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## ADDITIVE WORK ENVIRONMENT USED COMPLEX EROSION PROCESSING TO HARD STEEL

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**Abstract:** The processing through complex, electrical and electrochemical erosion represents a superposition and a sequence in time and space in the working areas of the activities for processing through electrical erosion and electrochemical erosion. The work liquid, with electrolyte role and having dialectical properties, by composition, density, the mode flow influences decisively the process of work through complex erosion. In this paper is presented the meaning of the added working place over productivity and working speed through complex erosion according to the intensity of the electric power and the comparison of these characteristics with the similar characteristics obtained at work using as a tool the sodium silicate. 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:** work environment, processed object, transfer objects, complex erosion, productivity, power intensity

### 1. INTRODUCTION

In the dimensional processing by complex erosion, the work environment used as a significant ponderosity is water glass. The water glass solution leaves a white film on the contact surfaces between the liquid and the machines, that can be removed by warm water cleansing. This means that the complex erosion machines must be equipped with warm water cleansing appliances in contact with the soluble glass. Due to the anodic dissolution phenomenon in the electrochemical process, the sampling from the OP processed object can be influenced by inorganic work environments. One of these environments is consisted of 30% silicate + 10% kaolin +5% NaNO<sub>3</sub> mixture when it occurs an improvement of the electric and electrochemical complete erosion processing, both due to metal anodic dissolution because of NaNO<sub>3</sub> electrolyte and the sampling process by impulse electrical downloads. The addition of kaolin argillaceous suspension in the sodium silicate solution contributes to the anodic film formed on the OP processed object.

### 2. THE EXPERIMENTAL PART

During the forming process of the passive film two stages occur:

#### 1. Forming of the film constituent compounds that is consisted of two steps:

- sodium silicate solvation;
- spiral kaolin mica dissociation;
- NaNO<sub>3</sub> electrolyte dissociation.

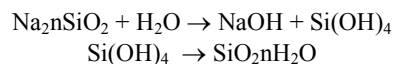
#### 2. Adsorption of compounds formed on the OP processed object surface.

##### 2.1. Forming of the film constituent compounds

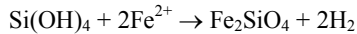
- Sodium silicate solvation.

Sodium silicate solubilization in water is consisted of:

- a chemical change or a hydrolysis in water excess:



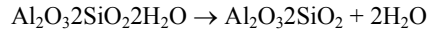
In case of steel, the fire resulted from the metal melting and anodic dissolution reacts with a part of silicate acid and forms ferrous ortosilicat:



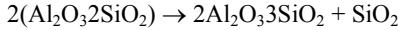
b) Spiral kaolin mica dissociation.

Kaolin,  $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ , in the presence of high temperatures in the work place is subjected to several transformations:

b<sub>1</sub>) in the 550-600 degrees C interval the crystalline network of the kaolin reorganizes, by dehydration it results a new mineral, the metakaolin  $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ :



b<sub>2</sub>) at 850 ° C the metakaolin transforms into a cubic spinel phase according to the change:



b<sub>3</sub>) over 1050°C the spinel phase transforms, with a separation from the cristobalit, in the mulit ( $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ). The negative charge of the mulit colloidal particles determine their movement towards the processed OP linked to the positive pole of the power source.

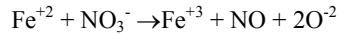
c) NaNO<sub>3</sub> electrolyte dissociation.

The presence of the soda nitrate ( $\text{NaNO}_3$ ) in the work environment determines an intensification of the anodic dissolution process which occurs in the first stage of processing by complex electrical erosion.

The electrochemical processes are:

For the cathode: oxygen emission:  $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$

For the anode:  $3\text{Fe} - 2\text{e}^- \rightarrow 3\text{Fe}^{+2}$



The global change:



Following the chemical analysis carried out on the sediment deposit and the PP pasivante film formed on the processed OP object surface; for this type of work environment it was found that the products resulted by the anodal dissolution of soda nitrate are found less in the pasivant film and more in the sediment, as iron nitrate without interfering though into the pasivante film structure.

