PARAMETERS AND FACTORS OF PROCESSING THROUGH COMPLEX EROSION

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ABSTRACT: *The process of processing through complex erosion is influenced by a large number of parameters and factors, acting in close interdependence and influencing each other in order to achieve the stability of the process of processing and the achievement of the final technological characteristics. The dimensions characterizing the process of processing, imposed on it and having constant values, are process parameters. The dimensions that contribute to the development of the fundamental phenomena of the mechanism of processing through complex erosion and contribute to the definition of the technological characteristics are factors.*

Keywords: complex erosion, tension voltage, current density, contact pressure

The characteristics of the parameters and factors determine the proportion of participation in the material sampling of one of the specific elementary processes, determining the overall erosive effect and ultimately the processing characteristics. The parameters and factors presented in Figure 1 are considered to be representative for the dimensional processing through complex electrical erosion.

The parameters characteristic to the method are of different nature, namely: electrical - defined by the intensity of the electric current, respectively the current density and the process voltage; mechanical - represented by the peripheral speed of the electrode- tool and the depth of machining and advancement in some studies, or in others, merging the latter two parameters, from the point of view of the pressing force between the electrode and the semi-product, namely the pressure force; hydrodynamical - represented by the working environment.

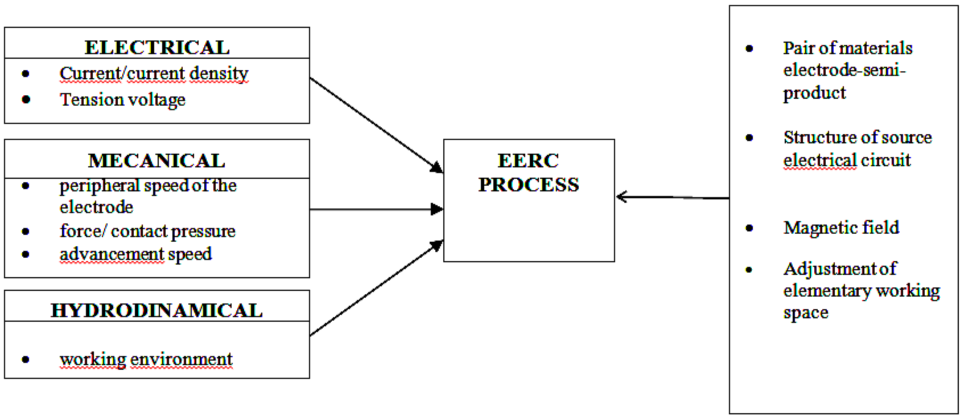

Fig. 1 *Parameters and factors of processing through complex electrical erosion*

The parameters influence the weight of elementary processes, and the factors determine the development of these processes.

The tension voltage on the working space is a parameter on the size of which depends the stability of the processing process. In the low voltage range (8 ... 12 V), the amount of released energy is reduced (about 2 ... 5% of the arc discharge energy) and is due to the Joule-Lenz heating effect.

In the field of medium voltage (12 ... 22 V), breaking of the contacts will cause the non-stationary arc to appear with pronounced thermal effects. It is appreciated that in this field the balance of the elementary processes is achieved, which ensures the stability of the process, the development of the energy of effect and the evacuation of the erosive products. This area is considered to be the optimal one and leads to a processed surface with the lowest value of roughness and depth of the modified layer, at minimum energy consumption.

In the field of high voltages (22 ... 32 V), the percentage of non-stationary arc discharges accompanied by pronounced thermal effects is high. The temperature of the bonding bridges is close to or exceeds the melting temperature so that the material melts and sometimes even vaporises explosively.

Dependence of voltage productivity is shown in Figure 2.

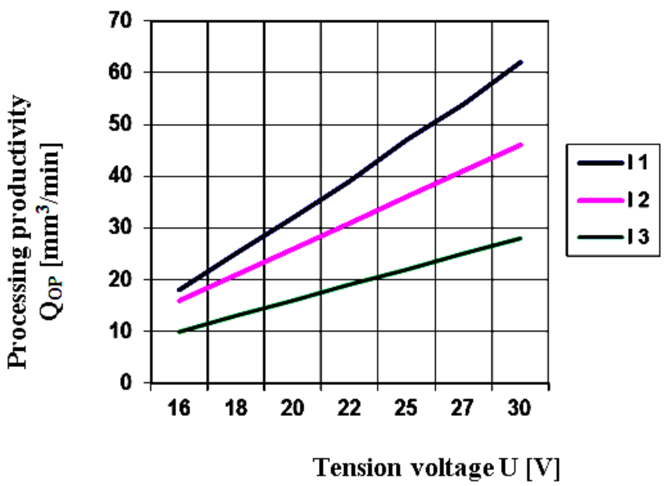

Fig. 2 *Dependence of processing productivityon working tension voltage*

The electric current is the determinant parameter of the process, being a relative size that depends on the size of the active surface that is involved in the process. Thus, the specific size $j = \frac{I}{S}$, current density, is considered to be the main parameter of the process.

