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The Results of the Brass Refining Process in the Reducer Conditions

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Abstract

This article contains information concerning of the analysis the possibility of defining refinery qualities of the slag based thermo-physical and thermo-dynamical data. It was showed the brass refining with the many-carbide reagents introduced in to the slag. The paper presents the results of the structure analysis of the brass after carbide slag refining in the industrial conditions. The results of the macrostructure analysis have confirmed the argument on high reducing effectiveness of manganese and aluminium carbide used during CuZn39Pb2 alloy melting. The X-Ray microanalysis of the ingot cross-section has shown considerable discrepancies in the disposition of the inclusions. This effects showed on the great influence of reduction melting condition in to the brass melting.

Keywords: Refining, Cooper alloys, Reduction conductions

1. Introduction

It proves that there is a big discrepancy in the opinions on the structure and the basic features of slag as well as the essence of their interaction with refined brass. There are three methods of slag refining in the copper alloys melting conditions [1-14]: the oxidising , the neutral and the alternative method of melting copper and its alloys in conditions of reduction with an activator introduced into the slag. An alternative for that methods is gas-slag refining [10] in where the concentration of impurities extracted by the slag is obtained. Most of the experiments have shown that in this way is possible to achieve optimum economic and technological results. On the basis of the analysis of the problem and the results of the author's research [1,6,7,14] it is stated that the most promising are the reducing conditions of refining, a special in to the Carbo-N-Ox method [1]. During the crystallization of brass alloys non-metallic inclusions give off in them [11-14]. The presence of melt inclusions waste materials. In them are the elements (nickel, Silicon, iron, Tin, chrome) forming in brass separation. In the work the authors wish to show what the importance of reducing the melting conditions is applied during the refining of brass alloys.

2. Analysis of problem

According to molecular theory figure such determines in solution carbides. The form of carbon as ion $[C^{2-}]$ it is however difficult acceptable, because element this having the building $1s^2 2 s^2 2p^2$ can create in solutions following ions mainly:

$$[C^-] \rightarrow [C^{2+}] + 3e \quad (1)$$
$$\text{or} \quad \rightarrow [C^{4+}] + 5e \quad (2)$$

Little probable are yet ion arrangements $\{C^+\} + 2e \rightarrow \langle C \rangle + 1e$ or $\rightarrow \{C^{4-}\} - 3e$. The latter possibility is inadmissible in slag because carbon would have to appear in configuration of helium. However the course of last reaction is the description of forming to soot black, there are observed on surface of crucible near mirror of refined metal, near at hand. Such figure of carbon can influence spot the atmospheres of fusion exclusively. In consequence after carbon dissolution in including oxygen alloy is possible setting reaction:

$$[C] + [O] = (CO) \qquad (3)$$

It taking into account reactions 1 and 2, the figure of oxygen ions was put in to the liquid metals how $[O^{4+}]$ as well as $[O^{-}]$ [9]. It the possibility of setting reaction was put additionally (3). Because carbon (how in reaction 3) in solution of copper alloys come from carbides of alloy additions (mainly M'C), it can the total figure of ion reactions of carbon monoxides formation have figure:

$$[M'C] + [O] = [M'] + (CO) + 2e \qquad (4)$$

With introduced reactions (3) and (4) it is possible to bring in, that possible is forming gas blisters - (CO). They can be one of main causes of casts porosity. It thermo-dynamical analyses' [8] for collected in table 1 carbides (the most popular in to the metallurgy) were moved from select oxides of brass component (tab.2). Thermodynamic analysis (tables 1 and 2) show that for the melting conditions of copper alloys with zinc and lead the best reduction effects will occur for aluminium Carbide.

