TECHNOLOGIES OF PROCESSING THROUGH COMPLEX EROSION

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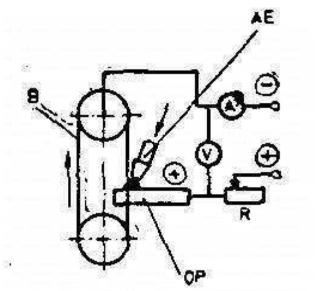
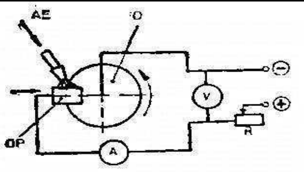
ABSTRACT: The process of processing through complex electrical and electrochemical erosion attempts to combine the advantages of processing through electrical erosion (good productivity) and electrochemical erosion (precision and quality), at the same time the process taking over the disadvantages of the two methods as well. As in any field of activity, the practical application of one or other methodologies depends on many factors, the choice taking into account the outcome to be reached..

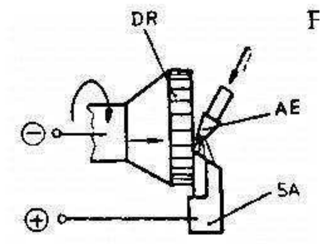
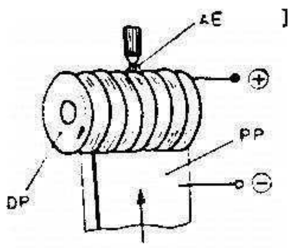
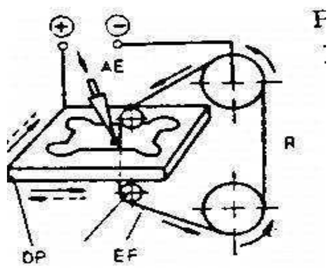
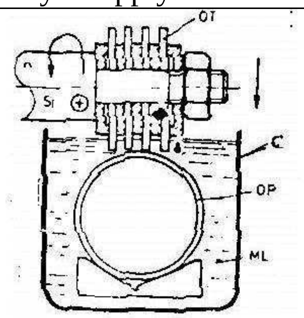
KEY WORDS: electrod, processed object, electrolyte, sodium silicate, machine

1. TECHNOLOGICAL OPERATIONS

The main diagrams of various operations of processing through complex erosion are shown in Table 1. For this purpose, the machines are equipped with numerous cinematic elements determined by specific conditions where processing takes place.

Table 1. The main diagrams of various operations of processing through complex erosion

Diagram on principle	**Operations which can be executed**	**Material**	**Working Environment**
0	1	2	3
 a) B-electrode; OP-processed object; AE- electrolyte supply; R-rheostat; voltmeter; ammeter	Yielding.More complex operations (band lathing). Band width 20-30 mm and 0.5-2 mm thickness.	Metallic carbides, refractory steels, hardened steels, etc.	Colloidal solution,especially of sodium silicate; Kaolin suspension in water; Aqueous solutions of aluminum silicate. Flow of approx. 1m3 / h.
 b) D-Disc electrode; OP-processed object; AE electrolyte supply; R-Rheostat;A- ammeter V-voltmeter.	Yielding.	Difficult to process materials, special alloys, metallic carbides.	Solutions of sodium silicate

 c) SA-splintering tool; DR-grinding disc; AE- electrolyte supply.	Correction of splintering tools; Correction of flat and profiled surfaces.	Metallic carbides and superhard alloys	Solutions of sodium silicate
 d) PP part to be profiled; DP profiled disc shaped; AE- Electrolyte supply.	Profiled processing is carry out with flattemplet or disc shaped tools	Metallic carbides	Solutions of sodium silicate
 e) EF- filiform electrode; R-Role; OP- processed object; AE-electrolyte supply.	Profile processing (cutting) in contour with filiform electrode	Hard materials	Solutions of sodium silicate
 f) D- discs; PT-tubular part; ML-working environment; C-tank; SL-longitudinal advance	Inserting narrow slits in tubular filter pieces (e.g.-oil extraction equipments).	Pipes and tubes of materials difficult to process	Solutions of sodium silicate

1.1. Yielding operations

Yielding metallic materials difficult to process is currently the field in which the procedure of processing through complex erosion is very efficient. Cuts can be achieved with minimum material loss and low energy consumption. Pieces can have sizes up to 500 mm in diameter or side, and the amount of material collected can reach values over 10000 mm^3/min. Cutting can be done with different electrodes (OT): tape, wire, disk.