At low current densities (j <20 A/mm^2), if working voltage is low, processing takes place on the basis of the electrochemical process. Higher processing qualities, high dimensional precision, pronounced shrinkage of the modified layer and heat-affected area (ZIT) are obtained, and almost total removal of the microfissures will occur, with productivity reduction in return.

At high current densities (j> 20 A/mm^2) and corresponding voltages, the processing is predominantly achieved due to impulse electrical discharges generated at the level of the microasperities peaks, the weight of the erosive process being determined by the effects of the thermal process. In this case the productivity increases, producing negative effects on the quality of the processed surface , on the dimensional precision, on the ZIT thermal influence zone, and on the modified layer.

With an excessive increase in current density, either in the presence of low or high tension voltages, the erosion process degenerates causing a short circuit to occur at low voltages or static arc electrical discharge.

The dependence between current density and productivity is shown in Figure 3.

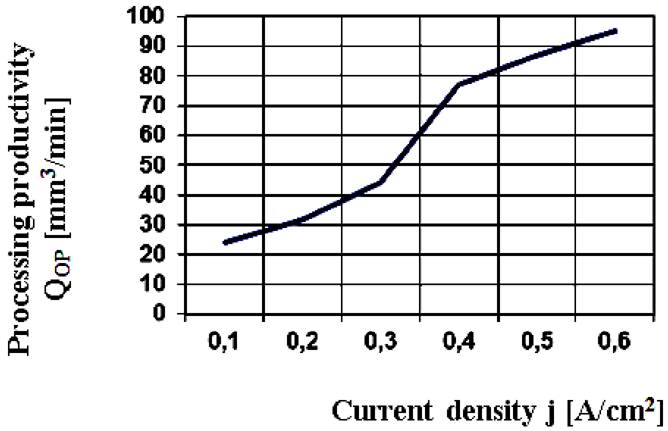

Fig. 3 *Dependence between current density and the productivity of the processing*

The contact pressure p = 1 ... 10 Mpa, on the value of which other parameters depend, especially the current density, is another important factor. The optimal pressure value limits the number of contact bridges between the transfer object and the object to be processed and the size of their section, the passive film having an important role in preventing the transfer object from and the object to be processed being short-circuited. If the pressure rises above a certain limit, there is no balance between the amount of formed and removed film, thereby increasing the contact surface between electrodes tending to short-circuit.

Figure 4 shows the influence of pressure on productivity

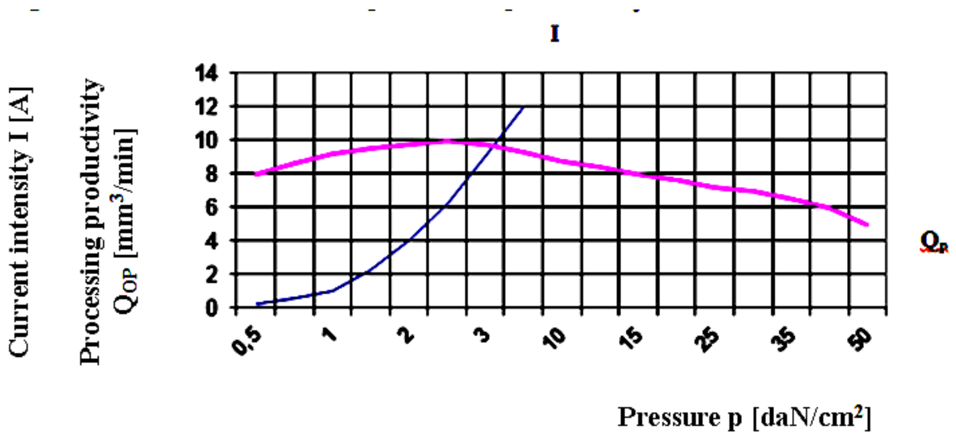

Fig. 4 Dependence of processing productivity on working pressure

Feed speed v_s = 1 ... 100 mm/s.

At low feed speeds, the absorbed power (transmitted to the processing area) is only 2/10 ... 3/10 of the maximum power of the transformer because there is a change in working mode with an idle running one and the spring is unstable and is often interrupted. The size of the feed leads to an increase in the number of discharges and the density of the current, thus increasing the absorbed power, which creates favorable conditions for the spontaneous vaporization and spraying of the whole molten metal out of the working space, but leads to a deterioration of the processed surface and a reduction of the pecific energy consumption.

