

APPLYING EXPERIMENTAL RESEARCH METHODS ON ELECTRICAL DISCHARGE MACHINING

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ABSTRACT: The paper presents some experimental and theoretical researches regarding rank I and rank II factorial experimental method employed in the process of quality assurance and management. Applications of this type are realized in collaboration with students from the "Lucian Blaga" University of Sibiu, Romania, as examples in the Master Programme entitled Quality Management in discipline Experimental Research and Data Processing.
KEYWORDS: quality, factorial experiment, statistical methods, parameters, experimental research, economy and safety norms, modelling and optimization

1. INTRODUCTION

Currently, the statistical processing of experimental or observation data is encountered almost in all sciences, from the social, medical or economic ones, up to engineering, physics, chemistry, biology or agricultural sciences.

Consequently, approaching experimental and theoretical problems, from a statistical point of view, led to valuable results in the most diverse fields of sciences which apply to the processing of experimental data.

In all technical and economic fields, knowing phenomena and processes of any nature is based on the processing and the optimization of some information acquired after making some experiments [1].

The integration of Romania in the European Union leads to the necessity of improvement of services and products quality and to the diversification and the refinement of material production.

In the present phase, the special duties put in charge of our industry can be carried out integrally and at a high qualitative level, only through a scientific approach and an optimal management of technological processes.

By applying science as a productive force, people's work displaces more and more towards the decision making and the reasoning activity, the active work being gradually taken over by machines and automated equipment.

Regarding the reasoning activity and the decision making, in the management of a process, science places at our disposal the necessary means under the shape of models – physical and mathematical – capable to react to any change in work conditions.

Science supports the rational and decision-making activity in process management by providing several physical and mathematical models, which are designed to react to any change in the working conditions [2].

For the reason that research on physical models presents certain major drawbacks, such as a longer research period and the impossibility of covering the whole economic factors, the present-day tendency in the management of technological processes is the employment of the mathematical models on a larger scale.

These models reproduce the process by means of certain functional relations and allow us to find optimal conditions of action in real time and with lower material costs than in the case of physical models [8].

Hence, the mathematical theory of the experiment was formulated and as a part of it, the experiment programming (management) was promoted.

The experiment is programmed proceeding from the previously designed plan, an optimal plan from the viewpoint of the factor modification algorithm, its accomplishment ensuring a complex influence on the variable states of the researched object.

The diversity of aims in scientific research generates a multitude of experimental programmes, the mathematical experiment theory providing a number of concepts, which are essential for the achievement of the research aims.

In general, experimental research is somehow situated outside of the constraints of a well-defined logic; it is done without a previous planning of the laboratory experiments and without previously and specifically establishing what it is to be done and, in fact, what is the final objective.

Quite often, those who experiment something new do all that they have to in order to obtain what they want and not what they should.

For the study of objects, phenomena and processes, scientists often appeal to experimental research.

The wide use of the concept of experiment has determined the development of the mathematical experiment theory and implicitly the appearance of certain specific concepts among which the concept of modelling play an important part.

The electric erosion processing procedure belongs to the most general category of concentrated energies processing methods. In this type of processing, the dimensional processing action is the cumulated result of certain elementary erosion processes, temporally and spatially concentrated between a transfer object and an object to be processed [10].

Thus, this hydrocarbon-based dielectric is a non-conductive liquid environment.

One can state that the experimental analysis of the influence of certain controlled, spatially homogeneous and correctly positioned joint external magnetic fields on the electric erosion dimensional processing can be made by means of certain well defined experimental programmes, meant to monitor the evolution of the objective-functions.

Various types of actuation of the electric erosion processing procedures have been tested so far, aiming at the improvement of certain technological parameters such as the processing efficiency, the volume wear, the relative wear, the quality of the surface, but also the improvement of the processing efficiency.

The experiments have been performed on an electric erosion-processing tool ELER 01, using an auxiliary device, its task being to actuate the process by magnetic fields.

The cleaning method has been different from that of the experimental programmes presented so far, namely:

- in the electric erosion process, the dielectric jet has been directed towards the processing location, respectively;

- in the second case, the dielectric has been injected through the transfer object.

2. EXPERIMENTAL RESEARCH

The monitored and statistically processed objective functions have been: the processing efficiency Q_p [mm^3/min], the volume wear Q_e [mm^3/min], the relative wear γ [%], the square mean deviation of the roughness profile R_a [μm].