The most commonly used are disc electrodes given their robustness in operation and the main-construction simplicity of the equipment.

Table 2 presents the characteristics of yielding discs, and in Table 3 usual standards of yielding through complex erosion

Table 2: Characterists of discs for yielding through complex erosion

Dimensions of semi-products [mm]	Dimensiunile discului			Material	Diameter of tightening flanges D_f [m]
	Diameter D [m]	Width g [m]	Alloy Diameter d [m]		
Up to 30	300	0,5	15...20	Carbon steel of general use STAS 500/2-80	40...50
30...100	200...400	0,8...1	25...30		50...80
100...200	400...700	1,0...1,5	30...35		100...150
200...400	700...1200	1,5...2,0	35...45		150...200

Table 3: Working conditions for yielding through complex erosion

Diameter of semiproduct d_s [mm]	Tension of working U [V]	Intensity of current I [A]	Pressure between electrodes p [daN/cm^2]	Yield of electrolyte Q [m^3/h]
10...20	20...22	20...40	0,5...1,0	0,5
20...40	20...22	40...80	0,5...1,0	0,5
40...80	20...22	80...125	0,5...1,0	0,5
80...125	22...24	125...200	1,5...2,0	1,0
125...150	24...26	200...275	1,5...2,0	1,0
150...200	24...26	275...350	1,5...2,5	2,0
200...250	26...28	350...450	2,0...3,0	2,0
250...400	28...30	450...600	2,0...3,0	2,5...3,0

A separate problem is the metal carbides. Their behavior to complex erosion processing is due to their physical and mechanical properties that are based on the content of binder (Co) as in such carbons as ICT TAC, CW (Table 4).
Under the action of thermal and mechanical stresses they may crack and therefore there are certain restrictions on processing, resulting in a differentiation of the schemes based on carbide type and depending on the chemical composition. The content of cobalt, which gives carbide increased storage capacity of deformation without cracking energy , can be an indicator to be taken into account when choosing treatment regimes and establish a suitable circuit impedance, (commonly inductive).

Table 4: Physical and mechanical properties of metallic carbides

Material	K 10	K 20	K 30	K 60	P 40	P 10	CW	Co
Composition [%] CW	94	85	77	75	74	64	100	—
Composition [%] Co	6	12	20	25	14	9	—	100
Composition [%] TiC+TaC	—	3	3	—	12	27	—	—
Tearing resistance by bending [daN/mm^2]	170	210	260	280	190	130	40	195
Coefficient of volume	15	16.5	17.9	20	17.5	21	21,6	15,3

dilatation γ [1/K]	10^{-6}	10^{-6}	10^{-6}	10^{-6}	10^{-6}	10^{-6}	10^{-6}	10^{-6}
Thermical conductivity termică λ [W/mK]	80	62	28,5	23,9	22	21	122	71
Mass calorie capacity C [J/kgK]	151	220	265	214	—	336	—	442
Specifică mass ρ [g/cm^3]	14,8	14,3	13,7	12,8	12,6	10,7	15,7	8,7
Thermical difusity α [m^2/h]	0,129	—	—	—	—	0,0254	—	0,0666
Melting temperature [K]	—	2870	—	—	—	—	3640	1760

Metal carbides have low resilience, their resistance to thermal or mechanical shock is very small. The cumulative action of thermal and mechanical effects inherent in the process of processing through complex erosion , rapid heating and cooling, may stress the material over the allowable limits of damage by bending, compression. As a result occur plastic deformation phenomena, sudden contractions and expansions, resulting in landslides layers, local ruptures, cracks, whose intensity depends on the structure or composition of carbide type.

Intensifying of work mode (U, I) leads to the intensification of these phenomena, with undesirable consequences for technological indicators such as productivity, precision, surface roughness etc. From this point of view it is important to establish restrictions on programming of pulse energy parameters based on chemical composition (structure) in order to achieve a particular technological indicator.

In Table 5 are reproduced indicative data obtained at normal processing of some types of carbides

Table 5: Working conditions at yielding metallic carbides through complex erosion

Type of carbide	Dimensions [mm]	Diameter of disc D [mm]	Tension of operation U [V]	Current of operation I [V]	Productivity Q_p [mm^3/min]	Electrolyte
P 01	30x20x10	160	18...22	20...30	45...50	Soluble sodium silicate
P 10	30x20x10	160	18...22	20...30	50...55	
P 40	32x18x10	160	18...22	20...30	50...60	
K 15	25x15x10	160	18...22	20...30	50...57	
K 30	60	160	18...22	30...40	62...65	

1.2. Rectification through complex erosion

Sharpening carbide plated tools or made of stainless steel with superior features like fast steels, superhard alloys, etc. requires a high consumption of diamond grinding discs, which increase the cost of operation.Replacing mechanical sharpening operation with sharpening through by complex erosion has a number of complex economic and technological advantages: low power consumption, constructional simplicity of the machine, very cheap electrode (OT), high precision of processing etc.

