ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XIV, NR. 1, 2007, ISSN 1453 - 7397

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The Influence of Metallic and Non-Metallic Inclusions on the Characteristics of Non-Ferrous Alloys Al-Si

This paper presents on experimental study which highlights the influence of metallic and non-metallic inclusions on the mechanical characteristics of, AlSi12 and AlSi10Mg alloys.

1. Introduction

Alpax are widely used in foundries due to their good casting properties also for their superior physical mechanical characteristics. Silicon gives to the alpax resistance to corrosion which permits their use to cast the less requested pieces which function in a corrosive environment. Because they do not suffer changes in solid state, cast in pieces are used for thermal treatment, the improvement of mechanical and technological characteristics being realized by their alliance with Cu, Mg, Mn, Ni, etc.

The physical mechanical properties of alpax are influenced by the inter-metallic components and the chemical phases which can be formed between aluminium, silicon and the chemical elements which come from the metallic load or are introduced willingly in the accompanying melt.

The study of the influence of metallic and non-metallic inclusions on the Al-Si alloys characteristics, this was realized on AlSi 12 and AlSi10Mg alloys, which were elaborated in a graphite crucible of induction furnace with low frequency (50 Hz) with content by volume of 400 kg, this ensuring small losses through furnace processing the alloying elements and the production of metallic materials having superior properties.

The influences of accompanying chemical elements which are part of the alloys chemical composition and which represent the subject of the research are manifested in several ways.

Thus, the iron, present as an impurity in alpax, leads to the reduction of the plasticity of these ones, worsening the mechanical properties. Magnesium, copper, zinc and manganese, elements which come from the metallic charge, contribute to the increase of mechanical characteristics of alpax, but diminishing their casting properties.

Titanium, used as a modifying agent, dresses the grain, improving the mechanical characteristics of the moulded/ cast piece. The simultaneous presence of copper, iron, manganese and titanium improves the machinability of Al-Si alloys, these being appropriate to chill or temporary mould casting of compounds.

2. Experimental results

As a result of the experimental study realized on the aluminium AlSi12 and AlSi10Mg alloys, we can analyze the influence of the chemical composition on the mechanical properties of the cast alloy. As a result of the performed chemical analysis of cast test bars, the chemical composition presented in table 1 was carried out.

The chemical composition of aluminium alloys [%] **Table 1**

The alloy mark	Charge no.	Si	Fe	Cu	Mn	Mg	Zn	Al
EN AC-AlSi12	1	11,1	0,58	0,01	0,33	<0,0005	0,01	Rest
EN AC-AlSi12	2	11,4	0,60	0,01	0,34	<0.0005	0,01	Rest
EN AC-AlSi10Mg	1	10,0	0,41	0,04	0,44	0,37	0,01	Rest
EN AC-AlSi10Mg	2	10,4	0,57	0,02	0,66	0,34	0,03	Rest

In Table 2 there are presented the results of the mechanical tests of these ones.

The mechanical properties of the rough cast alloy of aluminium alloys **Table 2**

The alloy mark	Charge no.	R_m [Mpa]	$Rp_{0,2}$ [MPa]	A_{50min} [%]	Brinell hardness [HBS]
EN AC - AlSi12	1	178;191;165	114;140;114	9;10;7	62,4;62,4;62,4
EN AC - AlSi12	2	165;165;171	82;127;101	9;9,2;6	56,8;56,8;56,8
EN AC-AlSi10Mg	1	229;276;254	165;216;203	2,5;3;4	92,6;92,6;82,5
EN AC-AlSi10Mg	2	230; 248;262	172;185;178	2,5;2;2,5	94,6;95,4;94,6

Resistance to traction (R_m), the flow limit ($R_{p0,2}$), extension/elongation (A_{50min}) and hardness (HBS) obtained for AlSi12 and AlSi10Mg alpax are represented graphically in Figure 1 (a and b), Figure 2 (a and b), Figure 3 (a and b) and Figure 4 (a and b).