Table 1.
The thermodynamic analysis of the carbides possible, according the dates from [8]

Element		Carbide		Gibbs Energy	ΔG_T^o [J/mol]	
.	T_{melt}[K]		T_{melt} [K]	$\Delta G_T^o = f(T)$	1200, [K]	1500, [K]
Al	933	Al_3C_2	1700	$\Delta G^o = -63330 + 22,7 \cdot T$	-35700	-33900
		Al_4C_3	2000	$\Delta G^o = -21200 + 7,7 \cdot T$	-14039	-11729
Ca	1112	CaC_2	2570	$\Delta G^o = -14400 - 6,3 \cdot T$	-22100	-22900
Mn	1517	Mn_3C	1300	$\Delta G^o = -3330 - 0,26 \cdot T$	-3572	-3649,8
		Mn_7C_3	1600	$\Delta G^o = -30500 + 5,0 \cdot T$	-25850	-24350
Si	1685	SiC	1800	$\Delta G^o = -17460 + 1,83 \cdot T$	-15758	-15209

Table 2.
The thermodynamic analysis of the possible reactions the cooper alloys component oxides with the carbide

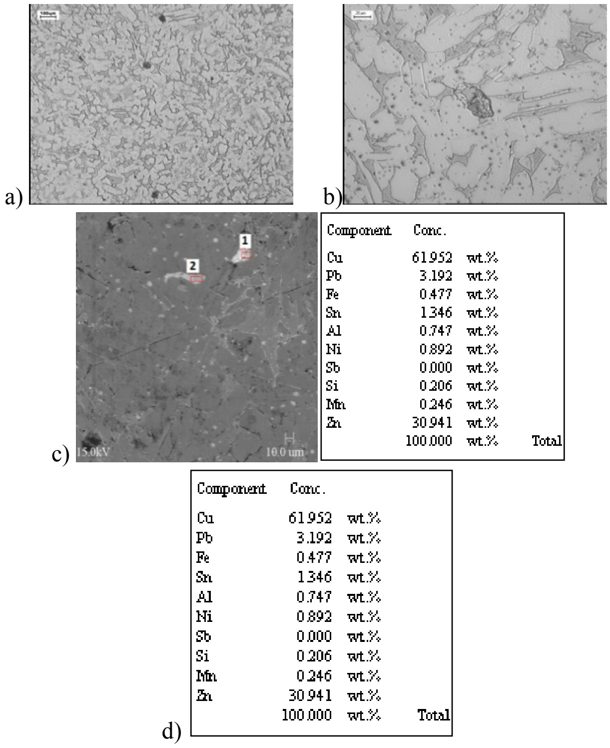
No	Equation of reaction	Calculated Value ΔG_T^o [J/mol]	
		1200 K	1500 K
1	$9ZnO + Al_4C_3 \rightarrow 9Zn + 2Al_2C_3 + 3CO$	-880	-1165
2	$2ZnO + CaC_2 \rightarrow 2Zn + CaO + 2CO$	-380	-495
3	$10ZnO + Mn_7C_3 \rightarrow 10Zn + 7MnO + 3CO$	-275	-655
4	$3ZnO + SiC \rightarrow 3Zn + SiO_2 + CO$	-165	-225
5	$9PbO + Al_4C_3 \rightarrow 9Pb + 2Al_2C_3 + CO$	-1045	—
6	$2PbO + CaC_2 \rightarrow 2Pb + CaO + 2CO$	-660	—
7	$10PbO + Mn_7C_3 \rightarrow 10Pb + 7MnO + 3CO$	-1455	—
8	$3PbO + SiC \rightarrow 3Pb + SiO_2 + CO$	-465	—

3. The brass melting

User the possibility of filtration of database [9] the slag constitution (tab. 3) with 40% addition of reagent has been applied in metallurgical and foundry conduction. There are used for kind of reagent: R1 with CaC_2 and C, R2 with Al + CaC_2 + C, R3 with Al_4C_3 and R4 with Mn_7C_3. The alloy CuZn39Pb2, in Poland as M059, melted in the induction crucible furnace with the capacity of 800 kg. The table 4 compiles the obtained properties of the alloy which has been casted as the ingot.