The experimental programme has used, as input data (independent variables): the magnetic field strength H [As], the strength of current I [A], the impulse time t_i [μs], the downtime t_p [μs].

The monitored objective functions have been optimized, namely their maximum or minimum for certain values of the independent variables has been determined.

By using the experimental statistic modelling and a statistic analysis of the aforementioned objective functions by means of an experimental statistic modelling and optimisation Software Package titled “STATISTIC DATA SYSTEM”, there was conceived and designed in Sibiu, Romania, a universal experimental statistic modelling software programme, which has been proposed for patenting.

When a magnetic field is overlapped, the processing of carbides is said to be easier, the efficiency reaching its maximum, the quality of the surface being good and the wear of the transfer object being lower (examples in figures 1 - 3), especially when the cleaning is done by injecting the gas-oil dielectric through the transfer object.

The actuation by directed, homogeneous or inhomogeneous exterior magnetic fields, spatially positioned in various ways, leads in all cases to substantial increases in efficiency, to the improvement of the processed surface quality and to the reduction of the transfer object wear. [8]

A tremendously important conclusion, which will be presented in detail independently, is that the processing by OL37 transfer object is impossible or difficult, regardless of the processed material if the electric erosion processing procedure proceeds without an actuation by magnetic fields of certain values determined experimentally.

