SOME ASPECTS REGARDING THE NEW MATERIALS PROCESSING USED IN MECHATRONIS PRODUCTS

Marcel Sabin POPA, Dan PREJA

Technical University of Cluj-Napoca, Romania, Telephone: +40-64-415113
e-mail: Marcel.Popa@tcm.utcluj.ro; dan.preja@personal.ro

Abstract: In choosing the material for some mechatronics products, for example robots parts, do to increased demands to improve mechanical proprieties, in the last time are used composite materials, some which are carbon fiber based. The main problem in processing this materials is: the final shape in given by the mold, but in the most cases after this operation are necessary some additional processing for pockets situated on different sides of the part and which are impossible to be obtain in the mold.

Because of material hardness, these pockets can be processed only trough unconventional technologies. Another problem in manufacturing of the parts for the mechatronics products is the tendency to miniaturization in robots construction. The aim of the paper is to take a comprehensive look at the latest development in using the unconventional technologies to process parts from mechatronics products and to present our studies in this field.

Keywords: new materials, manufacturing problems, Electrical Discharge Machining (E.D.M.), mechatronic products, robots.

1. INTRODUCTION

In the last decade the author with his team, has performed at the Manufacturing Department from the Technical University of Cluj-Napoca, researches on applying the unconventional technologies, especially on the EDM process.

The latest developments in the Industry have made possible the use of new materials for the components of mechatronic products. Many of these materials are composite materials, some which are carbon fiber based.

2. NEW MATERIALS AND THEIR MANUFACTURING PROCESS

In choosing the material for some mechatronic products, for example robots parts, do to increased demands to improve mechanical proprieties, in the last time are used composite materials, many of them which are carbon fiber based. The main problem with this materials is related to their processing, actually the final shape in given by the mold, but in the most cases after this operation are necessary some additional processing for additional pockets situated on different sides of the part and which are impossible to be obtain in the mold. Those pockets are used to assembly the part with other parts, and therefore they must be precise manufactured.

These pockets can’t be processed trough conventional technologies do to material hardness, therefore is left to the unconventional technologies to do this job. With the

appearance of new materials we must found ways to process this new materials and this takes us to discover new process methods, which become part of the unconventional technologies family.

Electrical discharge machining (EDM) is the most widely used advanced machining process; today represents around 80% from the unconventional technologies. EDM cuts holes in extremely hard metals, including steel alloys that cannot be cut by traditional methods. EDM produces smooth, accurate holes, some of which have extremely complex shapes. Another quality of EDM is the possibility to machine fine structures because the tools don't brake, no burr is generated and the manufacturing process doesn't depend on the hardness of the work piece. EDM is ideal to be used to manufacture these parts, if the material can conduct electricity.

In case of erosion working generally, and those of electric erosion especially, the process leading demands a much better technological knowledge from the operator, than in case of cutting working. The practical possibility to obtain the same result by more ways and a more complex correlation between process input and output, are function to the operator experience too. To eliminate the random component of the process, the specialists have searched in the past and still are searching for different modalities. Starting from the high integration degree of computer and numeric control, different constructor firms have involved Fuzzy Logic (Mitsubishi or Agie), respectively computer assisted command, to remember only two principal trends.

The optimization strategy is dependent on the principal aim: high productivity, low electrode wear, the surface quality, high precision, the thermal influenced aria as small as possible, etc.[2].

The regulating system loads, irrespective of operating personnel capacities are to assure the optimization strategy with a simple regulating of implements and with the disturbance factors effect compensation. Among these principal disturbance factors we note: the momentary conditions of dielectric medium washing-circulation, or the impurity degree and the momentary degradation of the same medium, all high connected with the materials couple tool-workpiece [3].

One of the secrets of the optimal results for electric erosion process is the permanent remaking inside the working space, of the initial conditions necessary for repeating useful discharges, respectively ensuring equilibrium between the amount of erosion material and the amount of evacuated material from the working space.

Today one of the means of quality and productivity increase for mechanical working is a wide utilization of computer adaptive control. In this field, the present study investigates the problem of using the adaptive command for electric erosion working leading, having as effect the working plant modernization and the erosive process improvement. But the electric erosion working doesn't describe always a convenient productivity indicator.

Another problem in manufacturing of the parts for the mechatronic products is the tendency to miniaturization in robots construction. Then comes the question: Does size mater? Yes it does. One of the fields where the size is important is the Nanotechnology, which will have a big impact in the future. Here the components (parts) have very small dimensions, also the dimensions for holes or pockets used to assembly the parts between them are ranging form a few microns to 1 mm. Almost all the parts used to build this robots, are manufactured trough unconventional technologies, do to their size. Also the machines used to build these parts are equipped with powerful microscopes.

