Research on the Process Activation Importance to Obtain the Quality of the Processing Surfaces

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Abstract: *Electrical erosion is one of the most common methods of processing with concentrated energy. In this way, the sampling method of the material is discontinuously and cumulative. The way in which the activation of dimensional processing is performed is effectively a cumulative result of erosion processes of an elementary and temporary nature and which is spatially concentrated. This concentration takes place between a transfer object and a processing object. In this context, this scientific paper highlights an experimental statistical analysis whose experimental set refers to the processing of sintered hard alloys of type P30. The transfer objects that were used were made of specific materials: electrolytic copper, steel and graphite. In this experimental study was examined the modeling and statistical optimization of some objective functions. These objective functions aim at the process productivity, the transfer objects volume and last but not least the quality of the surface that was processed, measured by the* R_a *[µm] parameter.*

Keywords: *electrical erosion, processing object, productivity, statistical analysis, transfer object, quality*

1 INTRODUCTION

The history of the development of electrical erosion spans a relatively short period, the first reports of industrial use of this process dating back to the 40s, namely 1943 when the Lazarenko couple propose reversing the action of breaking electrical contacts and directed use of electrical contact erosion to dimensional processing (Nanu, 2004).

Thus, the foundations were laid for the industrial application of a new processing process, which would soon revolutionize the technological concept of processability.

For electrical erosion follows a period of probing, laboratory research, successes, but also failures, which have created the premises for the industrial application of the process. Research is conducted in all industrially developed countries.

The studies in the field of electrical erosion undertaken by the authors are noteworthy: (Alexander, 1997), (Bommeli, 1979) and (Konvrog, 1997).

Considering that the development of this process is fast and spectacular, and the research results are more and more rich, the process acquires such a wide application that the concept is reached that the process can no longer be missing from any technological process of dimensional processing (Bommeli at al., 1979).

In general, experimental research is carried out without a very well-defined logic, without a programming of laboratory experiments and without establishing from the very beginning precisely what needs to be done and in fact what is pursued (Chiou et al., 2005).

Assisted programming of their experimentation to the dimensional processing by electrical erosion, in order to generally validate some theories, removes mistakes, compromises and puts order in thinking, conception, planning and leadership (Dwaipayan et al., 2018).

The processing of experimental data by statistical methods requires the knowledge and mastery of necessary knowledge (Grant & Leavenworth, 1998).

The analysis of complex technological processes, including the dimensional processing process by classical electrical erosion but also with magnetic activation, can be performed by various methods (Juran & Gryna, 1997). One of these methods is the systemic approach where the central element of this way of looking at reality is the system (Katiyar et al., 2018).

The system, defined in terms of dimensional processing by electrical erosion, is a complex of independent objects that work together for a common goal with inputs and outputs in an organized process of transformation.

Due to the fact that this experimental research refers to the dimensional processing by electrical erosion with magnetic activation during the work are presented the author's points of view.

The experiment on the chosen model should be as simple as possible; knowledge of how to calculate the parameters of the original based on studies performed on the model (Kumar et al., 2020).

The literature dedicated to the study of the processing process by electrical erosion, in general, highlights various types of models, namely: experimental models, physical models, mathematical models, cybernetic models.

2 EXPERIMENTAL RESEARCH

Because of the necessity of finding out more information regarding the material prelevation process by the dimensional processing by electric erosion with and without exterior magnetic activation, towards the conceived experimental programs of the active type, it was done the experimental research of the classical type, by which the processing of some material couples with various properties was modeled.

The independent variables were: the magnetic field intensity, the electric field intensity, the impulse time and the rest/pause time.

It is considered the last two types of independent variables were as being constant along the material prelevation and equal by some significant values from the technological point of view. The experimental data is highlighted in the table 1.

Table 1. Experimental data

H [A·sp]	logH [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

Independent Values	Q_p [mm^3/min]	γ [%]	Ra [μm]
Constant	-53.345649	239.230407	18.698145
LogH	-50.920148	16.368397	11.23564
I	23.841872	-42.601894	-5.699587
LogH^2	4.890852	4.089187	-1.078823
I^2	-0.749005	1.253383	0.185719

H [A·sp]	logH [A·sp]	I [A]	Q_p [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

Independent Values	Q_p [mm^3/min]	γ [%]	Ra [μm]
Constant	-23.5689	136.456	9.56231
LogH	56.123	11.99	9.5554
I	14.8956	-56.789	7.8889
LogH^2	2.5646	8.5649	-1.889
I^2	-0.5698	2.45678	0.22

Using "STATISTIC DATA SYSTEM 2000" program package was carried out the statistical analysis of the experiment made, also the modeling and then the optimization of the objective functions, the regression coefficient calculus that characterize and accompany the objective function equations.

