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## INORGANIC LIQUIDS AS A WORKING ENVIRONMENT USED FOR DIMENSIONAL PROCESSING BY COMPLEX EROSION II

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***Abstract** The essential functions of the electrolyte used at the processing through complex erosion are: the insurance of the electrical charge bearers presence in the space between the electrodes as well as the anodic dissolving of the remaking piece. The obtained ions can participate at the reactions of the electrodes. The electrolytes used at the processing through complex erosion must insure the initiation and the promotion of the anodic dissolving process. On the other side, the cathode process must insure the utmost efficiency by setting down the lowest quantity of metallic ions. When choosing the optimum electrolyte you must take into account a series of factors which cannot always be entirely observed, which sometimes means making compromises when choosing the electrolyte solution*

***Keywords:** transfer object, processing objects, working space, working fluid, complex erosion*

When choosing the best electrolyte, one should consider certain factors that cannot always be fully complied with, which sometimes causes making compromises when choosing the electrolyte solution.

The characteristics of the electrolyte solutions used for anodic dissolution processing are:

**a) Electrolyte solution concentration**

A concentrated solution has the advantage of low voltages due to its adequate conductivity. At the same time, electrolyte acting speed is high because the conductivity of a concentrated solution alters little due to temperature. On the other hand, diluted solutions of electrolytes causes the achievement of a smooth processing surface and decreases the probability for crystallization. An over-concentrated solution can become saturated thus determining the formation of crystals that may alter pumps, pipes, etc.

**b) Electrolyte conductivity**

This parameter depends first of all on concentration and temperature, having to be permanently controlled, because it directly alters the processing speed. In the case of high conductivity, input speed is also high. Electrolyte conductivity alters depending to temperature.

**c) Electrolyte flowing speed**

This parameter is very important because the electrolyte has to remove heat and reaction products. The higher the flowing speed, the more efficient is the release of heat and reaction products. At the same time, along with the growth of the electrolyte speed the pumping operation costs also grows, and very high speeds can cause the OT or OP erosion.

The flowing speed influences the finishing of the surfaces and the processing accuracy. High flowing speeds cause uniform alienation of the metal. Low flowing speeds cause precipitates adhesion to OP, which can cause alterations of the flowing status and can also alter the working status.

Processed tool geometry also influences the electrolyte flowing speed. In order to achieve a smooth, uniform surface of OP, tool geometry has to provide a homogenous flowing speed.

Interstitial speed is directly proportional to voltage and reversely proportional to the feeding speed and electrolyte resistivity. If the voltage, feeding speed and electrolyte resistivity are maintained constant during the interstate, then the space between electrodes shall remain constant. Unfortunately, electrolyte resistivity cannot be maintained constant because gas bubbles develop in electrolytes as well as a certain amount of heat. Gases tend to increase resistivity, and heat to decrease it. The conditions in the working interstate are affected by the electrical field as well, which is in turn influenced by the form of the electrode. The intensity of the electric field and power density are higher near the electrode.

If OT feeding advance is higher than the metal removal speed, the interstate becomes smaller and smaller. With the decrease of the interstate, the power and the metal removal speed grow accordingly. At a given time, the metal removal speed will equal the electrode feeding speed.

With the decrease of the feeding speed, at the beginning, the interstate will grow. Consequently, the current intensity will decrease due to resistance growth. Adequate accuracy is achieved through constant parameters.

**d) Processed object material**

The material of the processed object influences the metal removal speed and the power density. Results achieved at anodic dissolution based processes in a NaNO<sub>3</sub> electrolyte are completely different from the ones achieved in other electrolytes.

Table 1 presents power outputs achieved in a NaNO<sub>3</sub> based electrolyte and pH recorded alterations.

