductive (Popa M, et al, 2008).

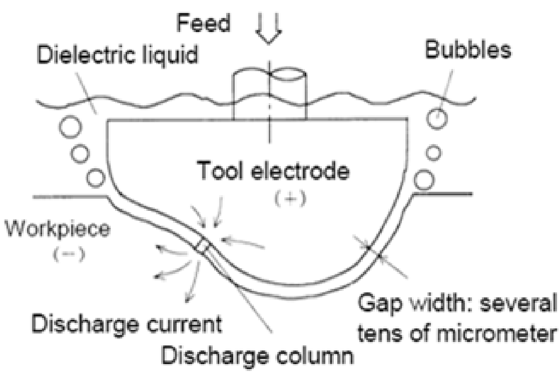

Fig. 1. EDM process

During the process, a voltage is applied between two electrodes—the tool and the workpiece—closely placed inside a liquid dielectric medium. When electrodes are very close to each other (gap distance) an electric spark discharge occurs between them forming a plasma channel between the cathode and the anode (Figure 1 shows a close-up of the machining region).

The tool wear at the electro discharge machining is a matter of interest at present and its reduction is discussed by many researchers. The tool wear process (TWP) is quite similar to the MRM (material removal mechanism) as the tool and workpiece are considered as a set of electrodes in EDM. Mohri claimed that tool wear is affected by the precipitation of carbon from the hydrocarbon dielectric onto the electrode surface during sparking (Mohri et al., 1995). He also stated that the rapid wear on the electrode edge was due to the failure of carbon to precipitate at difficult-to-reach regions of the electrode. From this simple understanding of TWP, some useful applications exploiting both the advantages and disadvantages of electrode wear have been developed. Marafona and Wykes introduced a wear inhibitor carbon layer on the electrode surface by adjusting the settings of the process parameters prior to normal EDM conditions (Marafona & Wykes, 2000). Although the thickness of the carbon inhibitor layer made a significant improvement on the TWR (tool wear rate), it has little effect on the MRR (material removal rate). On the other hand, for applications requiring material accretion, a large pulse current is encouraged to increase electrode wear implanting electrode material onto the workpiece.

2. ELECTRODE WEAR COMPENSATION MODEL

Research on electrode wear compensation focuses on geometric modeling of electrodes. The methodology consists of determining the wear of electrodes and its compensation by adding material on the active surface. To determine the minimum number of experiments required the ANOVA method will be used. The experimental tests will determine the electrode wear over time, depending on processing parameters of the machine. To determine the evolution of wear, there will be made 3D electrodes scanning after a Δt processing time. A database consisting of electrode wear based on the values of used parameters will be prepared. For electrodes compensation there will be produced two mathematical algorithms that describe:

- Dimensional compensation of the electrodes
- Geometrical compensation of the electrode.

With Visual C programming language will be redesigned the electrode shape and the form will be rendered using CAD software. For redesigned electrodes the CAM program will be automatically generated and their execution will be carried through the processing center. Testing will be resumed in order to validate the generated mathematical algorithms. The project will be completed through a program that will automatically generate the electrode depending on the form that is intended to be processed.