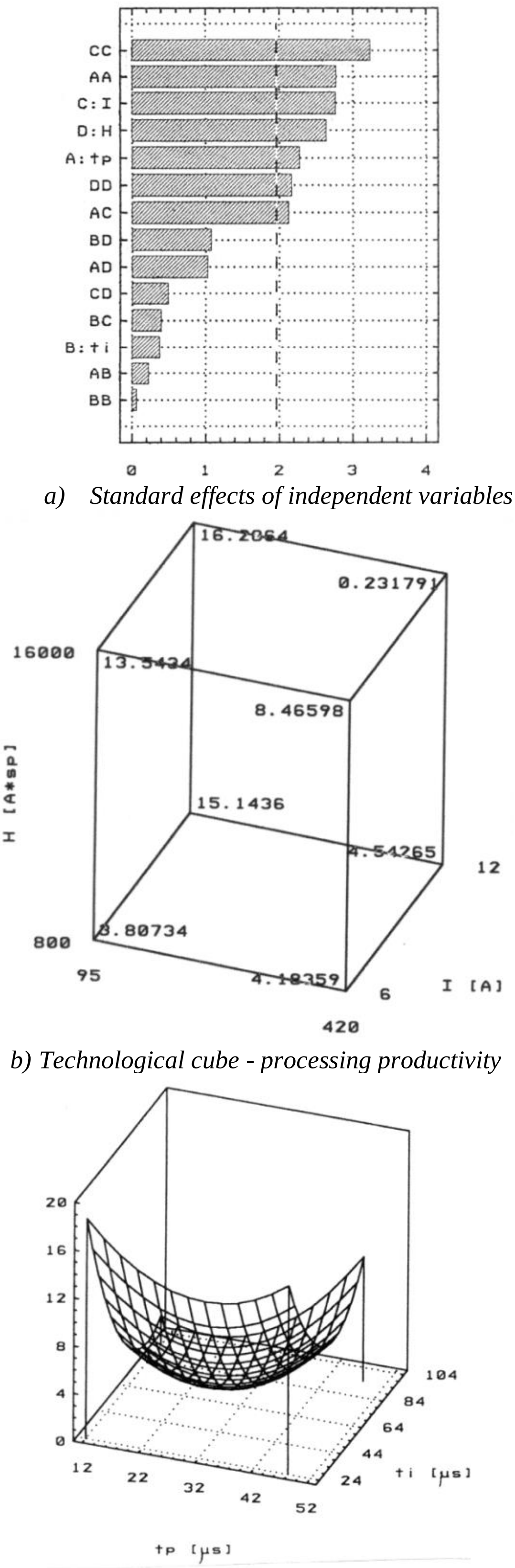
The obtained experimental results were quantified through plane variations curves of the objective functions mentioned above, statistic optimized.

Based on the first set of experiments, it was highlighted the antithesis of the electrolytic couple which was used to the transfer object manufacturing and a set of tests made of hard sintered alloys P30 were marked.

The second experimental program of the classical type was carried out using graphite transfer objects and tests made of P30 carbon.

In both cases the dimensional processing without magnetic activation is very difficult, that is almost impossible.

The graphical representations for the first experimental program exposed of the objective function Q_p [mm^3/ min] are presented in Figure 1.



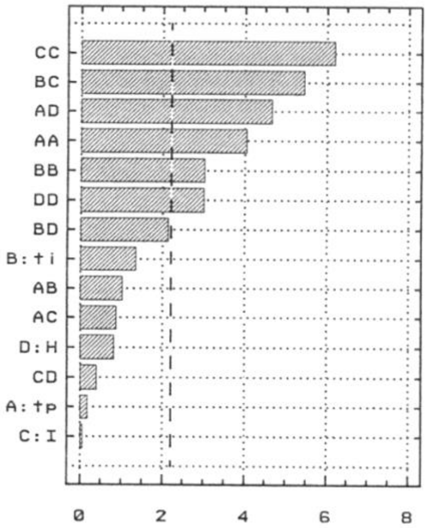
a) Standard effects of independent variables

b) Technological cube - processing productivity

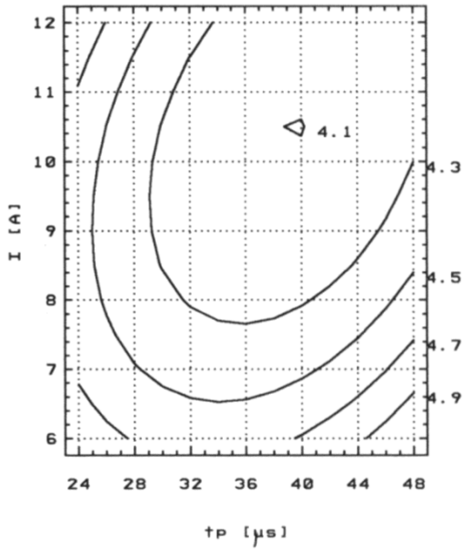
c) The evolution of relative wear

Fig. 1. The graphical representations for the first experimental program exposed of the objective function Qp [mm3/ min]