**Table 1:** Power outputs achieved in a NaNO<sub>3</sub> electrolyte and pH recorded alterations

Concentration NaNO <sub>3</sub> M	Cathode	Power density [A/cm <sup>2</sup> ]	Release power density H <sub>2</sub>	Release power density O <sub>2</sub>	Release power density Fe	Release power density O <sub>2</sub> și Fe	pH alteration	
							from	to
4,5	platinum	47	1,1	54,7	33,2	87,9	5,3	11,4
4,5	Brass	47	0	55,9	33	88,9	6,3	11,3
4,5	Brass	26	0	50,6	36,8	87,4	6,2	11,2
4,5	Brass	0	96,4	1,9	1,9	98,3	5,7	11,3
2	platinum	47	11,6	83,7	11,7	95,4	6	11,4
2	Brass	47	0	84,5	11,5	96	6,1	11,4
2	Brass	26	0	96,9	2,7	99,6	6,1	11,5

Cathodic reaction in this case is nitrate reduction observing the ammonium occurrence, hydroxylamine and nitrite in the case of complex erosion processing.

Power output is much lower than the case of a NaNO<sub>3</sub> electrolyte use, a part of the power being consummated for oxygen release at anode.

The passivator oxide film formed in a sodium nitrate is based on Fe<sub>3</sub>O<sub>3</sub> (magnetite).

Some part of iron can be diluted under the form of ferric ions, and a part of oxygen is consummated when oxidising the reaction products in order to form iron hydroxyl.

Working environment characteristics based on sodium nitrate, NaNO<sub>3</sub> can be improved in order to form the passivator oxide layer, by adding chemical compounds (additives).

Japanese experts have proved that by adding additives in the solution of sodium nitrate can improve the performances achieved at high power densities.

The presence of inorganic substances with the role of additives in NaNO<sub>3</sub> based electrolyte contributes the acceleration of the anodic dissolution process of the metal during complex electric erosion process, which positively influences the formation of passive film.

These examples reveal the special importance in choosing the electrolyte solution, with a determining role in the formation of the anodic film.

As an experimental strategy, the same working environment was used. In the case of these experiments the method of multiple regression was used in order to find some regression dependence relations of output and processing speed on the electric power intensity.

Regression analysis allows to establish functional dependence relations between an objective function and one or more influence factors through the particularization of coefficients and exponents or exponents of a mathematic function.

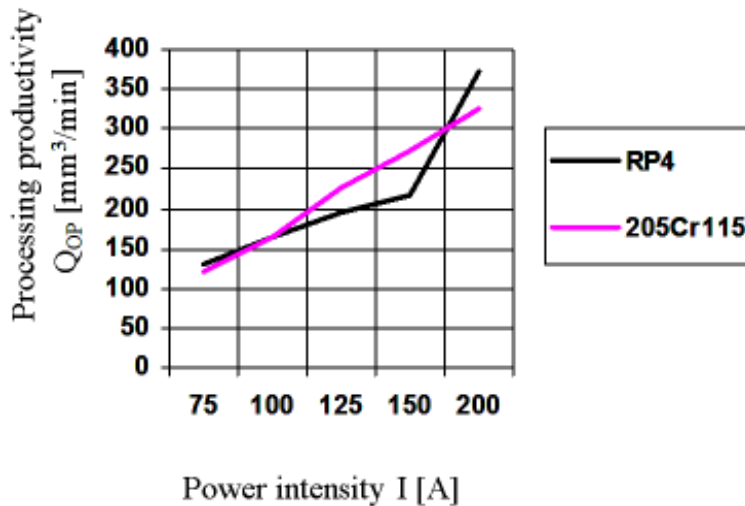
Experimental data processing was made with the help of computer using multiple regression. Experimental data achieved through this method synthesized in table 2 allowed to find regression relations  $Q_p=f(I)$  and  $v=f(I)$  for materials of the processed object RP4 and 205Cr115. Experiments were performed on the complex erosion processing plant for electric power intensities between 50 and 200A, voltages U=13-15V, constant processing time.