Table 6 presents comparative data between mechanical rectification and complex erosion for two sorts of fuel.

Sharpening is done by a scheme which is in essence shown in Figure 1. Construction of disc (OT) is shown in Figure 2. The disc is made of carbon steel for general use and more rarely cast iron or copper. In order to facilitate the access of liquid into the processing area on the front surface are made some channels with width and depth of 3 ... 4 mm and inclined to the radius with 15 ... 20 °.

Table 6: Comparative data at sharpening through complex erosion and mechanical rectification of tools

Procedure of sharpening	Working conditions	Productivity Q_p [mm^3/min]	Wearing of electrode from eroded material %	Roughness of surfaces R_a [μm]
With grinding discs	Roughing	35...40*	250	0,25...0,5
		25...30		
	Finishing	50...60	200	0,2...0,3
		40...45		
With abrasive paste	Finishing	7,0...8,8	2,0...3,0	0,2...0,3
		5,0...6,0		
Through complex erosion	Roughing	120...150	15...25	3,0...3,5
		150...200		
	Semifinishing	25...30	5,0...10	1,0...2,0
		40...45		
	Finishing	1,0...2,0	2,0...4,0	0,25...0,3
		2,0...3,0		

* Values from the numerator are for P 10 carbides and from the denominator are for K 40 carbides .

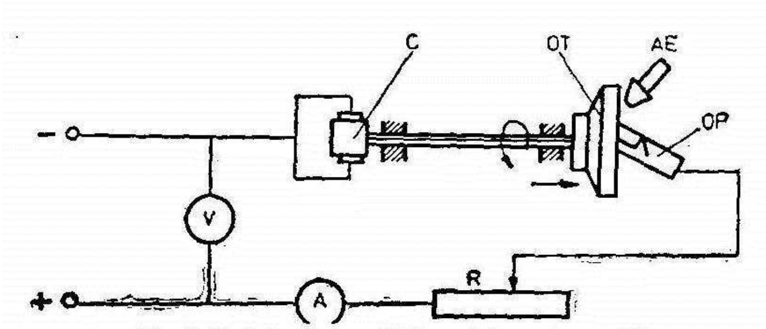


Figure 1: Diagram of sharpening tools through rectification:
OT transfer object; OP-processed object; AE-supply
electrolyte supply; C-collector; R-rheostat; A-ammeter; V-voltmeter.

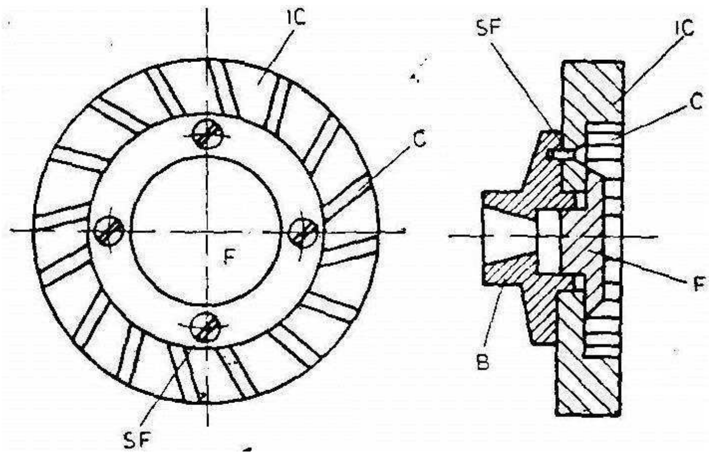


Figure 2: Construction of rectification disc:
IC - split ring; C - Channel; SF - screw;
F - flange; B - Hub

2. CONCLUSIONS

We note the following general conclusions resulting from the study of existing documentation :

• machines of processing through EEC in Romania at this time are reduced both in terms of numbers and the type of operations they perform;

• diversifying of production, increasing of the share of materials with special qualities or special type of products have produced changes in the organization of production, which allowed a momentum of theoretical research and practical applications of unconventional technologies;

• upgrading of the existing machines wholly or in certain parts, adaptation of some automated systems can often be an effective solution;

• use of computer systems to improve the performance of the machines is often a lot cheaper solution than the purchase of machines with integrated automated systems.

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