ENVIRONMENTAL PROTECTION AND RECOVERY BY ELECTRO-SEPARATION OF THE BRASS IN COPPER ASHES FROM NON-FERROUS METAL FOUNDRIES

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REZUMAT. Cercetările colectivului au în vedere preocupări pentru protecţia mediului şi se încadrează în tendinţele actuale pe plan mondial de recuperare a materialelor utile din deşeurile industriale cum sunt şi cenuşile cuprifere ce conţin alamă şi alte componente rezultate în urma proceselor tehnologice de turnare a aliajelor de cupru. Electrosepararea materialelor granulare în câmpuri electrice intense este una din multiplele aplicaţii ale electrostaticii şi se bazează pe forţele ce acţionează în mod diferit în câmp electric intens asupra particulelor granulare în funcţie de încărcarea cu sarcină elctrică, precum şi unele caracteristici fizico–mecanice (forma particulelor, greutatea specifică, starea suprafeţei particulelor) având un consum de energie electrică redus.

Cuvinte cheie: protecţia mediului, cenuşi cuprifere, electroseparare, recuperare.

ABSTRACT The research team is considering environmental concerns and current trends within the global recovery of useful materials such as industrial waste and ash containing copper brass and other components resulting from the processes of casting copper alloys. Electroseparation of granular materials in intense electric fields is one of the many applications of electrostatics and it is based on the forces acting differently in intense electric fields over granular particles depending on their electric workload, or some physical and mechanical characteristics (the shape of the particles, their specific weight, surface condition of the particles), having a low power consumption.

Key words: environmental protection, copper ashes, electro-separation, recovery.

1. INTRODUCTION

This paper presents research laboratory on the separation of ash copper brass for reuse it in non-ferrous foundries. Copper ash was collected from the technological flow of Armatura SA Cluj Company, subject to a process for preparing samples for electro-separation which contains:

- Magnetic Separation on SEPMAG separator to remove ferromagnetic particles;
- Ball milling;
- Sieving and sifting into 2 particle size fractions ranging in size from 0.4 mm - 1 mm.

By mass spectrometry there have been identified key components that make up the mixture of copper ash: brass, zinc oxide and other impurities.

In the Laboratory of Technical University of Intense Electric Fields - Cluj Napoca electro-separation tests were performed on plant ILES 1 in a corona-electrostatic configuration and the results obtained were processed using the statistical program MODDE 5. Recovering brass from the mixture of copper ashes is necessary, as it can be reintroduced again back into the melting process.

Worldwide, recovering the brass from copper ashes is being made by electro-separation, pyrometallurgical processes, pneumatics sieving, and by immersing the mixture in water followed by a sieving process after which is obtained the separation of the brass.

In this case the use of intense electric fields in theelectro-separation process is a modern and eco technology requiring lower power consumption compared to the procedures outlined above. [2], [8], [9].

2. IDENTIFICATION OF THE INDIVIDUAL COMPOUNDS THAT MAKE UP THE COPPER ASHES

It is known that brass is a CuZn pinchbeck, which includes in its mass other metal compounds; those are designed to improve the physical - chemical properties of the alloy depending on the needs [6]. A copper-zinc alloy CuZn37Pb example is presentend in the table 1:

Table 1 Chemical compound of copper-zinc alloy CuZn37Pb expressed as percentage

Elements / %	Min.	Max.
Cu	58.0	60.0
Sn	-	1.0
Pb	1.8	2.0
Ni	-	1.2
Fe	-	0.7
Al	0.3	1.0
Si	-	0.1
Mn	-	0.1
As	-	0.1
Sb	-	0.05
Zn	39.9	33.75

Following the melting process above the mass of material we obtain slag, which is made of metal oxides in the casting mixture and carbon arising from the combustion process.(Fig. 1)

Fig.1 Appearance of copper ashes mixture

The main chemical oxidation reactions occurring on the surface of fused mass are:

$$2Cu + O_2 \rightarrow 2CuO \quad (1);$$

$$2Zn + O_2 \rightarrow 2ZnO \quad (2);$$

The slag obtained will be milled and will result a mixture with different particle size fractions which is composed of oxides listed above and brasss, the mixture being called copper ashes.