Comparing the case of the inorganic working environment NaNO<sub>3</sub>, processing outputs and steel processing speeds RP4 with the ones of steel 205Cr115 (table 2), there result:

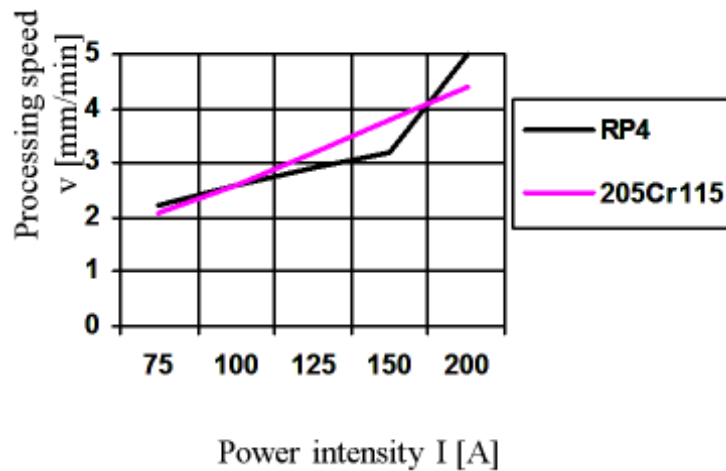
- For both steels, objective functions ( $Q_p$ ,  $v$ ) grow together with the growth of intensity (figure 1, figure 2);
- The growth of the two objective functions is more powerful for steel processing 205Cr115 rather than in the case of RP4 steel processing.

**Table 2:** Productivity and speed dependence on the power intensity using NaClO<sub>3</sub> working environment

I [A]	RP4		205Cr115	
	Q <sub>p</sub> [mm <sup>3</sup> /min]	v [mm/min]	Q <sub>p</sub> [mm <sup>3</sup> /min]	v [mm/min]
75	130,27	2,2	120,35	2,1
100	164,51	2,6	165,08	2,6
125	195	2,9	225	3,2
150	217,47	3,2	272,06	3,8
200	371,55	5	324,30	4,4



**Figure 1:** Productivity dependence on the power intensity (NaNO<sub>3</sub>)



**Figure 2:** Speed dependence on the power intensity (NaNO<sub>3</sub>)

## CONCLUSION

An adequate working environment as far as its composition is concerned, provides the way the anodic dissolution process of the piece develops as well as the possibility to develop the sampling process through electric discharging. NaNO<sub>3</sub> working environment causes high processing values and decreases the adherence of the film on the transfer electrode surface and of the processing machine.

The significant advantage of NaNO<sub>3</sub> is that, because the soluble glass or sodium silicate (the most known and used electrolyte so far) is not the only electrolyte, hard crust does no longer form, difficult to remove at the electrode and processing machine surface through complex erosion. It also decreases the concentration of

harmful aerosols released when using soluble glass as acid environment. Another advantage of  $\text{NaNO}_3$  is the achievement of smooth surfaces, finely processed of the piece. The main disadvantage of this working environment is the long time of complex electric and electrochemical erosion processing.

## REFERENCES

- [1] Gavrilaş, I. ş.a. ; Prelucrări neconvenţionale în construcţia de maşini -Editura Tehnică, Bucureşti, 1991.
- [2] Nagîţ, Gh., :Tehnologii neconvenţionale, Universitatea Tehnică „Gh. Asachi”, Iaşi, 1998.
- [3] Herman, R.I.E. : Prelucrarea prin eroziune electrică complexă, Editura Augusta, Timişoara, 1998.
- [4] Herman, R.I.E., ş.a. : Prelucrarea prin eroziune complexă electrică- electrochimică, Editura Augusta, Timişoara, 2004.
- [5] Nioaţă, A : Cercetări teoretice şi experimentale privind optimizarea unor parametri ai prelucrării prin eroziune complexă, Teză de doctorat, Sibiu, iulie 2007