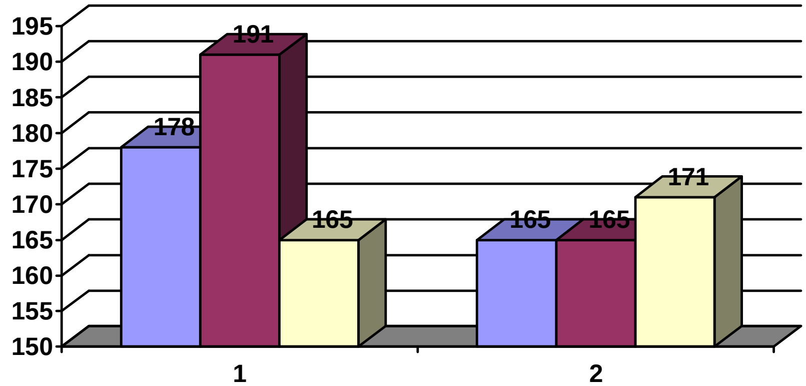

Figure 1.a. The tensile strengh, R_m of non-ferrous alloy, EN AC – AlSi12

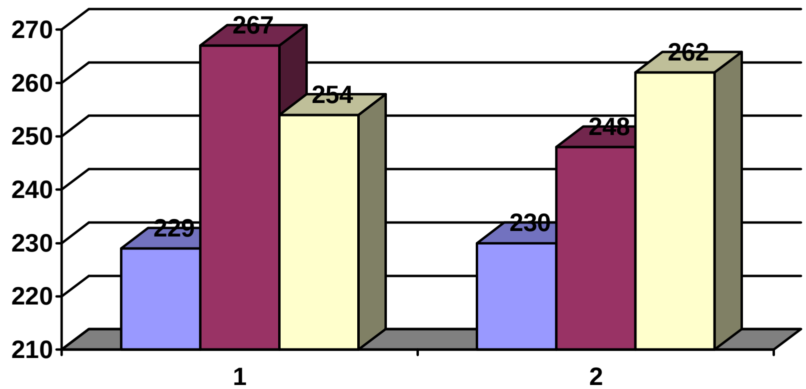

Figure 1.b. The tensile strengh, R_m of non-ferrous alloy, EN AC – AlSi10Mg

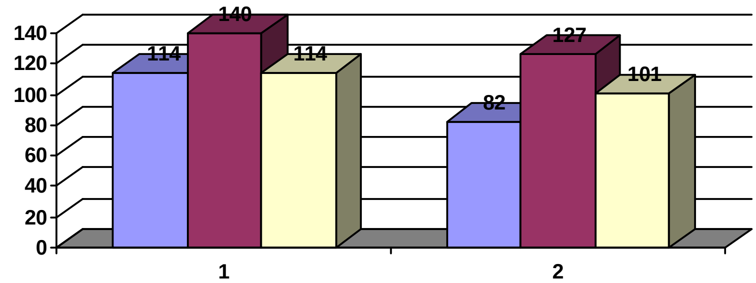

Figure 2.a. The 0,2% proof stress, $R_{p\,0,2}$ of non-ferrous alloy EN AC – AlSi12

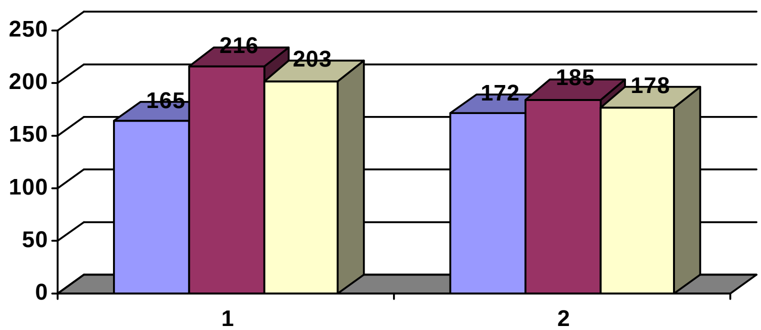

Figure 2.b. The 0,2% proof stress, $R_{p\,0,2}$ of non-ferrous alloy EN AC – AlSi12