By separation in corona electrostatic field we separate brass from the rest of the components in copper ashes, the purpose being to reuse it in the process of casting the brass.

To determine the main components that make up ash copper spectrometric analysis was done on a sample of material with grain size less than 0.4 mm, after which were observed following:

- ZnO (zinc oxide) - aprox. 80% (Fig. 2.1)

- CuZn (brass) aprox. 5-8% (Fig. 2.2)

- CuO (copper oxide) aprox. 3-4% (Fig. 2.3)

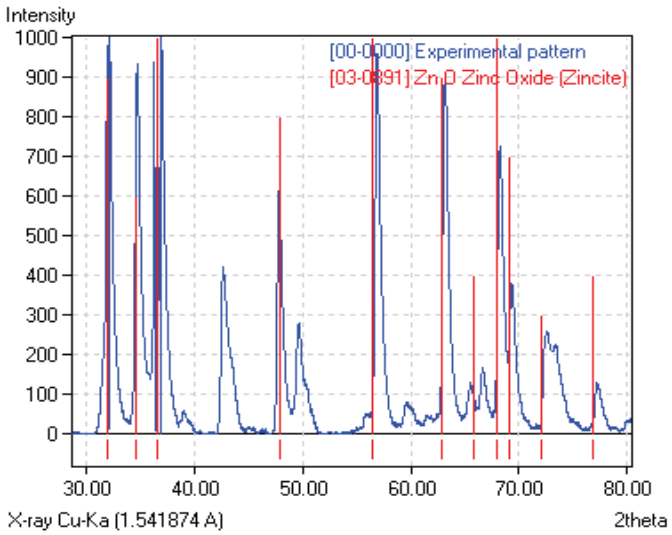

Fig. 2.1 The presence of ZnO (zinc oxide) in the mixture of copper ash highlighted by spectrophotometry with a sample size less than 0.4 mm

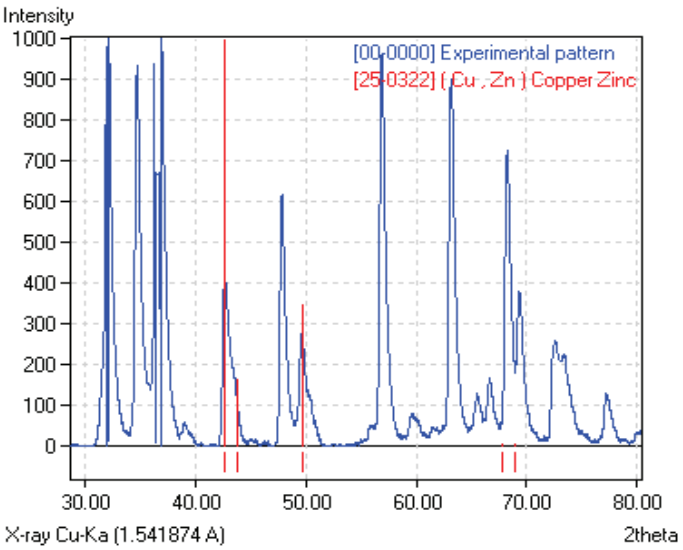

Fig. 2.2 The presence of CuZn (brass) in the mixture of copper ash highlighted by spectrophotometry with a sample size less than 0.4 mm

