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THE PROCESSING OF THE COPPER OXIDIC ASHES USING A MODERN TECHNOLOGY

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Abstract: In this paper, the metal used for the experiments is designed to obtain a brass category, according to STAS CuZn24 brand. Materials are everywhere in our lives, and industrial society has become extremely dependent on resources. Cu-Zn alloys are particularly intended for the casting production. The behaviour of the charge involves quick melting to limitate the slag and the refining to remove impurities like Fe, Mn and Al. For the alloying, we used zinc board brand R1, purity of 99,91%, at a quantity of 117,5 kg. The thermal balance calculated on the total quantity of metal produced was 2400 kg /charge, and the fuel consumption was about 228 kg. The aim of the paper was to study from a technological point a view, the processing of the cooper oxidic ashes, by a modern technological flow relative to the standard, which brings improvements, using a mixing system of the slag which can allow the complete reuse of copper oxidic ashes and to minimize the mechanical losses.
Keywords: cooper, ball-crusher, impurities, brasses

1. INTRODUCTION

Materials form the fabric of our present society; materials are everywhere in our lives, and life as we know it would be impossible without them. Industrial society has become extremely dependent on resources, as it produces more, builds an increasingly complex society and accumulates an incredible volume of resources[1]

Brasses are copper based alloys , where the main alloying addition is represented by zinc, and in special situations, in addition to copper and zinc, the brasses may also contain other elements. The spread of the brasses in industrial production, is higher, as compared to other cooper-based alloys. Cu-Zn alloys which contain in our composition, other alloying elements in addition to copper, are called special brasses and to specify their nature, are used designations like: silicon-brasses, manganesse-brasses, tin-brasses, brasses with lead and other categories. These alloys are particularly intended for the casting production. [2] The special brasses ranging, includes all copper and zinc special alloys, where can be added small amounts of silicon, aluminum, tin, lead, which improves their certain physical and chemical properties, especially machinability, hardness, mechanical strength and corrosion resistance.[3]

In recent years, the world is in a tendancy, to elaborate modern hydrometallurgical processes, environmentally friendly, non-conventional, of waste processing cooper alloys, which allow the recovery of the copper in the form of valuable products: cooper-powder, cathode cooper and cooper salts. The other elements presented like Zn,Pb,Sn,Ni,Si,Al and Fe, are separated in the form of recoverable intermediate products.[4]

2. METHODOLOGY

The obtained material from the ball-crusher, has the following characteristics:

bulk density: 2300-2400 kg / m^3; maximum grain: 75-100.

The general shape of the particles is rounded.

Impurities (%), from the weight of the processed material in the ball-crusher, are: rubber (0.2-0.4%), bricks (0.01-0.05%), iron slag, more than 5% iron and iron oxides (from 1,5 to 3.5%) and iron (2-5%). In table 1, is presented the general chemical composition of the main elements.

Table 1. General chemical composition of the main elements

Cu (%)	Zn (%)	Pb (%)	Sn(%)	Al(%)	Fe(%)	Ni(%)	Si(%)	Bi,Sb, As,Cd,P(%)
63-80	24-17	4-0.6	3-0.6	3-0.8	2-0.3	0,08-0.18	0.07-0.15	0.05

The complete processed material to obtain a 1000 kg/ load, is 1221 kg. The metal is intended to obtain a brass category, according to STAS CuZn24 brand, for the manufacture of radiators sheet, with the chemical composition shows in table 1.

The management of the charge involves three aspects:

- quickmelting for thelimitation of thegeneratedslag;
- therefining of the metal toremoveimpuritieslike Fe, Mn, Al;
- alloying, for bringing in a standard brand, as close as possibletotherefined metal.
- themost important technologyphase of theelaborationisthe metal refinerafterthe elaborate is complete.

Table 2 shows the composition of metal processing phases.

Table 2. Chemical composition of the metal

Chemical composition	Cu(%)	Pb(%)	Zn(%)	Si(%)	Sn(%)	Fe(%)	Mn(%)	Al(%)	Sb(%)
Processed rough slag	75.8	1.126	22.1	0.001	0.47	0.27	0.001	0.21	1.7
Melted metal	75.6	1.19	19.8	0.001	0.43	0.31	0.001	0.18	1.3
After refining	76.1	1.06	19.1	0.001	0.4	0.11	0.001	0.08	0.34
Alloying	74.5	0.93	23.8	0.001	0.36	0.1	0.001	0.08	0.22
STAS brand CuZn24	72-74	1	22-28	0.01	0.5	0.1	0.05	0.05	0.2

3. ANALYSES/ RESULTS

This paper aims was to study from a technological point a view, the processing of the cooper oxidic ashes, by a modern technological flow relative to the standard. Experiments were conducted in the graphite crucible furnace and the experimental installation is shown schematically in Figure 1.

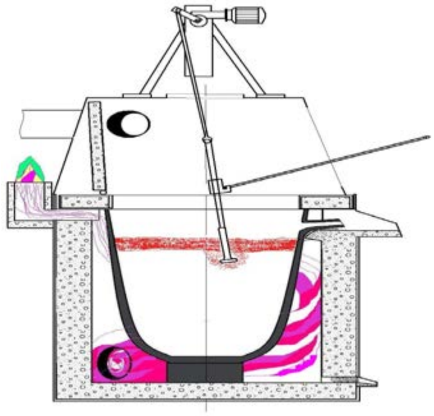

Figure 1. Graphite crucible furnace with a capacity of 2400 kg

The termic balance of the furnace and fuel consumption has the following features: The dimensions of the furnace:

Interior diameter: 1080mm; Outer diameter: 1620mm; Armor thickness: 15mm; Interior space height: 1480mm; Fuel consumption: CLU3 - 50-80kh / h; Wheel of the charge: 3.5 hours; Necessary preparation time: 0.5 hours; Time required for casting: 0.5 hours.