## 2.2. Adsorption of compounds formed on the OP processed object surface.

An important part in the adsorption on the OP surface process belongs to the migration speed of the formed particles determined by their size. The kaolin colloidal, having a much more complex structure, bigger volume, move much slower under the influence of the electric field, favoring the adsorption of the compounds resulted from the water-glass decomposing.

Adsorption is a spontaneous process consisted of crowding the molecules of a component particle on the separation surface between two stages, in higher concentration than in the rest of the gas or solution. In this case we have the adsorption in a first stage of silicate, ferro silicate and silica gel on the surface of the processed OP whose particles are kept on the anode by Van der Waals attraction forces.

Adsorption is influenced by:

a) Temperature: adsorption decreases with the temperature rise, as it occurs an intensification of the particle kinetic energy which will lead to a decrease in the molecule number adsorbed on the surface unit.

b) Pressure: pressure rise determines molecule number growth adsorbed on the surface unit.

In case of electric complex erosion processing, the risen temperatures developed in the work space influence negatively the adsorption process, however, the interstice small value between the transfer object OT and the processing object OP determines a particle congestion on the anode surface, therefore, intensifying the adsorption.

It occurs the first layer consisted of compounds resulted from the water glass dissociation due to adsorb kaolin colloidal particles subsequently because of the slow migration speed.

The passive layer formed has a higher mechanical and electrical resistance due to  $\text{Al}_2\text{O}_3$  from the kaolin structure. The double layer formed on the electrolyte interface bears particular importance. When metal comes into contact with electrolyte solution there occurs a charge separation due to the following reasons: charged particles passing through interface, water dipoles orientation, non-concordance of positive charges centre with negative charges centre on metal surface, specific adsorption. Of all these, the greatest ponderosity belongs to passing of charged particles through the interface leading to a metal loading with charge surplus  $q_M$ , respectively loading the solution with charge excess  $q_S$ :  $q_S = -q_M$ , in the double layer occur high intensity electrical fields that influence the course of electrochemical changes.

The charge excess on metal it occurs in case of congestion or exhaustion of electrons in the interface region. The entire electrons excess or deficit is located on the metal surface.

As experimental strategy it is used the method of dispersion single factor analysis in order to establish the influence of the work environment and OP processed object material on the productivity and processing speed.

This method aims to the comparison of the two discussed work environments: sodium silicate and Additive work environment( 30% silicate + 10% kaolin+ 5% NaNO<sub>3</sub>) in the material complex erosion processing: RP4 and 205Cr115. Productivity and processing speed average values were calculated for each of the two processed materials in each of the two proposed environments. The estimative values along with the trust intervals for an estimation safety of 95% are presented in tables 1 and 2.

**Table 1:** Productivity and speed dependence on the power intensity for RP4 steel.

I [A]	Sodium silicate (Na <sub>2</sub> O·nSiO <sub>2</sub> )		Additive environment 30% silicate + 10% kaolin +5% NaNO <sub>3</sub>	
	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	298,35	3,9	529,87	7,5
100	304,94	4,2	1059,75	15
125	320	4,4	1177,5	16,66
150	338,74	4,6	1180,3	17,64
200	362.63	4,9	1413	20

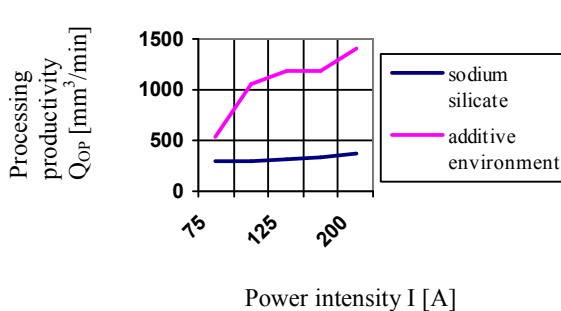
**Table 2:** Productivity and speed dependence on the power intensity for 205Cr115 steel

