SUPPLY SOURCES USED FOR COMPLEX EROSION PROCESSING

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ABSTRACT: The origin of the electric circuit is very important for processing through complex erosion, being one of the possibilities of guiding of technological characteristics. The accomplishing of this condition in the processing through complex electric erosion is obtained by modifying the electric circuit either using some different supply sources, or by maintaining the same source and introducing the parameter R, L, C in the working circuit.

Heating the superficial layer of the metal to the smelting or vaporization withont thermically affecting the mass of the object which undertakes the processing may be obtained by transmitting to this layer a large quantity of energy in a short period of time.The shorter the heating time is, the higher the quantity of heating will be and the lower the thermic conductibility and the caloric capacity of the metal is the easier the superficial smelting of the processed metal object will be accomplished.
The circuit of electric supply of the working area for processing through complex electric erosion consists in a source which debits a variable resistance R_s=R(t), as a aleatory function of recurring variation as a rule with the form $R(t)=R_0(1-k\sin\omega t)$ when k<1. Different parametrical circuits have been studied with L inductivity in a series with the working area (figure 1) and capacity C parallel with the working area (figure 2).

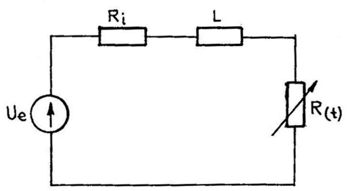

Fig.1 The electric scheme of the inductive electric circuit

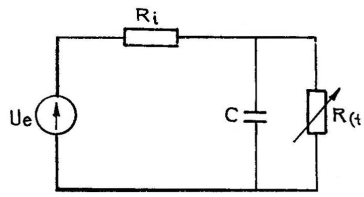

Fig.2 The electric of the capacitive electric circuit

For the inductive circuit the increase of the power for a discharge is dragged on. The amplitude, duration and the energy of discharges is decreased. Through , in practice the global erosive effect does not, it is to be observed that the rugosity of the processed surface is the much smaller. For the capacitive circuits, the tension for the area of a discharge is maintained within relatively high values. The amplitude, duration and energy of a discharge increase. In some extent the global erosive effect increases, but the rugosity of the surface gets worse.
The fundamental parameter of the process may be modified by designing an adequate electric scheme in a order to obtain a certain technologic effect. The connection among the duration, amplitude and the force of impulses may be modified, in case this connection increases, some impulses may cause discharges in electric arc.
Knowing the electric characteristics of the working circuit is important because between the parameters of the electric discharges affected by these characteristics and the final parameters there is a close interdependence. For the processing through complex erosion different supply sources may be used:
a) the equivalent circuit in case of supplying the working area from a continuous power generator (figure 3)

L_i – internal inductivity of the source; V_i – internal resistance of the source; u_e – electromotive tension; V, L, C – resistances, inductivities, superfluous capacities of the circuit for the working area; E – electrode; O – object; a, b – terminals.
b) equivalent circuit – in case of supplying from three-phase rectifier (figure 4)
T_i, L_i, C_i – resistance, inductivity and internal capacity of the source; E_{cc}, E_{ca} – continuous and alternative components of the electromotive tension; r, L, C – resistance, inductivity and superfluous capacity of the exclusive circuit for the working area; E – electrode; O – object; a, b – terminals.

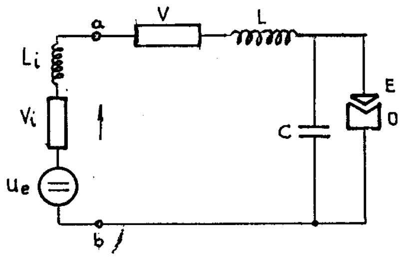

Fig. 3 Inductive circuit

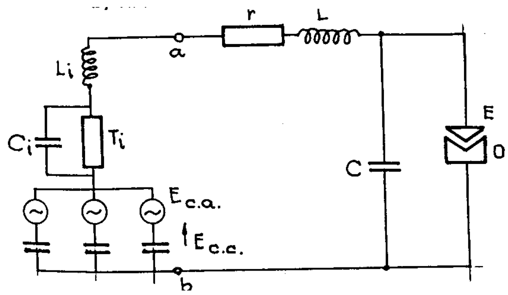

Fig 4 Capacitive circuit

The supply sources influence through their character an external circuit in such a way that the variations of the tension and the power for the working area are different for each and every type of source. The character of the working circuit way be modified by introducing an inductivity in series with the working area or of a capacity in derivation with the working area.