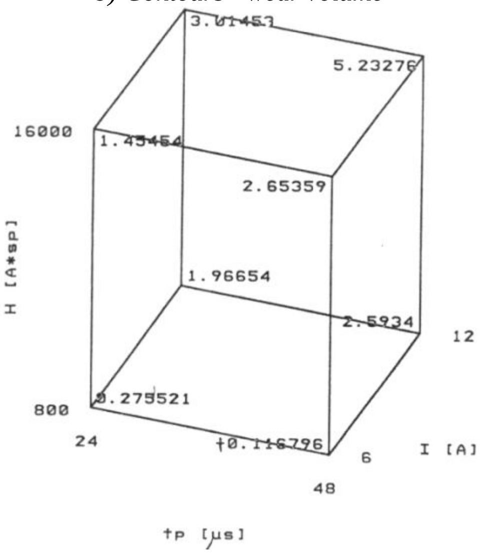
The graphical representations for the first experimental program exposed of the objective function R_a [µm] are presented in Figure 2.



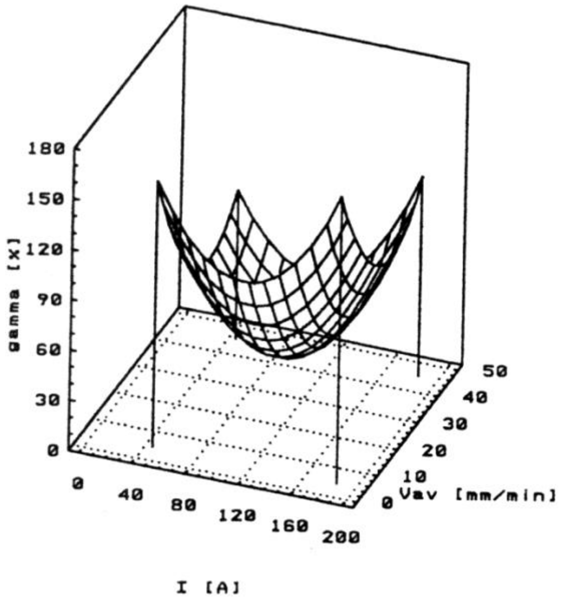
a) Standard effects of independent variables



b) Contours - wear volume



c) Technological cube - processing productivity



d) The evolution of relative wear

Fig. 2. The graphical representations for the first experimental program exposed of the objective function R_a [µm]

The highest value of the processing productivity was obtained when the power was 15A and the value of the magnetic field intensity was about 4500AS.

For the same numerical values imposed and determined experimentally, the objective quality function of the processed surface expressed by the arithmetic mean deviation of the roughness profile Ra [µm] has a minimum value, which is a practical advantage.

A similar and obvious conclusion was drawn from the analysis of the contour plots that characterize the relative wear.

The processing of sintered diagrams of P30 type is preferred as a means of sampling the material when the transfer object is made of graphite.

In this case, the experimental program concluded that the maximum processing productivity was reached for the magnetic field intensity 2050AS H [AS], the minimum for the relative wear was obtained for the magnetic field intensity 1950AS, while the quality of the treated surface was about 4800AS for the magnetic field intensity H [AS].

3 CONCLUSION

Considering all the information obtained during the operation of classic test programs, which were managed and refined by the STATISTIC DATA SYSTEM 2000, the results were confirmed by active test programs and we concluded that the electrical erosion of the efficiency of the measurement program and, in particular, the quality of the treated surface.

The optimization of the objective functions leads to the obtained test results, which show that in the processing of particularly hard sintered alloys, the overlap of the magnetic field with the corresponding production process leads to better use of the analyzed process.

Some conclusions that are considered important can be highlighted.

The need for these studies was determined by the fact that changes in volume wear have a decisive influence on the accuracy of processing as well as creating an opportunity to verify the influence of the magnetic field on the electronic and ionic components of the discharge current.

The relative wear of the transfer object generally characterizes the phenomena of removal of material at the surface of the elements in interaction with dimensional processing by electric erosion with magnetic activation, by expressing as a percentage the amount of material taken from the surface of the transfer object to take the unit volume.

The object to be processed. As by applying external magnetic fields the quantities of material taken from the object to be processed, respectively from the object of transfer are modified, changes of relative wear will also appear implicitly.

Taking into account those mentioned and underlined in these lines, it can be said with certainty that the activation of the dimensional processing process by electrical erosion leads to an increase in productivity of up to 20 times.

This without taking into account certain real experimental values obtained for various processing regimes used, values removed from the experimental statistical modeling program and considered to be aberrant although they existed, have been verified many times but statistically have was irrelevant.

In the same sense, in the dimensional processing by electric erosion with magnetic activation, the volume wear is clearly lower than that obtained in the classical processing without activation.

The surface quality keeps the same note, namely in a dimensional processing by electric erosion with magnetic activation it improves compared to that obtained in a classic processing, which as I told you and demonstrated concretely leads to an increase in processing accuracy.

The objective functions analyzed and commented for the process of processing by electrical erosion have led to special results that only raise the scientific level of research and that lead to a modeling and subsequently to the optimization of the mentioned processing process.

The obtained results open new paths in the scientific research carried out with the help of experimental programs for modeling and statistical and experimental optimization.

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