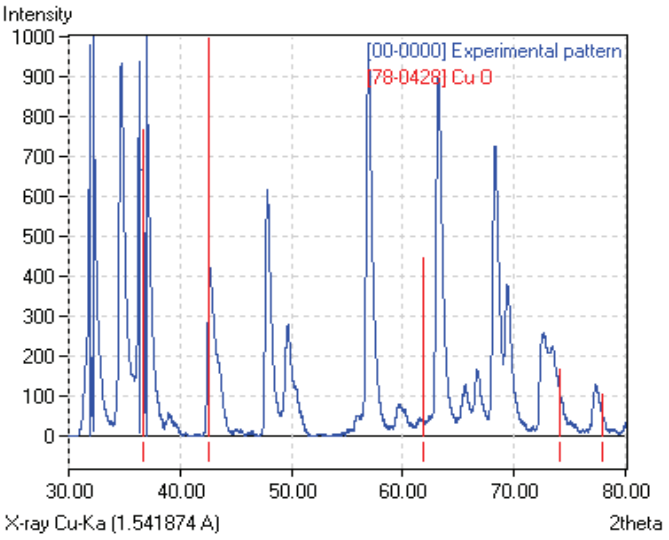

Fig 2.3 The presence of CuO (copper oxide) in the mixture of copper ash highlighted by spectrophotometry with a sample size less than 0.4 mm

SAMPLE PREPARATION OF MATERIAL FOR ELECTROSEPARATION TESTS IN CORONA ELECTROSTATIC FIELD

The preparation of material sample was made following the technological scheme above (fig.3). The slag has the density (2,7 – 2,8) x10^3 kg / m^3, is non-conductive and non-magnetic, unless it contains a high quantity of Fe_2O_3 (over 6 – 8 % Fe_2O_3). Grinding to release brass is done in ball mills. Classification and magnetic separation are designed to create optimum conditions for the electroseparation process. Both particle size classes bigger or smaller than 1 mm are being electrically charged for processing them on electro-separators, so that we obtain 2 different brass concentrates. Granular material resulted from casting brass contains it as free particles or fragments embedded in slag.