- ***The "U" potential difference***

It is the factor determining the stability of the processing process and the most often used in managing the automated adjustment systems.
The usual values of the U difference are between 10 – 30 V, and the control is made by modifying the nature of the electric circuit or through the supply source.
These values of the difference develop both anodic dissolution processes (AD) as well as impulse electric discharge (IED). When **overcoming the maximum difference**, between the OT transfer object and the OP processing object it becomes possible to the electric arc quasi stationary electric discharge which causes the instability of the process, with a final negative result upon the technological characteristics: productivity decrease; processing precision decrease; roughness increase; increase of the thermally influenced area; increase of the OT wear.
The U potential difference is influenced by: the nature of the electric circuit; the OP and OT material; the pressure in the SL working space; the supply source; and in turn, it influences the stability of the process and the following technological parameters: the productivity of the Q_{OP} processing; the processing precision; the roughness of the OT surface; the thermally influenced area, the OT wear.
For example, the influence of the U tension upon the Q_{OP} material prevailing productivity, in the case of OT arc cutting, by introducing the LL working fluid through the OT is presented in figure 5. We notice an increase of the productivity in direct proportion to the increase of the voltage.

- ***The intensity of the current***

Together with the voltage, the intensity of the current I is a determining factor of the EEC process. The intensity of the current depends on the external characteristic of the supply source, which is relatively rigid and makes the voltage decrease not significantly when the intensity increases.

The increase of the I intensity is due to the increase of the pressure in the SL working space, followed by:

- The increase of the IED number so that a higher current be distributed in more simultaneous DEI. In this case, the power of discharge on every impulse remains constant and therefore the OP roughness does not suffer;
- The IED number remains constant, in which case the power of individual discharge increases, leading to some higher currents (in diameter and depth) and thus to the alteration of the processing results. It is the possibility that has proven to be correct based on the results of the experimental research.

For example, the influence of the I intensity upon the productivity of the Q_{OP} processing, in the case of OT disk cutting by introducing the LL through the OT, is presented in figure 6. We notice the increase of Q_{OP} in direct proportion with the I increase. The favourable result of the Q_{OP} increase is compensated by the alteration of other technological characteristics, as presented in figure 7, where we observe the increase of the deviation and of the profile height, in direct proportion with the I increase.

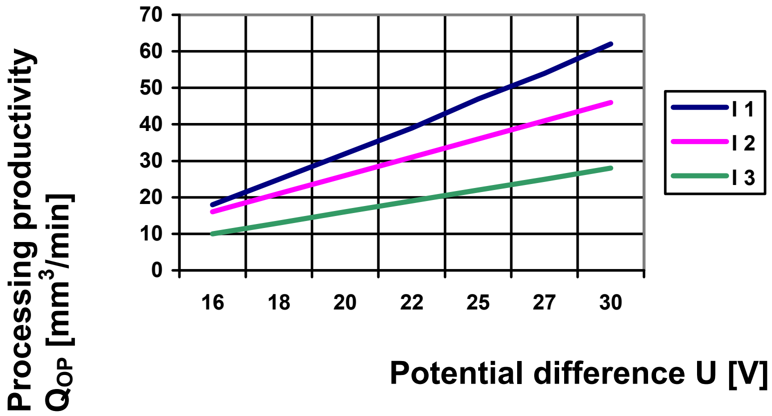

***Figure 5:** The influence of the U difference on the Q_{OP} processing productivity, for the values of the I current I_1 = 40 A; I_2 = 30 A; I_3 = 20 A*