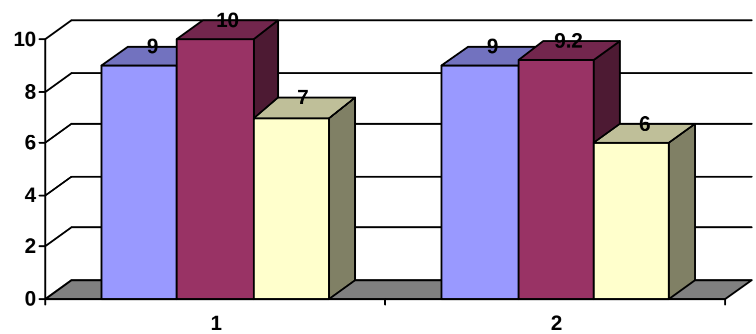

Figure 3.a. The elongation, A_{50min} of non-ferrous alloy EN AC – AlSi12

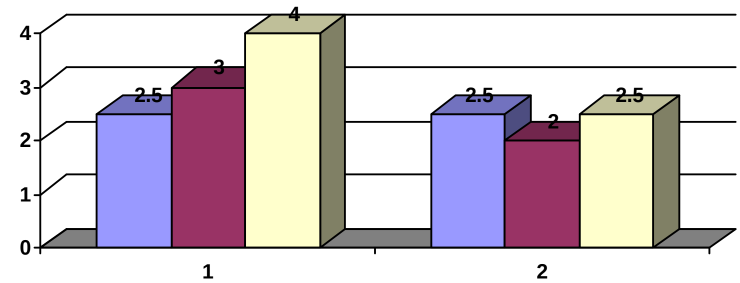

Figure 3.b. The elongation, $A_{50\ min}$ of non- ferrous alloy EN AC – AlSi10Mg

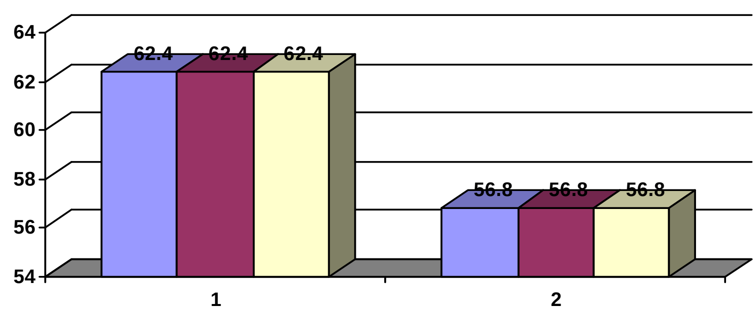

Figure 4.a. The typical hardness of non-ferrous alloy EN AC – AlSi12

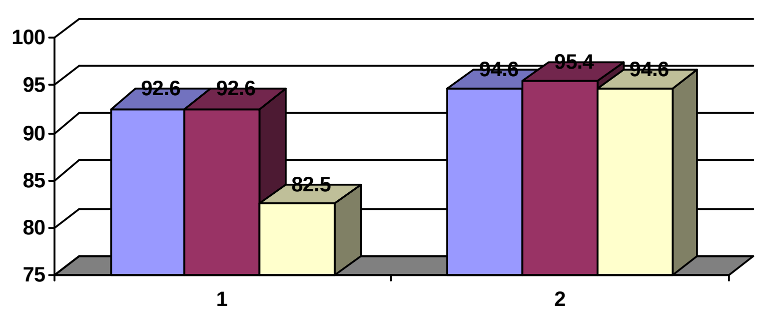

Figure 4.b. The typical hardness of non-ferrous alloy EN AC – AlSi12

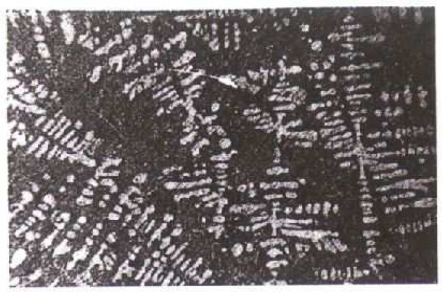

Figure 5.a. The metallographic structure of EN AC – AlSi12 (100:1) (charge 1)

Figure 5.b. The metallographic structure of EN AC – AlSi12 (200:1) (charge 1)