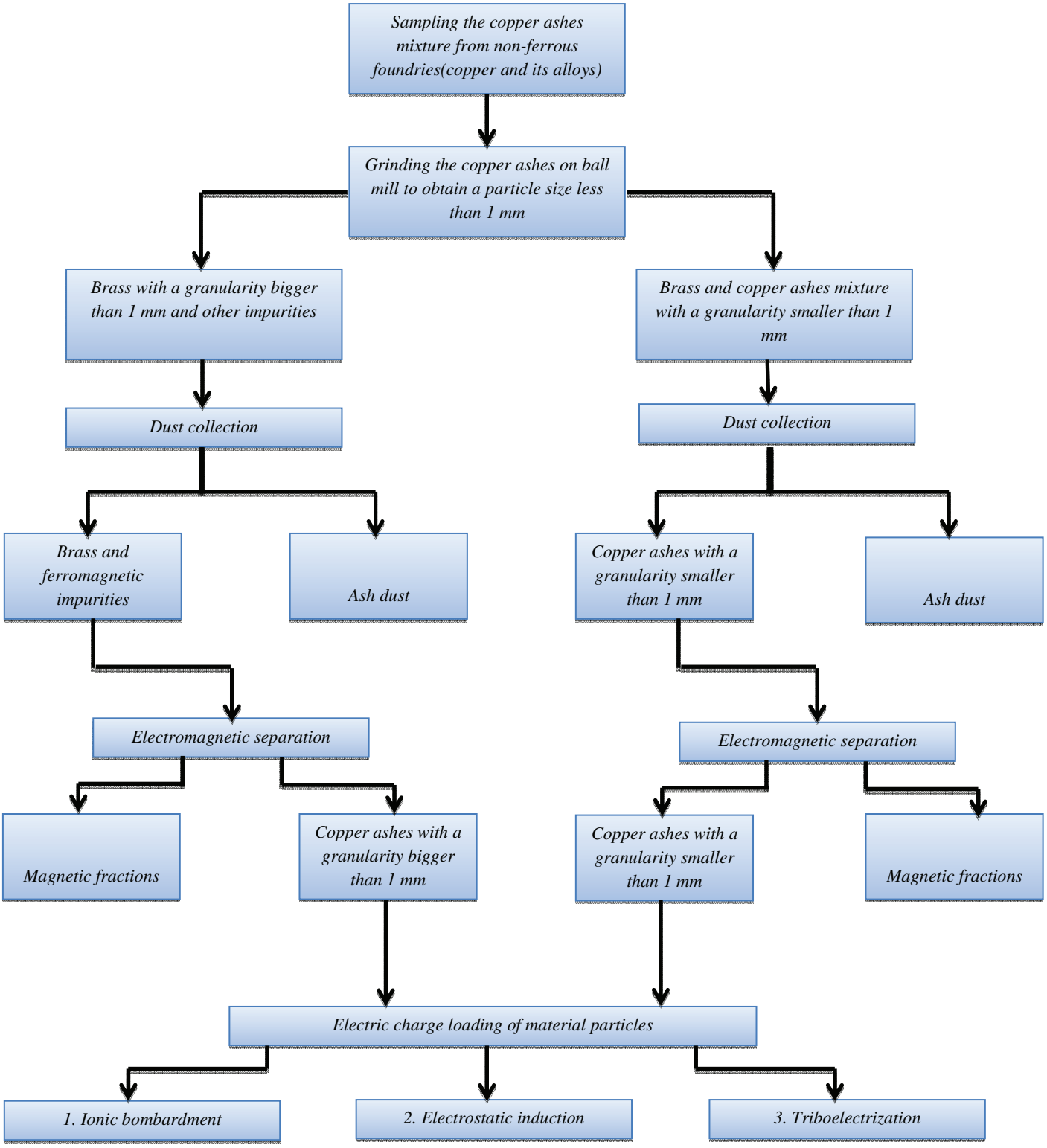

Fig. 3 Technological scheme for preparing the copper ashes sample on processing it on electro separator

3. ELECTROSEPARATION TESTS IN CORONA-ELECTROSTATIC FIELD ON SEPARATOR ILES 1

Corona-electrostatic field is generated within the core of the two electrodes corona and electrostatic and grounded rotating drum. Material to be separated is transported by a vibrating conveyor bumper to the rotating cylinder in the active zone [4], [9].

In the mixture of copper ashes we have semiconductor material properties (zinc oxide) and conductive material (brass).

Non-conductive particles through the corona field and image force will stick rotating cylinder and conductive particles yield their load to the grounded rotating cylinder and will be attracted by the electrostatic electrode; so the assigned material will be collected in different collecting boxes.

The main factors influencing the separation in corona electrostatic field of the conductive particles from the non-conductive ones are:

- voltage, U [kV];
- speed rotating cylinder, n [rpm];
- the angle of the electrodes to the rotating cylinder axis α_1 şi α_2 [°].

The factors on which the process of separation in corona-electrostatic field field was studied on electro-separator ILES 1 (fig. 4)