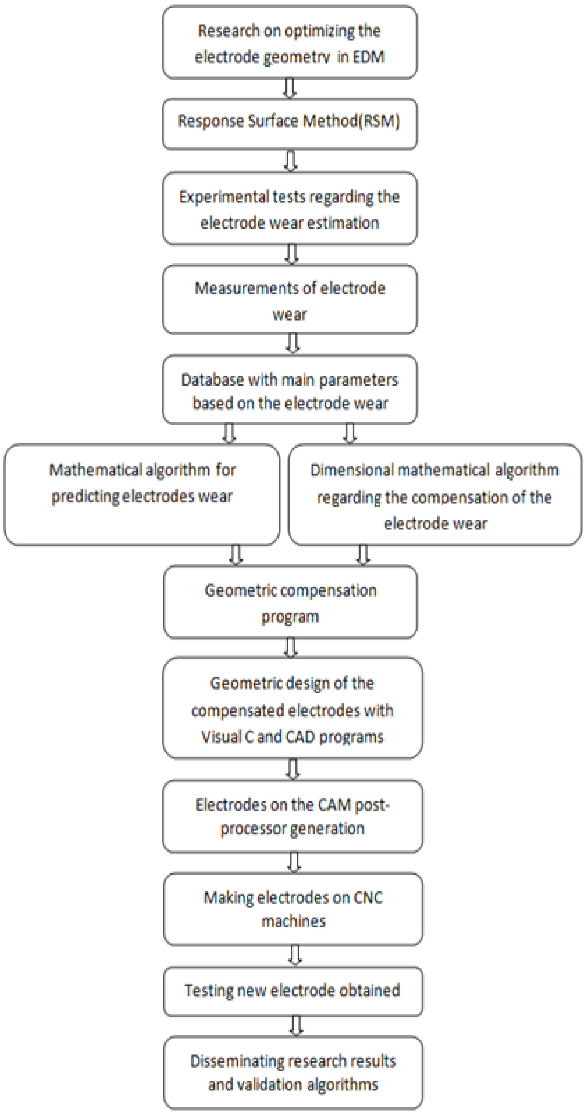

Fig. 2. The methodology of the tool wear compensation model

3. EXPERIMENTAL RESEARCH

This paper presents the results for the first set of experiments where it is desired to observe the impact of tool wear on the electrodes. For the experiments it was used stainless steel 1.4112 and graphite as raw materials. There were made two types of electrodes, one with a flat active surface and the other one with a conic active surface. The purpose was to notice the surface's modifications and to observe if the conical surface flattens out. This flatten will appear due to the wear effect. For a better understanding the conical dimension was established to 2 mm. Because the machine is capable of achieving a roughness between 0,1 μm and 18 μm it was decide to make three machining sets with the next values 0,3 μm, 1,1 μm si 6,3 μm. The machining depht was set to 3 mm.

After the machining process there were measurements made and the active surface of the electrodes was scanned in order to observe the radius modifications that apears to the conical ones. For this operation it was used a Carl Zeiss CONTURA measuring center, equipment that also brings the 3D model of the electrodes. After that with a CAD (computer aided design) software the electrodes profiles were overlaid and we obtained the needed information.

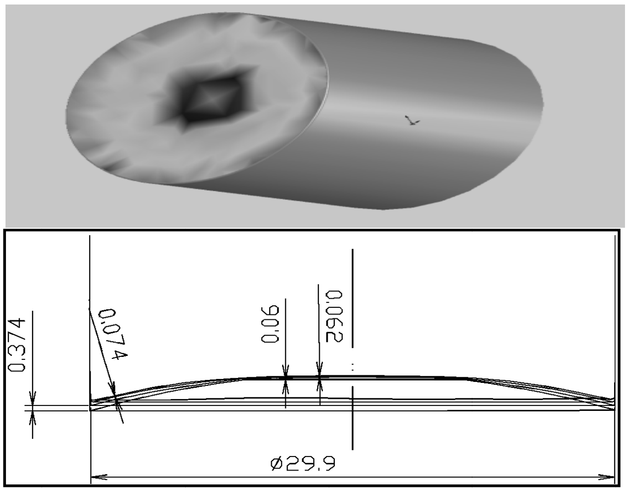

Fig. 4. The overlay of the conical profile

After the measurements it was observed that the radius increases at the same time with the processing blank, the wear being more pronounced at the extremities of the electrode. A strange phaenomenon take place in the center of electrode were it was obtained a constant wear, regardless of the roughness required and, implicit, regardless of the machining parameters.

Exp. nr.	Electrode type	Initial lenght	/final [mm]	Initial diameter	/final [mm]	Wished roughness	/obtained [μm]
4	Ø30 Conical	22,8	22,426	30,46	29.98	0,3	0,442
5	Ø30 Conical	22,426	22,207	29.98	29,92	1,1	1,99
6	Ø30 Conical	22,207	22,09	29,92	29,81	6,3	6,376

Wished depht	/obtained [mm]	Machining program	Edge difference	Central difference	Conical surface radius
3	2,626	P6 -> P2-P4	0.374	0,06	47,75
3	2,781	P8 -> P6	0,16	0,06	54,15
3	2,883	P8 -> P6	0,093	0,62	56,23
					58,03

Tab. 1. Results for the electrode with conical active surface

4. CONCLUSIONS

The tool wear at the electro discharge machining is a matter of interest at present and its reduction is discussed by many researchers. The proposed concept involves designing a model of dimensional and geometrical compensation of the electrodes used in electrical erosion processing, performance to meet current world level. Regarding the interpretation of experimental data obtained can be concluded that the direction of research is good.

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