Table 3.
Slagcomposition

Slag (Z) wt.%				
Al_2O_3	Na_2CO_3	$Na_3B_5O_7$	SiO_2	Reactionstymulators
15	25	12	40	8



c)

Component	Conc.	
Cu	61.952	wt.%
Pb	3.192	wt.%
Fe	0.477	wt.%
Sn	1.346	wt.%
Al	0.747	wt.%
Ni	0.892	wt.%
Sb	0.000	wt.%
Si	0.206	wt.%
Mn	0.246	wt.%
Zn	30.941	wt.%
	100.000	wt.% Total

d)

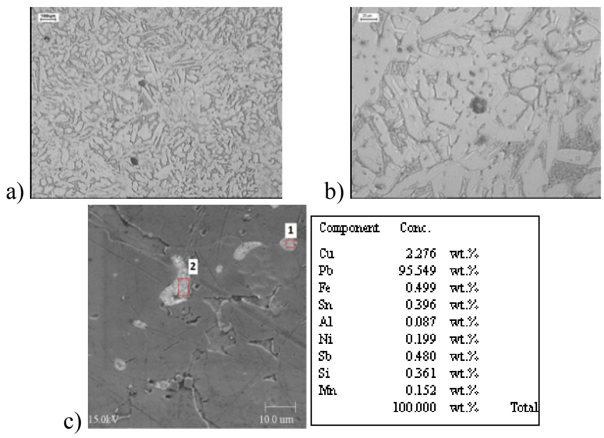
Component	Conc.	
Cu	61.952	wt.%
Pb	3.192	wt.%
Fe	0.477	wt.%
Sn	1.346	wt.%
Al	0.747	wt.%
Ni	0.892	wt.%
Sb	0.000	wt.%
Si	0.206	wt.%
Mn	0.246	wt.%
Zn	30.941	wt.%
	100.000	wt.% Total

Fig. 1. The microstructure of the CuZn39Pb2 ingot after slag Z+R1(CaC_2 and C) where: a) 100x – [14], b)500x – [14], c) chemical results of the field 1, d) chemical results of the field 2

Table 4.
The properties of the CuZn39Pb2 (MO59) brass

	Rm Mpa	A5 %	$*P_o$ %
Z+R1 **	385	15,7	1,5
Z+R2**	396	13,2	1,3
Z+R3	392	13,0	1,1
Z+R4	390	14,0	1,1

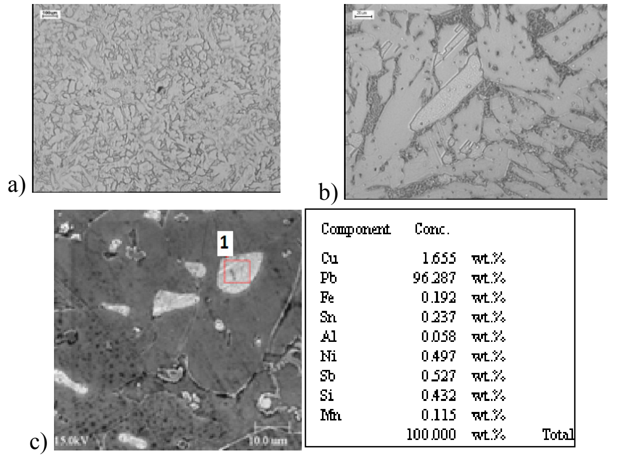
* porosity , ** - published [14]



c)

Component	Conc.	
Cu	2.276	wt.%
Pb	95.549	wt.%
Fe	0.499	wt.%
Sn	0.396	wt.%
Al	0.087	wt.%
Ni	0.199	wt.%
Sb	0.480	wt.%
Si	0.361	wt.%
Mn	0.152	wt.%
	100.000	wt.% Total