I [A]	Sodium silicate (Na <sub>2</sub> O·nSiO <sub>2</sub> )		Additive environment 30% silicate + 10% kaolin +5% NaNO <sub>3</sub>	
	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	253,66	3,02	706,5	10
100	299,79	3,04	1059,75	15
125	353,11	3,5	1115,52	15,78
150	471,43	3,64	1324,68	18,75
200	528	4,48	1413	20

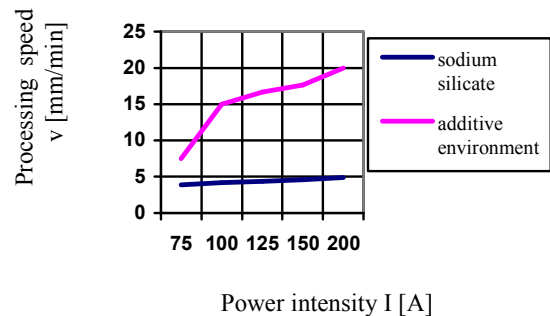
### 3. RESULTS AND DISCUSSIONS

Processing productivity comparative analysis was pursued (mm<sup>3</sup>/min) and respectively, the processing speed depending on the electric power intensity for materials RP4 and 205Cr115. The comparison was made for the sodium silicate (Na<sub>2</sub>O·nSiO<sub>2</sub>) and the additive work environment (30% silicate + 10% kaolin+ 5% NaNO<sub>3</sub>). The processing productivity in the case of sodium silicate increases as the power intensity increases being noticed a more accentuated declivity at processing the material 205Cr115 than RP4; the processing speed in the case of this environment is always higher at steel RP4, intensifying along with the intensity growth of both materials(table 1 and 2). In the case of additional work environment there are increases of both productivity and processing speed, with the power increase for both materials (RP4 and 205Cr115); there are no significant differences in this work environment between the processing productivity and speed processing in case of material change (table 1 and 2).

By making a comparison, in the case of steel RP4, between the processing productivity and speed processing of sodium silicate and the ones of the additional work environment (table 1) it results that:

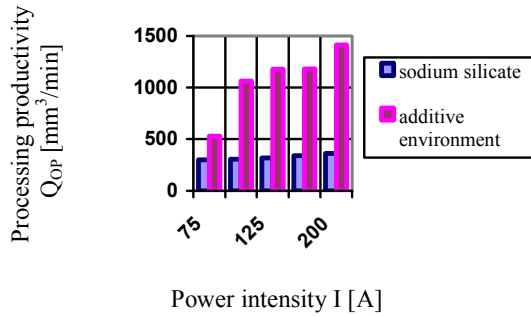


**Figure 1:** Productivity dependence on the power intensity for RP4 steel

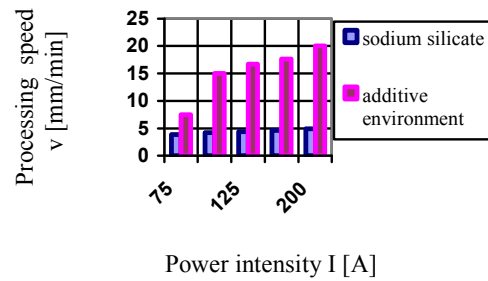


**Figure 2:** Speed dependence on the power intensity for RP4 steel)

- the increase of the two objective functions is higher in the case of additional work environment than the sodium silicate being recorded growth of approximately 350% for productivity and 400% for speed (figure 3 and 4).