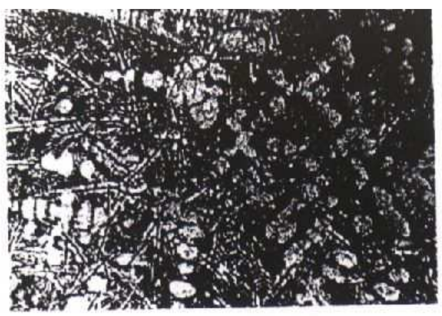

Figure 6.a. The metallographic structure of EN AC – AlSi12 (100:1) (charge 2)

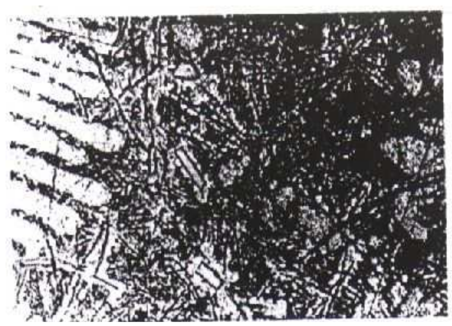

Figure 6.b. The metallographic structure of EN AC – AlSi12 (200:1) (charge 2)

Figure 7. The metallographic structure of EN AC – AlSi10Mg (100:1) (charge 1)

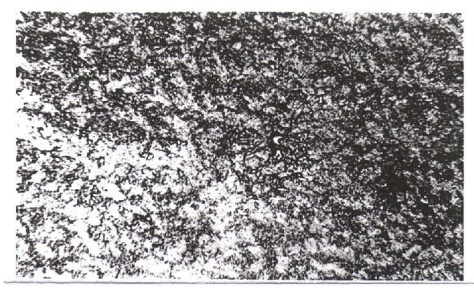

Figure 8. The metallographic structure of EN AC – AlSi10Mg (100:1) (charge 2)

Conclusions

As a result of the analysis of metallographic structures obtained of Al-Si alloys, we can make the following concluding observations:

- In the two Al-Si charges, we observe basic/primary dendritic aluminium crystals, on an eutectic background (Al+Si), but having different shapes for each batch. Thus, if in the first batch the eutectic presents a fine grain, in the second batch, we can observe some acicular and polyhedral eutectic shapes. In the second batch, this eutectic shape can be determined by a little bit bigger contents of iron and manganese and even of silicon than in the first batch.
- The dendritic shape of the basic/primary aluminium can be attributed to the unmodified alloy.
- In the two charges of A non-ferrous alloy AlSi10Mg, we observe the same structural differences as in the previous case. In the first AlSi10Mg charge, the aluminium crystals have a dendritic orientation and a point eutectic (Al+Si) which supposes using the Navac modification of the respective alloy developed with a maximum efficiency. In the second charge, even if the modification had a similar effect as in the first charge, the small differences of manganese and silicon contents led to the separation into chinese letters of the Mg_2Si compound.
- Related to the structural metallographic aspects obtained in the four studied charges of non-ferrous alloy Al-Si, the mechanical properties obtained are in correlation with the structure.
- Even if the values of the obtained mechanical tests are clearly superior to those provided by the European standards, they present some differences.

Thus, the first charge of non-ferrous alloy Al-Si12 presents, however, bigger values than those of the second charge. We have the same case for the situation of mechanical properties for non-ferrous alloys AlSi10Mg.

In the end, we can conclude that both the metallographic structure and the mechanical properties of the non-ferrous alloys Al-Si are strongly influenced by the modification effect as well as by the chemical elements contents and by the impurity contents, respectively.

The results analyzed being obtained on some charges of non-ferrous alloys Al-Si strongly controlled during the elaboration, respecting all the technical and technological conditions self-imposed by the conditions of obtaining some non-ferrous alloys cast in superior quality pieces highlighted, however, the theme of study initiated by this paper.

References:

[1] Ienciu M., Moldovan P., Panait N., Buzatu M. *The smelting and casting of special non-ferrous alloys*, E.D.P.,Bucureşti, 1985, 135-140.
[2] Ienciu M., Moldovan P., Panait N., Groz I., Buzatu M., Marinescu D. *The ellaboration and casting of non-ferrous alloys*, E.D.P.,Bucureşti, 1982, 255.
[3] Şontea S., Vlădoi M., Zaharia N. *Metals and foundry non-ferrous alloys*, Ed. Scrisul românesc, Craiova, 1981, 296.

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