

EXPERIMENTAL RESEARCH REGARDING THE MODELLING OF PROCESS PARAMETERS OF DIMENSIONAL PROCESSING THROUGH ELECTRICAL DISCHARGE MACHINING

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ABSTRACT: The processing by electric erosion is part of the most general category of the processing methods using concentrated energies, by which the material prelevation is discontinuously and cumulated produced, the dimensional processing activation being the cumulated result of some elementary erosion processes, temporary and spatially concentrated between a transfer object and a processed object. Therefore, the statistic experimental analysis of the experimental package refers to the processing of the steel using transfer objects made of materials like electrolytic copper, steel and graphite. We examined the statistic experimental modelling and optimization of some objective functions of the type processing productivity, the volume wear of the transfer object and especially the quality of the processed surface measured by the rigorous parameter Ra [μm].

KEYWORDS: Electrical discharge machining, Statistical methods, Parameters, Experimental research, Modelling and optimisation.

1. INTRODUCTION

The electric erosion processing is part of the most general category of concentrated energies processing methods.

In this type of processing, the action of dimensional processing is the cumulated result of certain basic erosion processes, temporally and spatially concentrated between a transfer object and an object to be processed.

It is well known that the liquid used as dielectric in electric erosion dimensional processing with shape copying is, in most cases, a hydrocarbon of the type gas-oil.

Thus, this dielectric hydrocarbon based is a non-conducting liquid environment [1].

One can state that the experimental analysis of the influence of a system of directed, spatially homogeneous, correctly located exterior magnetic fields [1], on the electric erosion dimensional processing, can be performed by means of certain well-defined experimental programmes, which monitor the evolution of the objective functions.

2. CASE STUDY. EXPERIMENTAL RESEARCH

The technological parameters (the objective functions) can be improved by a uniform actuation of the erosive space by means of a system of homogeneous, directed exterior magnetic fields, so as

the quantity of material removed in the time unit to be uniformly extracted from the crater, regarding the quantity in relation to depth and surface [9].

The designed experimental programmes have focused on the dimensional regulation of the magnetic field electric erosion dimensional processing.

Thus, tables 1 - 5 presents certain experimental data on one of the most important experimental programmes designed on this purpose.

The analysis of the diagrams presented and obtained as a result of experimental statistic modelling of the process, and eventually statistically optimised, leads to the idea that what is important is “how” the erosion process is magnetically actuated and as well the experimental values of the parameters of the process (for example, the resultant magnetic field strength H [A/m]) [1].

Depending on the situation mentioned in figures 1 - 3, the evolution of the volume and relative wear, in the magnetic fields electric erosion dimensional processing, is presented.

Moreover, the quality of the surface depends not only on the processing parameters, but also on the experimental stand that is used [2].