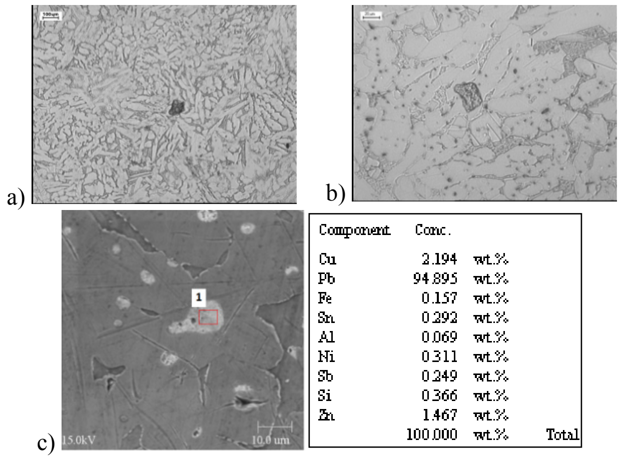
Fig. 2. The microstructure of the CuZn39Pb2 ingot after slag Z+R2 (with Al+CaC_2+C)) where: a) 100x – [14], b)500x – [14], c) chemical results of the field 2, (field 1 as on the fig. 1c)



c)

Component	Conc.	
Cu	1.655	wt.%
Pb	96.287	wt.%
Fe	0.192	wt.%
Sn	0.237	wt.%
Al	0.058	wt.%
Ni	0.497	wt.%
Sb	0.527	wt.%
Si	0.432	wt.%
Mn	0.115	wt.%
	100.000	wt.% Total

Fig. 3. The microstructure of the CuZn39Pb2 ingot after slag Z+R3 (Al_4C_3)) where: a) 100x, b)500x, c) chemical results of the field 1



c)

Component	Conc.	
Cu	2.194	wt.%
Pb	94.895	wt.%
Fe	0.157	wt.%
Sn	0.292	wt.%
Al	0.069	wt.%
Ni	0.311	wt.%
Sb	0.249	wt.%
Si	0.366	wt.%
Zn	1.467	wt.%
	100.000	wt.% Total

Fig. 4. The microstructure of the CuZn39Pb2 ingot after slag Z+R2 (with Mn_7C_3) where: a) 100x, b)500x, , c) chemical results of the field 1

Apart from high quality brass a considerable reduction of melting losses was also observed (Fig.1-4).The best results were obtained in structural for manganese carbideMn_7C_3.The experiments on CuZn39Pb2 brass melting proved that optimum is achieved while using technical carbide with to the carbon and aluminum carbide Al_4C_3. A refiner of commercial name RZX was patented and introduced to foundry and scrap processing industry. This assented as a confirmation of the following foundations that reduction conductions should be chosen on copper alloys deliberately but the essential emphasis should be put on properly elaborated factors of multistage reaction.

4. Conclusions

The experiments on brass melting with the activity slag refining with calcium, aluminum and manganese carbide and carbon as the complex reagent showed that the reducers of this kind not only make it possible to keep a constant deficit of impurities in the slag layer but also let carbon in the melting atmosphere. There has been described that during brass melting the most important flow on the structure and tendency of the mechanical properties the art of the refining processes, and in that slag reducer were.

A considerable intensifying of the reduction processes have very great influence on the structure CuZn39Pb2 alloy. As a reactant in the partial divisions of non-metallic carbide were different elements. The X-Ray microanalysis of the ingot cross-section has shown considerable discrepancies in the disposition of the inclusions. The dispositions of Fe, Ni and Sb have turned to be the most important. The inter-metallic phases appear in the following order: Mn, Fe, Co, Ni, Cu, which is confirmed by the bibliography.

For stronger reagents as Al_4C_3 and Mn_7C_3 carbides not observed partial divisions containing of tin and nickel. However the alloys in accordance with the technology presented have very good properties, flowing power and degree of fineness structure homogeneity and little loss in melting. The described observations are extremely important because they explain the process of forming of the products of the reaction taking place in the interfacial surface of the copper alloys – carbide slag, in thus the most important on the effectiveness extraction process are role of the carbon, as well $\{C^{2+}\}$ and $\{C^{4+}\}$ ions from actives carbides reagents.

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