3. EXPERIMENTS AND RESULTS

Any technological process can be seen as a system which has input and output parameters. In case of manufacturing processes trough EDM appear specific phenomena with their own specific parameters. This elementary erosion processes must be integrated in to a macroscopic process, but this thing is harder to make in case of electric erosion in comparison with the chip removal processes.

The connections (links) between the parameters have been obtaining trough experiments; these results have been specified in the machine book in erosion units. Therefore the productivity demands are limited strictly on respecting the standard conditions prescribed on this machine book. A possibility of improving this control process is by using the Fuzzy logics theory.

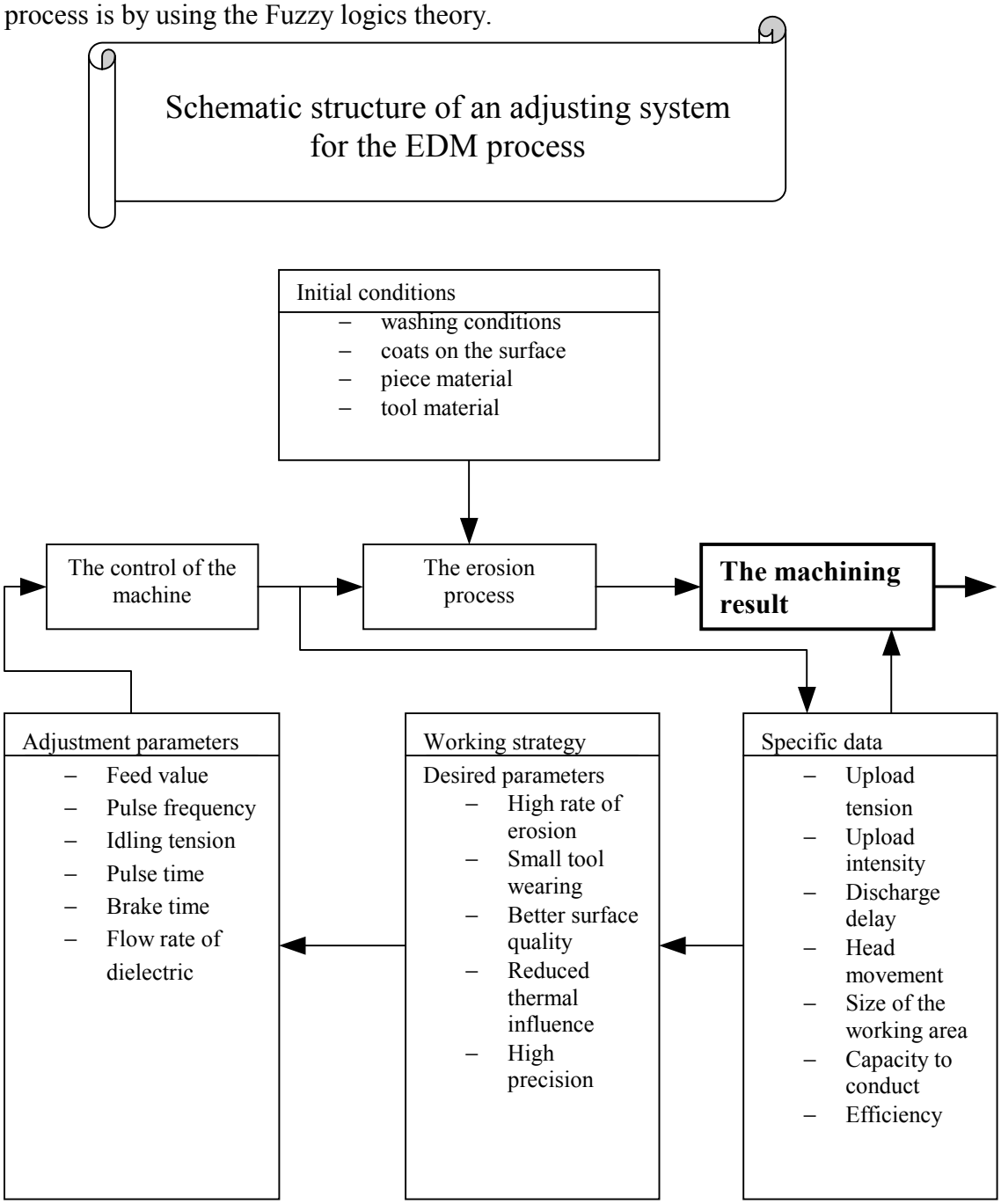

Figure 1. The schematic structure of an adjusting system for the EDM process

As we said above the erosion units require a specialized user with good knowledge of the possibilities to adjust those equipments and the results, which are to be obtain by this adjustment.