Table 1. General equations of the objective functions

“STATISTIC DATA SYSTEM” Central composite factorial experiment General equations of the objective functions	
Q_p [mm ³ /min]	$Q_p = -156.3160 + 3.81195 \bullet t_p + 0.243426 \bullet t_i + 19.9559 \bullet I + (1.35684 \bullet 10^{-3}) \bullet H + (-1.00356 \bullet 10^{-3}) \bullet t_p \bullet t_i + 0.0535691 \bullet t_p \bullet I + (3.06527 \bullet 10^{-5}) \bullet t_p \bullet H + (-7.67544 \bullet 10^{-3}) \bullet t_i \bullet I + (-3.39428 \bullet 10^{-6}) \bullet t_i \bullet H + (1.04058 \bullet 10^{-4}) \bullet I \bullet H + (-0.056795) \bullet t_p^2 + (-3.06058 \bullet 10^{-4}) \bullet t_i^2 + (-1.01142) \bullet I^2 + (-9.70028 \bullet 10^{-8}) \bullet H^2$
Q_e [mm ³ /min]	$Q_e = -1.46597 + (-0.0795975) \bullet t_p + 0.0118319 \bullet t_i + 0.295407 \bullet I + (1.98182 \bullet 10^{-4}) \bullet H + (-2.19212 \bullet 10^{-4}) \bullet t_p \bullet t_i + (7.25104 \bullet 10^{-4}) \bullet t_p \bullet I + (4.29537 \bullet 10^{-6}) \bullet t_p \bullet H + (-2.3460 \bullet 10^{-3}) \bullet t_i \bullet I + (-6.92976 \bullet 10^{-7}) \bullet t_i \bullet H + (-1.16228 \bullet 10^{-6}) \bullet I \bullet H + (1.0054 \bullet 10^{-3}) \bullet t_p^2 + (2.16899 \bullet 10^{-5}) \bullet t_i^2 + 0.0211503 \bullet I^2 + (-2.17508 \bullet 10^{-9}) \bullet H^2$
γ [%]	$\gamma = 26.29 + (-1.0549) \bullet t_p + (-0.0327923) \bullet t_i + (-1.13521) \bullet I + (1.01338 \bullet 10^{-3}) \bullet H + (2.37115 \bullet 10^{-4}) \bullet t_p \bullet t_i + (-0.012649) \bullet t_p \bullet I + (-1.55853 \bullet 10^{-6}) \bullet t_p \bullet H + (-5.62933 \bullet 10^{-3}) \bullet t_i \bullet I + (-1.10399 \bullet 10^{-6}) \bullet t_i \bullet H + (-9.42242 \bullet 10^{-5}) \bullet I \bullet H + 0.0162608 \bullet t_p^2 + (1.16647 \bullet 10^{-4}) \bullet t_i^2 + 0.227228 \bullet I^2 + (2.10407 \bullet 10^{-8}) \bullet H^2$
Ra [μm]	$Ra = 8.95248 + (-0.0561048) \bullet t_p + (1.12562 \bullet 10^3) \bullet t_i + (-0.543319) \bullet I + (-1.53166 \bullet 10^{-4}) \bullet H + (-1.02564 \bullet 10^{-4}) \bullet t_p \bullet t_i + (-5.90278 \bullet 10^{-3}) \bullet t_p \bullet I + (-4.11184 \bullet 10^{-6}) \bullet t_p \bullet H + (-1.28205 \bullet 10^{-4}) \bullet t_i \bullet I + (-2.42915 \bullet 10^{-7}) \bullet t_i \bullet H + (2.57675 \bullet 10^{-5}) \bullet I \bullet H + (2.2768 \bullet 10^{-3}) \bullet t_p^2 + (1.18358 \bullet 10^{-5}) \bullet t_i^2 + 0.0308732 \bullet I^2 + (4.27461 \bullet 10^{-9}) \bullet H^2$

Table 2. Input data. Physical values. First experiment

Input Data (Independent Values) - physical values -					
H [A·sp]	$\log H$ [A·sp]	I [A]	Q_p [mm ³ /min]	γ [%]	Ra [μm]
0	1,00000	5,0	1,009	78,0131	8,0
800	2,80209	10,0	3,466	20,5321	3,8
4200	3,90115	12,5	9,152	10,1616	1,6
12000	4,10612	17,5	6,974	18,6354	4,0
22000	4,60915	17,0	5,467	33,9637	5,2

Table 3. Input data. **Dependent** values. First experiment

Input Data			
Independent Values	Q_p [mm ³ /min]	γ [%]	Ra [μm]
Constant	-53,345649	239,230407	18,698145
$\log H$	-50,920148	16,368397	11,23564
I	23,841872	-42,601894	-5,699587
$\log H^2$	4,890852	4,089187	-1,078823
I^2	-0,749005	1,253383	0,185719

Table 4. Input data. Physical values. Second experiment

Input Data (Independent Values) - physical values -					
H [A·sp]	$\log H$ [A·sp]	I [A]	Qp [mm ³ /min]	γ [%]	Ra [μm]
0	1,2568	6,0	1,56	56,568	6,0
800	2,4567	8,0	3,56	18,6981	1,8
4200	3,1111	9,5	9,66	11,365	0,6
12000	4,10612	17,5	6,001	17,698	2,0
22000	4,60915	17,0	5,467	22,1125	0,2

Table 5. Input data. Independent values. Second experiment

Input Data			
Independent Values	Q_p [mm ³ /min]	γ [%]	Ra [μm]
Constant	-23,5689	136,456	9,56231
Log H	56,123	11,99	9,5554
I	14,8956	-56,789	7,8889
Log H^2	2,5646	8,5649	-1,889
I^2	-0,5698	2,45678	0.22

Thus, the evolution of the volume and relative wear is presented in the next pictures.

3. CONCLUSIONS

As resulting from the analysis of the diagrams, the dimensional regulation, on the three axes, of the processing (of the craters) depends on the spatial positioning of the subsequently composed magnetic fields, fact that considerably improves efficiency [2].

One can state that the processing efficiency drops to minimum values if the dimensional regulation is not adequate.