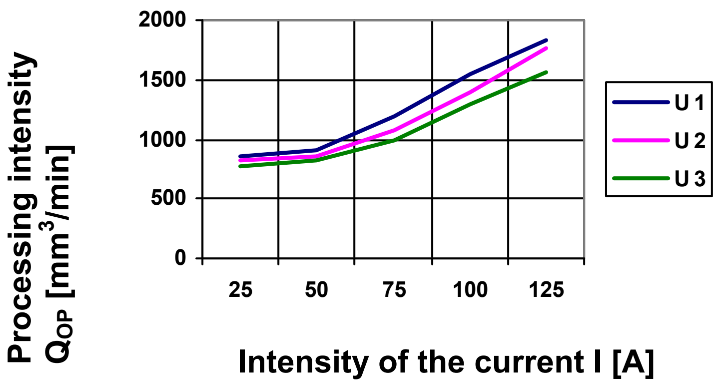

***Figure 6:** The influence of the intensity of the I current on the Q_{OP} processing productivity for the values of the voltage U_1 – 28V; U_2 – 24 V; U_3 = 20V.*

The intensity of the I current is influenced by: the type of the supply source, the type of washing with the LL work fluid; the type of processing; the structure of the electric circuit; the pressure between OP and OT; OP and OT and in its turn, influence technological parameters; the productivity of the process; the quality of the processed surface; the roughness of the OP surface.

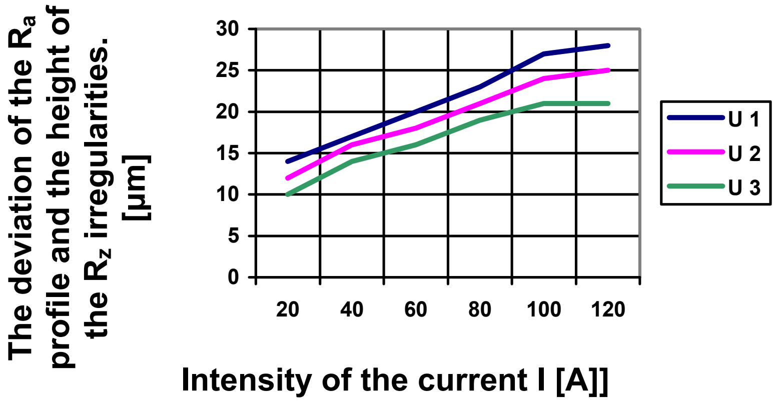

Figure 7: The influence of the I current intensity on the R_z irregularities height for the values of the voltage: U1 = 28 V; U2 = 24V; U3 = 20 V.

- ***The " j" current density***

It is an important factor in the EEC processing and represents the intensity of the current I [A] which goes through the contact surface S [cm^2] between OT and OP:

$$j = \frac{A}{S} \qquad [A/cm^2] \qquad (1)$$

In strong relation with I, the j current density controls the contribution of the elementary fundamental processes, from SL:

- When j is **low,** the electro-chemical phenomenon prevails. The weight of impulse discharges is low (and if U is low, they cannot form) and we result a good result of processing from the point of view of geometric and state parameters of the surfaces but the Q_{OP} is also low.
- When j is **high,** the electric erosion provides material sampling, through thermal effect, which increases Q_{OP}, but the quality characteristics decrease (geometrical and state parameters of the surface).
- When j is very **high,** the material sampling becomes uncontrolled, short-circuits appear (if U is low) or electric discharges in stationary arc (if U is high), which through the previously mentioned thermal effect leads to the degradation of OT and OP through weight and volume alteration.

For example, the influence of the current density (j) on Q_{OP}, in the case of EEC cutting, with the introduction of LL through OT is presented in figure 8.

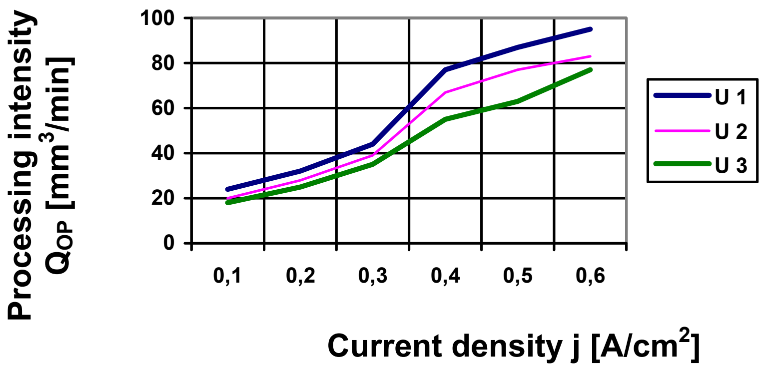

Figura 8: The influence of the j current density on the productivity of the Q_{OP} processing for the values of the voltage U1 = 28 V; U2 = 24 V; U3 = 20 V.