The necessary reagents for each element is:

4% Cu_2O⟶for ⟶1% Al; 4.5% Cu_2O⟶for ⟶1% Fe; 3% $CuCl_2$⟶for ⟶1% Fe;
2,8% NaCl⟶for ⟶1% Al; 3% Na_2CO_3⟶for ⟶1% Sb.

The amount of each element to be eliminated is:

$$\Delta Fe = 0.21\% \; ; \; \Delta Al = 0.13\% ; \; \Delta Sb = 1.5\% ; \; \Delta Pb = 0.26\%$$

The necessary reagents for removing the excess impurities from a charge of 2400 kg is:

The quantities of the regeants used are:

$$Cu_2O \cong 28.5Kg;\ CuCl_2 \cong 15kg; Na_2Co_3 = 100kg; Na_2Cl = 10.5Kg\ .$$

The complete quantity is: 182,38 ≅ 183kg.

The balance of the refining in the metallic liquid get: 23.5kg Cu. From the metallic liquid is eliminated: 34.08 kg.In the slag are passing the combinations of elements considered impurities which can react with the oxygen, Al and $Fe\colon 4.53kg$ Al_2O_3 and $6.17KgFeO$. The total oxides which are passing into the slag: 10,7kg oxides. In gases, are passing Sb and Pb in the quantity of:4,17kg $PbCl_2$.

The correction of the Zn alloy is only to cover the losses by volatilization. For the alloying , it can be used zinc board brand R1, purity of 99.91%, in a quantity of:117,5kg.

Heat balance calculated on the total quantity of metal produced: 2400kg/charge;

Fuel consumption: $\cong 228kg$; Heat entered:$Q_i = 1808.3 \cdot 10^3 kcal$; Outgoing heat:$Q_{useful}$–: Heat contained in elaborate brass, where:$Q_{useful} = 1507.2 \cdot 10^3 kcal$;.

The heat losted with flue gases is $12232 \cdot 10^3 kcal$. Heat losted with slag: $78.37 \cdot 10^3 kcal$;q_{dross} =2317kg. The heat losted through the walls of the furnace.

The values are aggreably with figure 2 : $q_e = 51313 kcal/m$ and $Q \cong 76 \cdot 10^3$

The configuration of the termic balance of the furnace at the elaboration of the charge of 2400 kg, is shown in table 3.

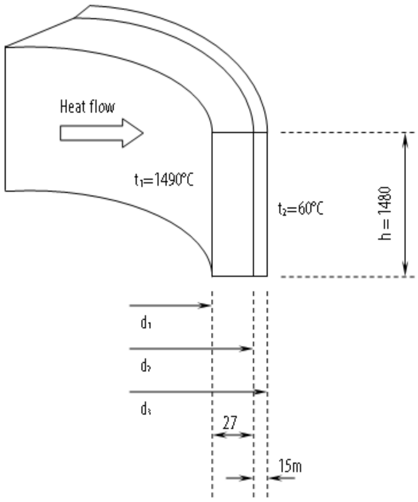

Figure 2. Sistem heat loss through walls furnace

The difference of the balance it is about 1,3%. The difference occurs due to calculation errors and measuring errors. The share of total useful heat is 83,3 %. the heat efficiency of the furnace balance. Productivity of the furnace : The cycle time of the second castings is about 4.5 hours. Normally, the furnace elaborates 2 to 3 charges per day, optimum is 3 charges.Technological productivity: 7,2 t/day

Table 3. The termic balance of the furnace

Heat trapped (kcal)		Outgoing heat (kcal)	
Q from the fuel combustion	$Q_{ica} = 1808.3 \cdot 10^3$	Q useful metal Q flue gas lost Q lost with slag Q lost throughthe wall	$Q_u = 1507.2 \cdot 10^3$ $Q_{pga} = 122.2 \cdot 10^3$ $Q_{dross} = 78.37 \cdot 10^3$ $Q_{pa} = 76 \cdot 10^3$
Totally	$Q_{ica} = 1808.3 \cdot 10^3$	Totally	$Q = 1783.4 \cdot 10^3$

4. CONCLUSIONS

The paper has proposed to study technologically processing copper oxidic ashes, on a flow that upgraded technology compared to standard technology brings the following improvements:

- magnetic separation and processing of the material processed by remelting alloys with an high iron content;
- melting in graphite crucible furnace and mixing system using molten metal slag throughout the elaboration of the charge. This feature allows the reuse of copper oxidic ashes and to minimize the mechanical losses in dross brass alloy. The reduction in specific fuel consumption due to higher thermal efficiency of this type of furnace in comparation with the furnace rotative flame;
- the manual separation of the impurity of tin, aluminum, lead, which allows obtaining alloys with low levels of impurities.

References:

[1.] ERNST WORRELL, MARKUS A. REUTER, “Recycling: a key factor for resource efficiency”, Copernicus institute of sustainable development, Handbook of recycling, 2014

[2.] Technical Metallurgical Manual, Volume 1

[3.] PETRE DANILA, MARIA DANILA, “,Useful Mineral Series "Technical publishing, Bucharest, 1982

[4.] RODICA ROMAN, MARIANA ZSIGMOND, MIHAI BUTU, „Valorisation of by-products of extractive metallurgy of copper and copper based metal scrap”, Printech Press, Bucharest,2004