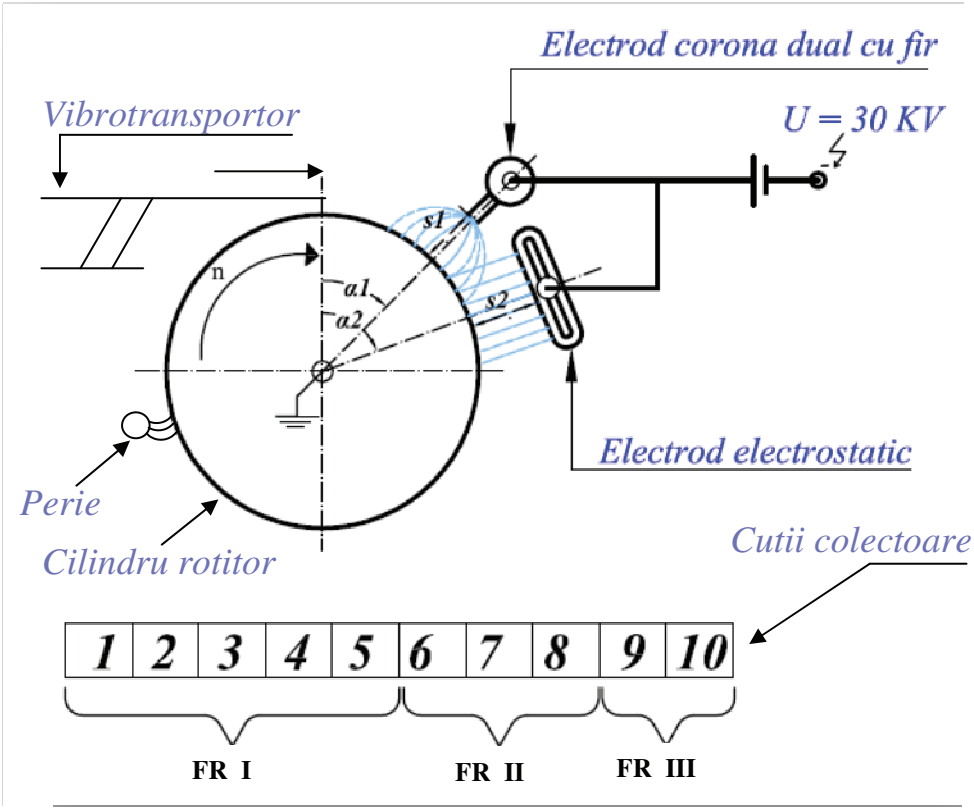

Fig. 4 The configuration of corona-electrostatic separator ILES 1 and collection boxes division into 3 collecting groups FR I = semi-conductor and non-conductor material; FR II = mixt material; FR III = conductor material, s_1 şi s_2 – the distance between the electrodes and the rotating cylinder; α_1 şi α_2 the electrodes angle towards the rotating cylinder axis, n- speed of rotating cylinder

The discharge corona field is generated by an electrode of smaller radius of curvature than called dual corona electrode wire [fig.5] and electrostatic field is generated by an electrostatic electrode and rectangular with rounded edges [fig .6] supplied from a high voltage source.

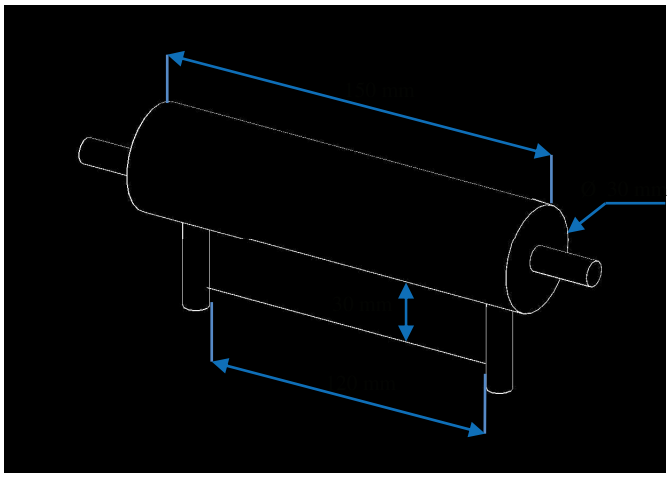

Fig.5 Constructive aspect of dual corona electrode wire

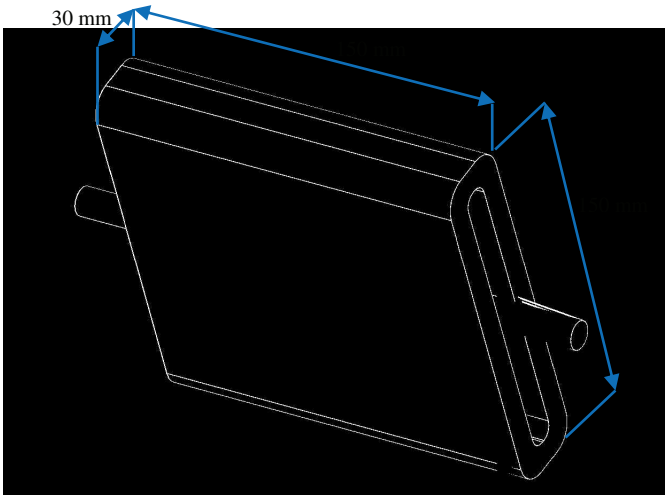

Fig.6 Constructive aspect of electrostatic electrode

In the electroseparation in corona-electrostatic field on ILES 1 separator process was used as a sample copper ashes grained less than 1 mm. There have been done 17 different measurements and for each measurement were used 100 g of ash cupriferă. To define the number of experiments and to determine the amount of factors that need to be variable and the values determined we used the statistical program MODDE 5.1 such factors with values varying were chosen voltage U [KV], rotating drum speed n [rpm] and dual corona wire electrode angle to the axis rotating cylindrical α_1 [°]:

- ***U = 10 - 34 KV***
- ***n = 20 - 50 rpm***
- ***α1 = 15 – 40 degrees***

The environmental conditions setting the separator parameters that influence the separation corona-electrostatic process are:

- Temperature =25 °C
- Humidity = 24,6 %
- Grain 0,8 – 1 mm
- M = 100 g
- α_2 = 65 degrees
- s_1 = 55 mm
- s_2 = 55 mm.

Table 2 presents the results obtained from experiments on the separator ILES 1

Table 2. Experimental results on the separator ILES 1

Exp Nr	***Voltage U [KV]***	***Speed n [rpm]***	***Angle α1 [º]***	***NC GR I***	***M GR II***	***C GR III***
1	10	20	15	0,1	99,5	0,2
2	34	20	15	2,1	70,32	24
3	10	50	15	0,7	96	30
4	34	50	15	2,6	70,1	25
5	10	20	40	0,1	99	0,5
6	34	20	40	1,3	84,1	14
7	10	50	40	0,1	99,5	0,15
8	34	50	40	2,1	76,3	21,03
9	10	35	27,5	0,1	99,4	0,2
10	34	35	27,5	1,7	77	20,5
11	22	20	27,5	0,8	90	8,8
12	22	50	27,5	1,8	85,5	10,6
13	22	35	15	0,75	91,3	7
14	22	35	40	1,2	90,2	7,8
15	22	35	27,5	1,3	88,4	9,8
16	22	35	27,5	1,07	90,1	8
17	22	35	27,5	1,3	89,9	8,5

From experiments on laboratory made on separatorILES 1 was found that brass is in considerable quantities of material in mixed group In graphics in fig. 7.1; fig 7.2; fig 7.3 quantities of material can be seen separately by the voltage of the electrodes and cylinder speed reported in 3 different values of corona electrode angle.

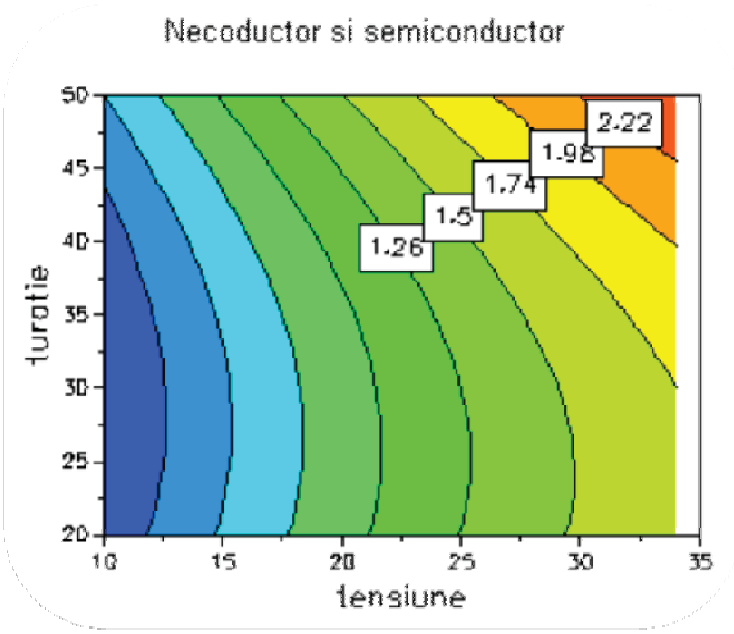

Fig 7.1 Selectivity of semiconductor and non-conductive material graphic according to the speed and voltage when ***α1 = 27,5 degrees*** ; α2 = 65 degrees; s1 = 55 mm; s2 = 55 mm