Processing depth t = 0.1 ... 5 mm.

The influence of the processing depth on the absorbed power and thus of the specific energy consumption is similar to that of the feed rate.

The size of the processing depth and of the feed rate determines the surface on which the material is sampled; they must be chosen in such a way that the perimeter of the surface on which the material is to be sampled should be minimal; the choice of the feed rate depends on the depth of processing.

Peripheral velocity of the electrode v_e = 10 ... 50 m/s; It is advisable to rotate the electrode in the opposite direction to the semi-product.

The speed ensures the balance of the elementary processes, determines and limits the energy of effect in the elementary space, having a decisive role both in determining the contact duration and in printing the discharging character in the non-stationary arc.

The low speeds determine the increase of the existence duration of the microcontacts and consequently there is a strong increase in the electric power introduced by the Joule-Lenz effect, but much of it is lost by dissipating in the body mass in contact without being useful for the erosion process. At such speeds, the material sampling is due in particular to the long arc - from the cathode to the anode, and the total anode erosion is reduced.The quality of the surface and productivity are inadequate.

At high speeds, productivity increases, roughness decreases and structural changes in the superficial layer are reduced. Due to the action of the working environment (especially water), the metallic contacts decrease as the speed increases, so that if the speed is too high, the contacts may no longer appear.

The working environment: soluble glass solutions, compressed air, kaolin aqueous solutions, technological water with added sodium and potassium salts, technological water.

Presently, on technical and economic considerations,the industrial practice has mostly validated compressed air and technological water as working environments. There are three main directions of action of the working environment, namely: activation of the erosive phenomenon, localization of effect energy and activation of the evacuation process.

The working environment must be maintained at optimal processing temperatures. Research has shown that space heating above 40C leads to substantial changes in the conditions of the process. The cooling the action area of the electric arc and the rapid movement of the electrode lead to the destabilization of the arc and the reduction of the length of the arc.

Pair of electrode material–semi-product: The electrode can be made of graphite, steel, brass, aluminum, cast iron, copper, and the semi-product must be an electrically conductive material with a lower melting temperature than that of the arc.

The method is economically efficient for the processing of heat-resistant materials and high ohmic resistance, namely metals and alloys with high hardness and toughness: alloyed steels, austenitic and martensitic stainless , refractory alloys, etc.

The pair of electrode material - semi-finished material is an important factor in the characterization of the processing ability of the materials, constituting the direction of generalizing the complex electrical erosion processing. The pair of electrode - semifinished material can direct and optimize the processing characteristics, their thermophysical properties, giving them a different processing behavior: for example, the roughness of processed surfaces resulting from sintered carbide is lower and the productivity slightly higher than that obtained in the same conditions for the processing of fast steel; using a copper electrode leads to a lesser relative wear (less than 20%) than when using an OLC 45 steel (over 40%); also, the productivity on processing with a soft steel is slightly lower than in the case of using a copper electrode.

Structure of electrical circuit of power supply:

- welding transformers / converters;
- special transformers.

It influences the amount of heat introduced into the process: the idea is to transmit to the electrode-semi-finished surface a large amount of energy in a very short time so that to produce a strong heating of the contact microwells without affecting the mass of the semi-product in depth. These conditions are provided by the inductive structures and relatively rigid characteristics of the power supply.

The magnetic field:

- internally – having a role in evacuating the erosive products and ensuring the stability of the process;
- externally - perpendicular to the axis of the discharge channel and parallel to the axis of the semi-product.It reduces energy consumption, wear of the electrode and the possibility of melting drops of molten metal on the surface of the semi-product.

Automatic adjustment of the workspace:

- determines the stability of processing with high weight and is an effective way of conducting and optimizing the process;
- correlates electrical and mechanical parameters for objectively observing a function during processing: maximum productivity, minimum specific consumption of electrical energy, roughness of the processed surfaces and minimum ZIT heat-affected zone ;
- even in the case of a partial correlation of parameters, the automatic adjustment of the elementary workspace has very important repercussions in the processing itself and the achievement of the desired technological characteristics.

Conclusions

The factors that influence the processing through the EREC act in close interdependence and influence each other. They can be grouped into **determinant factors of influence for other factors** and **factors of influence determined in turn by others**. This complexity of factors and their mutual influences demonstrate the complexity of the EREC process and is an explanation for the complexity of the models required for the theoretical analysis of the processing.

In conclusion, due to the special character of the processing through the EREC , the fundamental phenomena developed in SL depend on a whole range of parameters and factors, while acting in a dynamic interdependence at the same time.

Depending on the variation of these parameters and factors, they are also influenced by the results of the processing, namely:

• global erosive effect;
• weight of elementary processes;
• stability of the processing process;
• global technological features.

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