The volume and relative wear are the objective functions that vary with the process parameters, but also with the dimensional regulation.

A minimum wear of the transfer object is desirable, so as the dimensional regulation to be obtained for a certain position of the magnetic fields systems overlapping the processing.

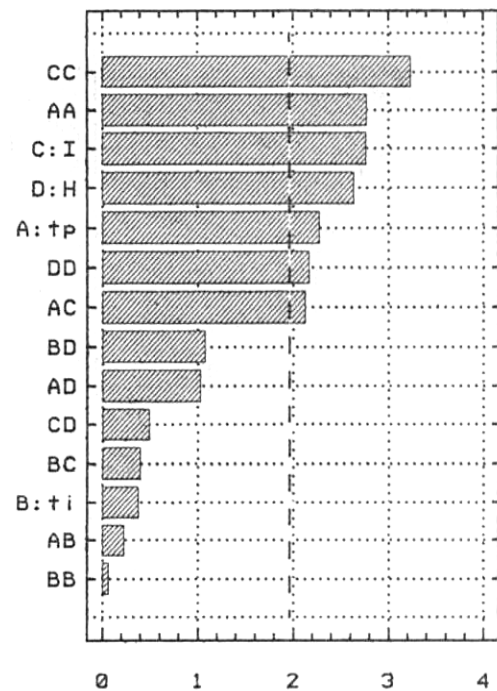


Figure 1. Pareto analyses of the volume wear evolution

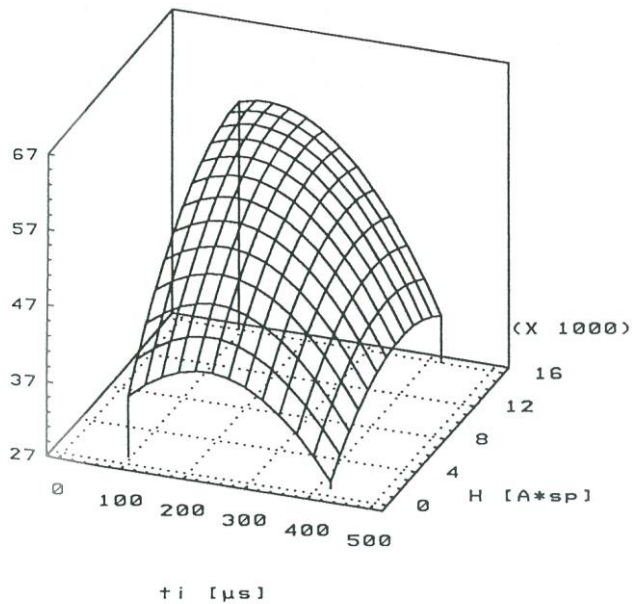


Figure 2. Evolution of the relative wear

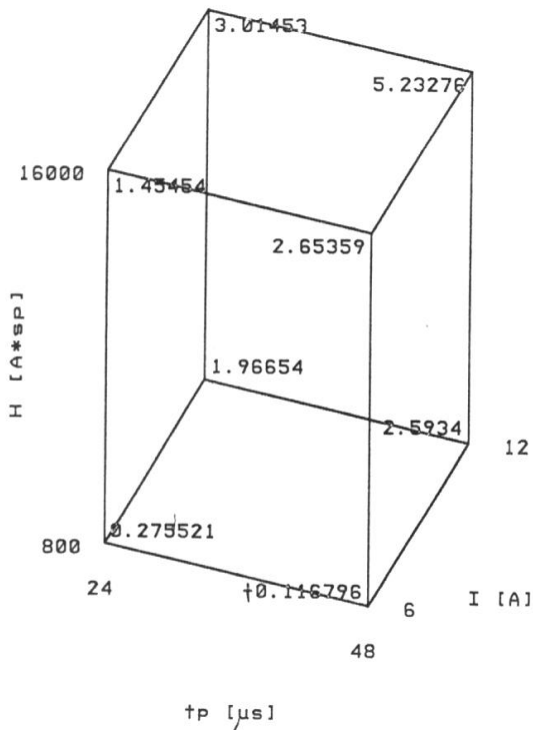


Figure 3. The relative wear technological cube

The spatial modelling of the magnetic fields overlapped with the shape copying electric erosion leads to a univocal positioning of the resultant magnetic field, fact that leads to an adequate dimensional regulation of the processed cavity, respectively of the basic craters obtained as a result of the electric discharges in impulse induced in the presence of an adequate dielectric environment.

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