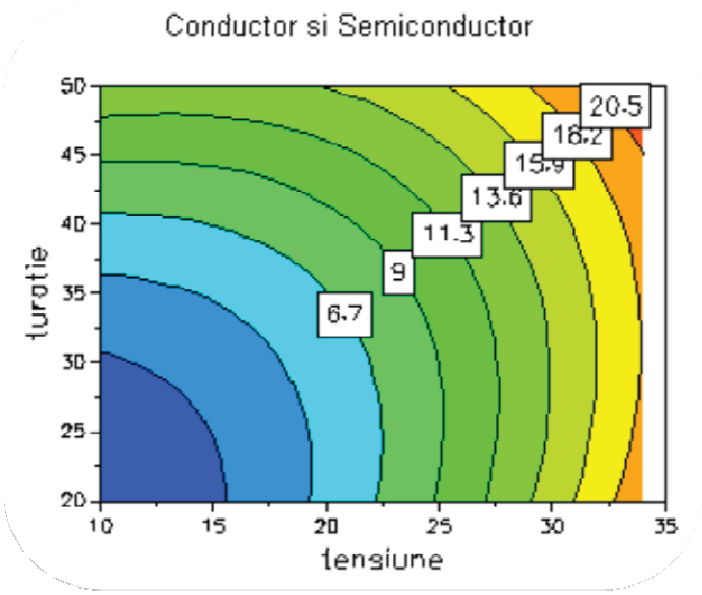

Fig.7 .3 Selectivity of conductor and semi-conductor material graphic according to speed and voltage when ***α1 = 27,5 degrees***; α2 = 65 degrees; s1 = 55 mm; s2 = 55 mm

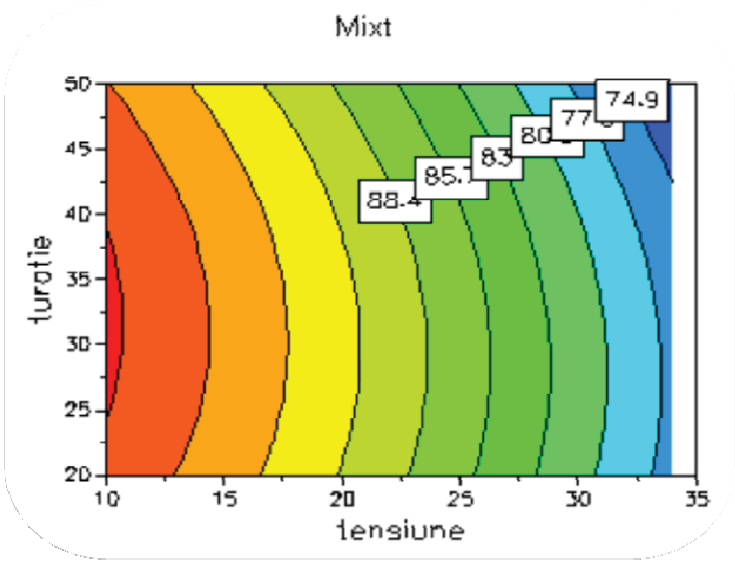

Fig.7.2 Fig. 5.2 Selectivity of mixed material graphic according to the speed and voltage when α1 = 27,5 degrees; α2 = 65 degrees; s1 = 55 mm; s2 = 55 mm

4. CONCLUSIONS

Separation in corona-electrostatic field on ILES 1 separator manages to extract brass from copper ashes mixture in small quantities as the mixture is composed mainly of zinc oxide and brass where the conductivity of both main components are close.

By changing the main parameters (U [KV] and n [rpm]) which influence the electroseparation in corona-electrostatic on ILES 1 separator process can be achieved a more efficient separation of brass from copper ashes mixture but with a with a lower purity due small difference of conductivity material particles relative to brass.

To increase purity brass research team will continue by using the installation with rotating cylinder surface separated from the ground.

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