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

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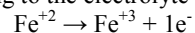
Abstract The essential functions of the electrolyte used at the processing through complex erosion are: the insurance of the electrical charge bearers presence in the space between the electrodes as well as the anodic dissolving of the remaking piece. The obtained ions can participate at the reactions 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

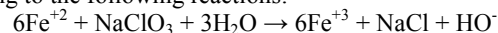
Sodium chlorate is part of the electrolytes promoting anodic dissolution process at within the complex electric erosion processing. For this electrolyte, most of the anodic dissolution process occurs at low potential values; iron is dissolved under the form of bivalent iron Fe^{+2} which can be oxidized by the dissolved oxygen into trivalent iron Fe^{+3} . Along with the increase of the electrode potential, a critical value is reached for the power density, the anode surface being covered with a layer of oxide, Fe_2O_3 . Through the oxide film, the anodic dissolution process is inhabited and the passivation state installs.

The electrochemical processes are:

Anodic reaction of iron oxidation passing to the electrolyte solution under the form of trivalent iron:

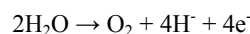


Cathode reaction is the release of hydrogen. During the anodic dissolution process, NaCl forms through the reduction of $NaClO_3$ according to the following reactions:



These results are determined by the oxide film formed at the anode surface, considered to be porous allowing the basic ions to pass quickly with small pores randomly distributed. At the same time, the film acts as a barrier preventing the reaction products to move. Metal removal speed decreases in time depending on thickness of the oxide layer.

By decreasing the removed metal quantity, a part of the power is used for generating oxygen, the electrode reaction is the following:



Along with the power density increase, the oxide film becomes thin, so that the metal removal velocity grows. Because the iron oxide is higher soluble at low pH values, oxide film thickness decrease can be caused by small pH values near the anodic surface.

Figure 1 reveals that the addition of sodium perchlorate, $NaClO_4$, in a sodium chlorate based electrolyte, $NaClO_3$, causes an increase of the power output. The oxide film is influenced by the concentration of the new solution of electrolytes. The main effect for adding the solution of $NaClO_4$ is the decrease of the oxidizing power of the sodium chlorate solution.

At high $NaClO_4$ concentrations, this compound shall attack the oxide film causing the pitting phenomenon (concentration higher than 0,25M). Iron and steel complex erosion processing in $NaClO_3$ based

electrolytes is different from nickel processing in the same electrolytes. The results achieved from steel and nickel processing in a NaClO_3 based electrolyte are described in Table 1.

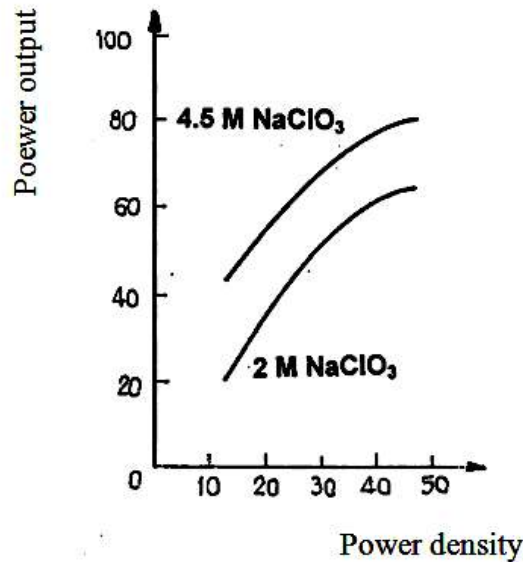


Figure 1: Power output at the dissolution of the bivalent iron ion depending on the power density

The table reveals that the power output at the nickel removal increases as fast as in the case of steel but does not reach high values like in the case of steel.

Under identical operating circumstances, the maximum nickel processing maximum speed is half the steel processing speed. Measuring the surfaces roughness has led to values between 0,25 and 0,39 μm for nickel compared to 0,026-0,052 μm for steel. These results comply with the measurement of the polarization phenomenon that indicates that for high power potentials, the thickness of the anodic film on nickel compared to the oxide film on steel, under similar circumstances, becomes thinner, more uniform.

Table 1: Results at steel and nickel processing using electrolyte on base of NaClO_3

Metal	Power density [A/cm ²]	Power output (when removing the metal)	Power output (when generating oxygen)
Steel	40	0,3	78 40 18
	80	22	
	150	62	
	300	86	
Nickel	40	8	79 40
	80	15	
	150	58	
	300	67	

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 $U=13-15\text{V}$, constant processing time.

Comparing the case of the inorganic working environment NaClO_3 , 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 2, figure 3)
- 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_3 working environment

I [A]	RP4		205Cr115	
	Q_p [mm ³ /min]	v [mm/min]	Q_p [mm ³ /min]	v [mm/min]
75	143,63	2,36	155,38	2,5
100	172,78	2,7	163,99	2,6
125	177	2,75	220	3,2
150	181,40	2,8	262	3,7
200	184,85	2,84	280	4,2

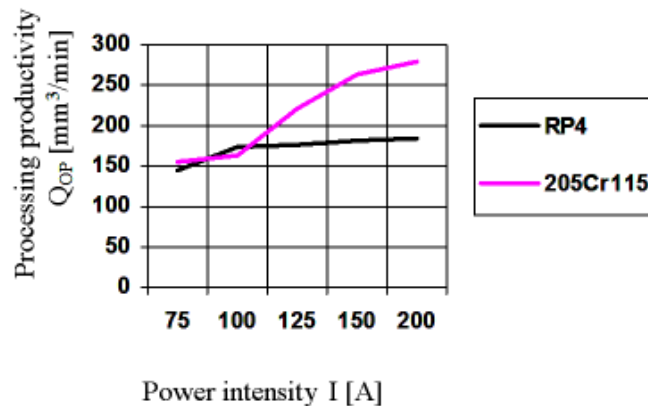


Figure 2: Productivity dependence on the power intensity (NaClO_3)

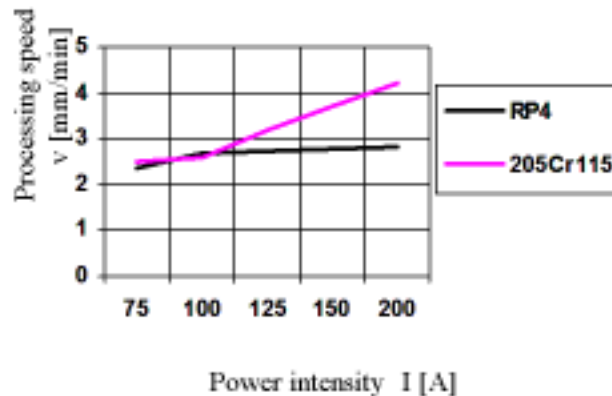


Figure 3: Speed dependence on the power intensity (NaClO_3)

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. NaClO_3 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 NaClO_3 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 NaClO_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. ș.a. ; Prelucrări neconvenționale în construcția de mașini -Editura Tehnică, București, 1991.
- [2] Nagîț, Gh., :Tehnologii neconvenționale, Universitatea Tehnică „Gh. Asachi”, Iași, 1998.
- [3] Herman, R.I.E. : Prelucrarea prin eroziune electrică complexă, Editura Augusta, Timișoara, 1998.
- [4] Herman, R.I.E., ș.a. : Prelucrarea prin eroziune complexă electrică- electrochimică, Editura Augusta, Timișoara, 2004.
- [5] Nioață, A : Cercetări teoretice și experimentale privind optimizarea unor parametri ai prelucrării prin eroziune complexă, Teză de doctorat, Sibiu, iulie 2007