The criteria to evaluate the manufacturing result could be:

- Quality of the manufacturing surface;
- The precision of the manufacturing process;
- The influence of the piece shape.

Even the erosion rate of the working piece, respectively the rate of wearing on the tool is depending by the adjustment chose by the operator and initial conditions. Those links are presented in the figure 1.

In that figure is seen that the system-adjusting load (current) must independently to the adjustment capacity from operator to compensate the perturbing influences on the process, in that manner to be obtain the desired result. The optimization strategy is based on the technological knowledge and a parameter, which is the target, is précised, for example: high productivity, small roughness.

To better understanding the process in the figure below is represented the main types of discharging.

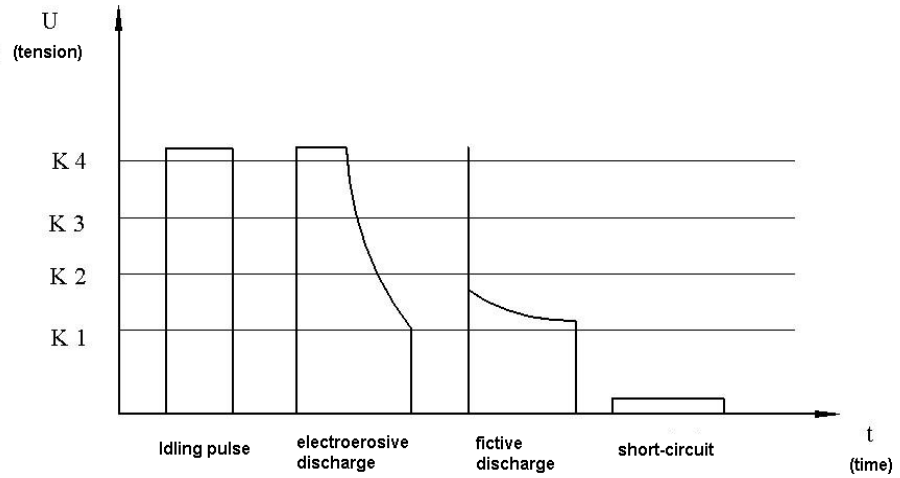

Figure 2.

It can be seen that the material removal is possible (takes place) only in case of the electro-erosive discharge, in the other cases the material removal is not possible and appears some negative phenomena like short-circuits.

The efficiency η, is the ratio between the number of discharging and the all impulses obtain from the generator. A sensor, which makes possible the control of this value, has the following construction presented in the figure 3.

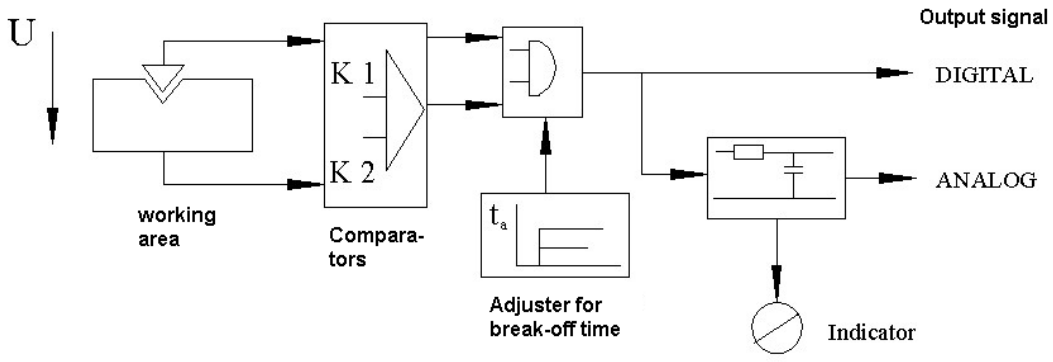

Figure 3.

This sensor evaluates the length of tension discharges with the help of comparators. The next logic prepares the output signals from the comparators K1, K4 until a time t_A well précised, which to a conductor from the break off time establish "the erosive discharge yes or no".

This information is give by a efficiency signal digital or analog (temporally restored). Others sensors which can intervene in the process are those which are measuring the delay time of the discharges, the conductive capacity of the working area and the delay of valve from the feed system.

Another possibility of conducting and optimizing the EDM process is the adjustment of the discharge tension U_f where the superior side of the scheme is composed from the feed adjusting circuit of an conventional EDM machine.