The current density (j) depends on the following factors: the type of supply source and structure of the electric circuit; U voltage; I current intensity, and influences technological parameters through the weight of fundamental processes in the SL working space; processing productivity, the quality of the surfaces (geometrical and state characteristics of the surface).

- ***The power of the supply surface, P [W]***

Power (is an electric influence factor which defines its involvement through the two elements it is made of: U and I. therefore, at the I increase, we notice an increase of the Q_{OP} (the decrease of the processing time t_p) until a threshold is reached above which the process becomes unstable due to the too high current density (j), which leads to the appearance of the electric arc (figure 9).
Power P has a powerful influence upon the OT wear, in the sense that at a low power, the wear is high, because the abrasive effect is very obvious, and in the case of high powers, DEI turns into electric arc. A representation of the OT wear dependence is given in figure 10.
The power induced by SL is used both for electric discharges sampling as well as for anodic dissolution.

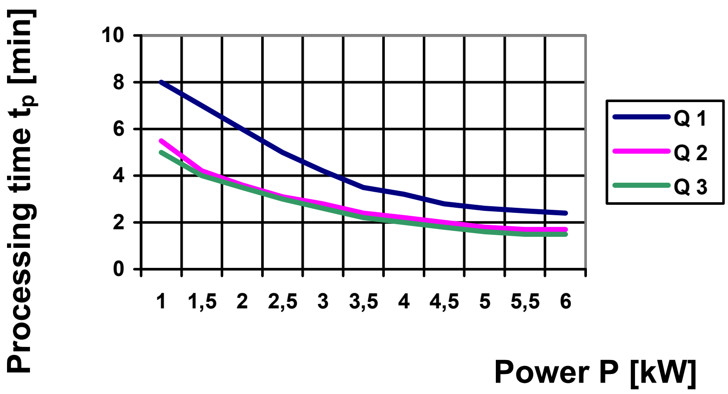

Figure 9: The influence of the induced power in SL on the cutting time t_p for the values of the Q_1 = 30 l/min; Q_2 = 25 l/min

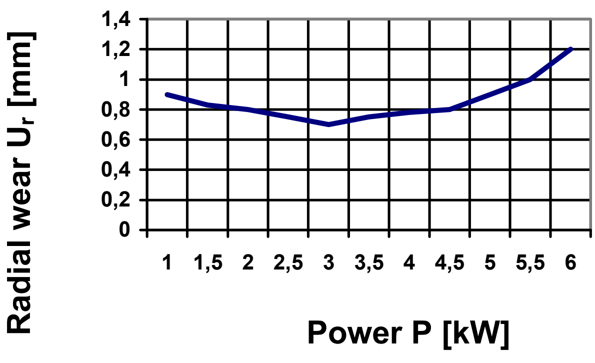

Figure 10: The influence of the power induced in SL upon the radial wear U_r

Conclusions:

As a factor with high share in the process of complex erosion, the electric circuit through its structure - using concentrated parameters R (resistive circuits), L (inductive circuits) and C (capacitive circuits) – it causes substantial changes within the dynamics of the unfolding of the fundamental phenomena which determine the duration, succession and

share of the elementary processes for the working area. Qualitatively and in point of quality, they imply effects upon the transfer object and the object to be processed as the energy used for the erosive process.
The factors influencing the EEC processing, act in strong interdependence and mutually influence one another. They can be grouped in determining influence factors for other factors and determined influence factors by others. This complexity of factors and their mutual influences prove the complex character of the EEC process and it is an explanation for the complexity of the patterns necessary for the theoretical analysis of the processing.
In conclusion, due to the special character of the processing process through EEC, the fundamental phenomena developed in SL depend on an entire range of parameters and factors acting at the same time and in a dynamic interdependence.
In accordance with the variation of these parameters and factors, the results of the processing are influenced at the same time, namely:

- the global erosive effect;
- the weight of the elementary processes;
- the stability of the processing process;
- the global technological characteristics.

In conclusion, the main processes taking place within the EEC processing develop inside the system limited by OP, OT and LL.

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