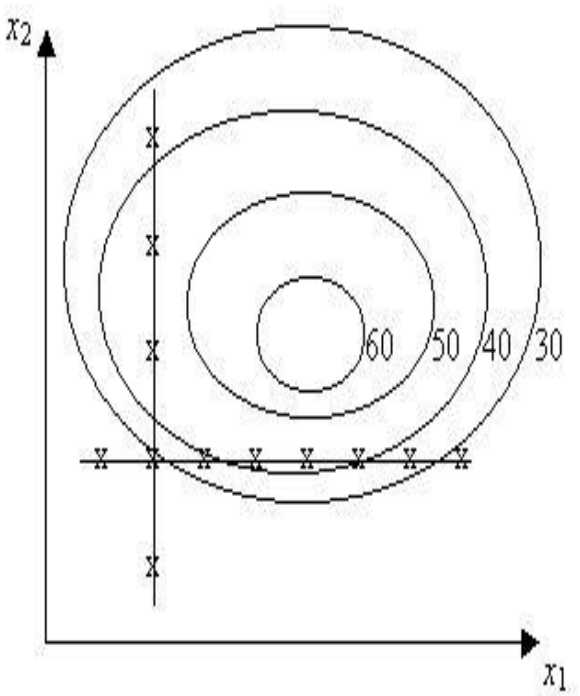

Figure 1. The field of extremely points

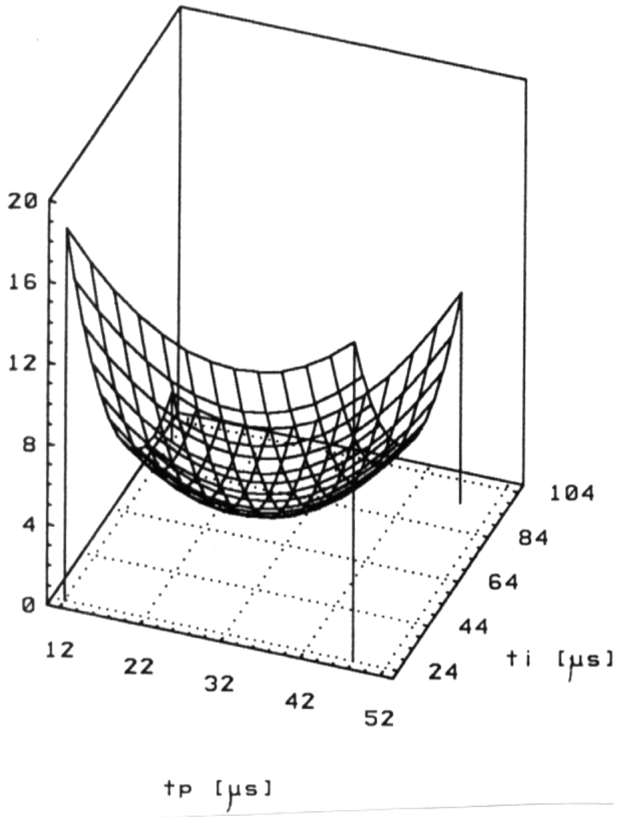

Figure 2. The processing productivity evolution. Second experiment

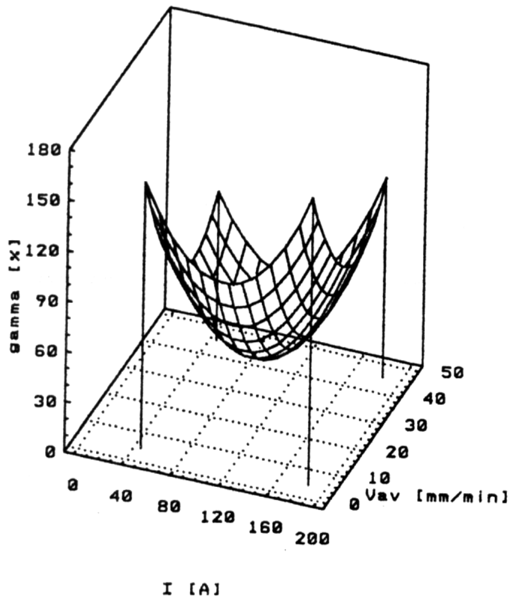

Figure 3. The evolution of the volume wear. First experiment

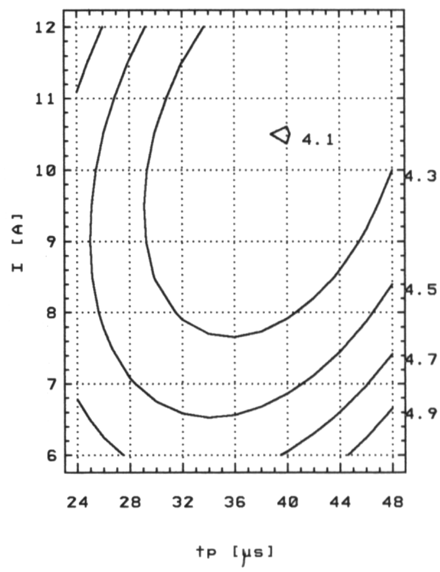

Figure 4. The evolution of the R_a objective function. First experiment

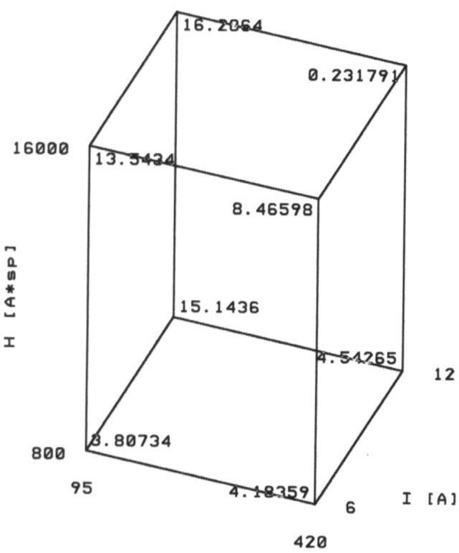

Figure 5. The evolution of the R_a objective function. Second experiment

3. CONCLUSIONS AND REMARKS

The roughness parameters R_a evolution is concretely determined by spatial positioning and by composing the magnetic fields so that the crater can be dimensionally regulated on the 3 axes and the way in which the material is removed from it (figures 4 and 5).

The unconventional methods, appeared along the last decades, come to fill up an experienced gap during the introduction of some materials in the industry, which were more and more difficult to be processed by classical methods, as well for the significant growth of the works complexities, as because of the technical gift and of the pretensions regarding the production increase/growth especially in the secular sections [3].

We can affirm that the scientists of this new domain of the modern techniques lead their research to the growth of the processing productivity and the decrease of the cost of the transfer object and of course to the rise of the processing surface quality and of the dimensional precision.

Considering all the information obtained from the running of the classic and the active experimental programs managed and finalized by means of the package of programs "STATISTIC DATA SYSTEM", the results were validated by means of active experimental programs, and we came to the conclusion that the activation of the dimensional processing program by electric erosion leads to substantial productivity upgrading, to the decrease of transfer object wear, all these correlated with an increase of the processing efficiency and especially with an increase of the quality of the processed surface.

The regression modelling and optimization of the objective functions mentioned above lead to the experimental results that were obtained, which stand for the fact that especially in the processing of the hard sintered alloys, the overlapping of the magnetic field with the respective manufacturing process leads to wider usage of the analyzed process and better results.

In the reference material dealing with this issue is that the factorial experiment is so powerful that, even if inefficiently used, provides better results than the majority of all the other existing experimental data processing methods [1].

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