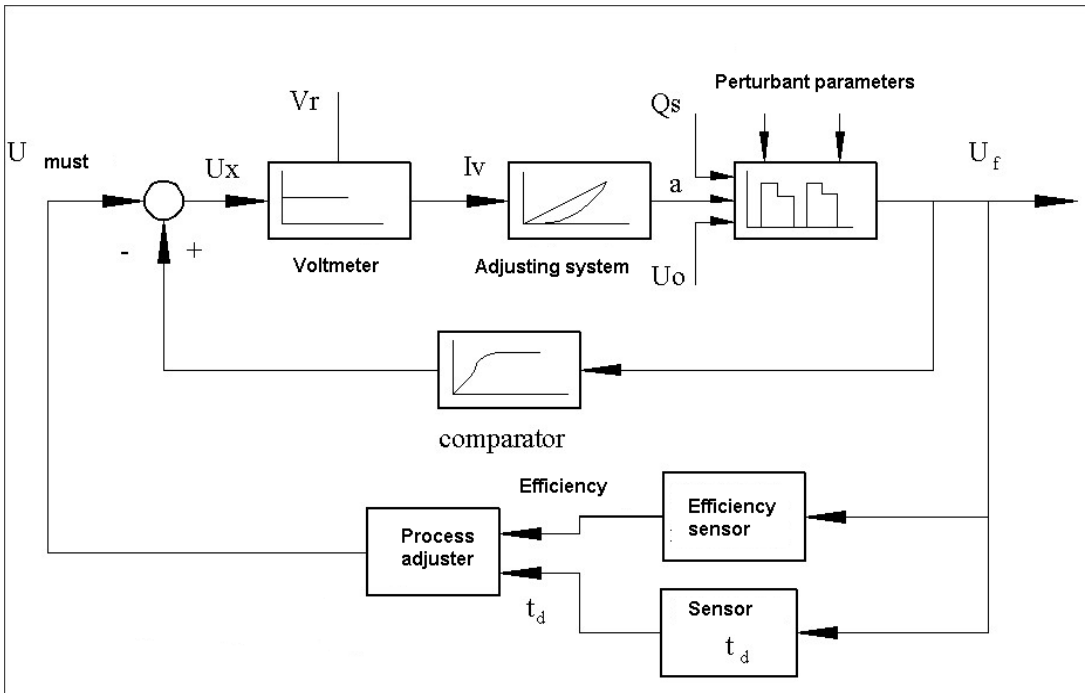

Figure 4.

The abbreviations from the figure are:

- U_{tehnic} – the value "must" from tension;
- U_{fm} – the average tension of the discharge;
- U_x – the deviation of tension;
- V_r – the adjustment amplifier;
- i_V – the delay of the valve;
- a – the working area;
- Q_s – the pre flow quantity of dielectric;
- u_0 – the idling tension;
- u_f – the discharge tension;
- η – efficiency;
- t_d – the delay time of the discharge.

In this case the "must" value U_s of the feed adjustment system is to be adjusted (set) conform to the manufacturing load, manually trough a potentiometer from generator. Taking as base the "must" value and the medium (average) discharge U_{fm}, were resulting a flatten component in the reduction at the U_f tension, it's applied a signal over the tension regulator and the adjusting system.

It had been proved that the right choice of the "must" value for a working load is difficult to realized. A continuous adapting of this parameters (measures) adjusting at the moment working conditions, contributes to the optimal use of the equipment. This adaptations is done by the adjusting apparatus which with the help of measuring the efficiency η and the delay time of the discharge t_d; inform us about process status and changes depending on situation a strategy by adjusting parameters U_s and f (frequency).

Another problem in manufacturing of the parts for the mechatronic products is the tendency to miniaturization in robots construction. Then comes the question: Does size mater? Yes it does. One of the fields where the size is important is the Nanotechnology, which will have a big impact in the future. Here the components (parts) have very small dimensions, also the dimensions for holes or pockets used to assembly the parts between them are ranging form a few microns to 1 mm. Almost all the parts used to build this robots, are manufactured trough unconventional technologies, do to their size. Also the machines used to build these parts are equipped with powerful microscopes.

4. CONCLUSIONS

In conformity with the facts presented above we can conclude:

- In the future the unconventional technologies will be used on an even bigger scale;
- With the development of new materials will appear new manufacturing processes that will become part of the Unconventional Technologies family;
- Miniaturization is the way of the future in several domains such as medicine, and the industry has to come with viable solutions in order to build nanorobots;
- Those materials, which can conduct electricity will benefit from the advantages of the EDM manufacturing process, such as the process doesn't depend on the hardness of the work piece.
- Trough EDM we can produces smooth, accurate holes, some of which have extremely complex shapes.
- EDM has the advantage over other unconventional technologies because the section of the hole or pocket that is processed is constant on all of her length and not conical on the input area as in other unconventional technologies;
- It is necessary to find new and more accurate ways to control the parameters of the manufacturing process in all processes related to the unconventional technologies;
- Simplifying the decision in process trough new approaches such as fuzzy logics and the better understanding of adaptive control is priority in developing the next generation of CNC equipments.

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