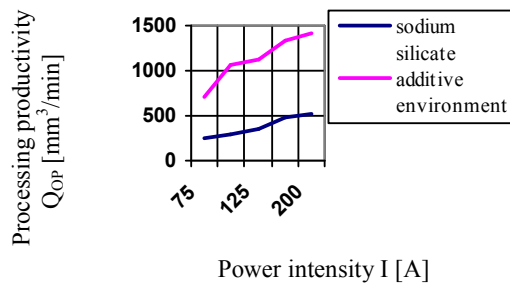
**Figure 3:** The comparison of processing productivity for the two work environment (RP4)



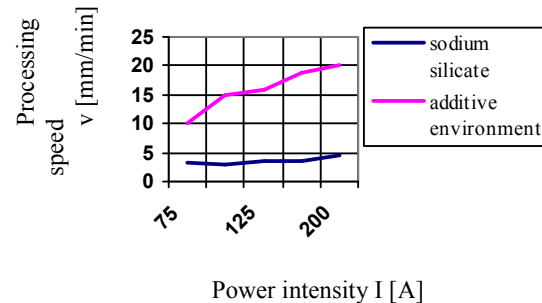
**Figure 4:** The comparison of processing speed for the two work environment (RP4)

In the case of 205Cr115 steel processing and following the comparison between the sodium silicate and the additional work environment (table 2), it can be stated that:

- as in the case of RP4 processing, for the two work environment and for both objective functions the processing productivity and processing speed increase along with the growth of power intensity (figure 5, 6);

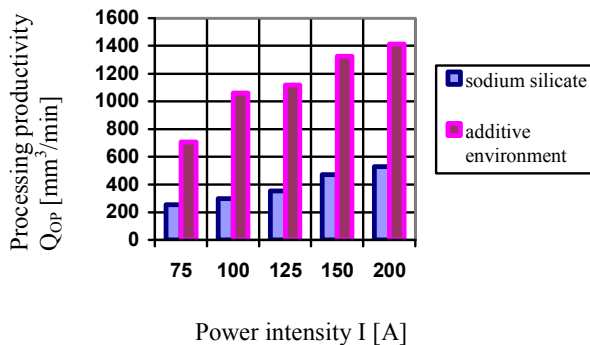


**Figure 5:** Productivity dependence on the power intensity for 205Cr115 steel

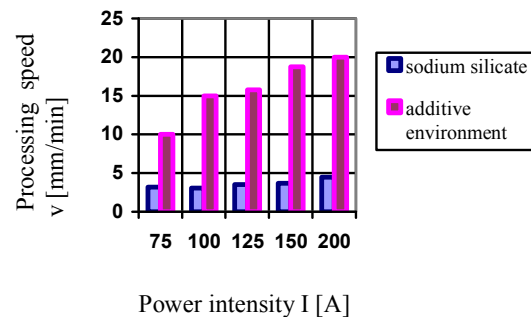


**Figure 6:** Speed dependence on the power intensity for 205Cr115 steel

- the best results regarding processing productivity and speed productivity are obtained by using the additional work environment (figure 7,8).



**Figure 7:** The comparison of processing productivity for the two work environment (205Cr115)



**Figure 8:** The comparison of processing speed for the two work environment (205Cr115)

Following the analysis of the results obtained it can be stated that the additional work environment based on colloidal suspensions allow impressive superior performance (regarding the maximization of productivity and speed processing).

#### 4. CONCLUSIONS

An adequate work environment by its composition ensures the course method of the process of anode dissolution of the piece and at the same time the possibility of sampling process by electric discharge. The sodium silicate used presents the disadvantages of forming a rough film due to water evaporation, on the surface of the erosion machines as well as discharging noxious aerosols. The additive work environment(30% silicate + 10% kaolin+ 5%  $\text{NaNO}_3$ ) determine high speeds of processing due to the excess sodium silicate and decreases the adherence of the film on the transfer electrode surface and of the processing machine, because a part of the adherence forces are consumed by linking the colloidal mica to the kaolin. Because of the electrolytic addition based on soda nitrate the solution conductivity increases respectively the sampling by anode dissolution.

The main advantage of the additional work environment is represented by the fact that soluble glass or sodium silicate are no longer the only component of the environment, the rough film fails to occur which is hard to remove off the electrode surface and the complex erosion processing machine. It also decreases the noxious aerosol concentration discharged in the case of soluble glass as work environment.

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