Influence of the treatments on the behavior and the damage in tensile and with the shock of the recovery alloy AlSi12: application to the recycling of waste

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Abstract

This study aims to determine the influence of the chemical composition of industrial sand casting and metal shell cast by gravity at room temperature or under pressure both mechanical and manual metal parts for the various achievements SNVI (Aluminum Foundry Unit Rouiba) and ENEL (Unit engine Freha in Tizi-Ouzou) Algeria and heat treatments on mechanical behavior of fracture, quasi-static axial tensile united, Brinell hardness, almost dynamic resilience and microstructure of the alloy foundry chemical designation AlSi12 and digital 44000, The addition of 12% silicon and magnesium percentage (0, 1% Mg) in aluminum are the principal agents of the improvement of mechanical properties in addition to specific heat treatments which show different types of precipitates that hinder the movement of dislocations.

Keywords: Al-Si, sand, shell, maturation, income, mechanical properties

1 Introduction

The physical characterization, chemical and general engineering in particular is crucial for the design of various metal parts subject to external forces varied constituents various mechanisms in motion a mechanical component. The designer can neither calculate nor resize these parts without identifying and quantifying their characteristics. To determine them, we reproduce these solicitations using static and dynamic tests, usually conducted on standard specimens.
The alloy AlSi12, which governs our study, is a shade containing some magnesium added in small amounts (0, 05 to 0, 10) % Mg alloy to allow hardening and efficient use in applications with high mechanical properties in T46 condition. This alloy contains 12low volumetric contraction during solidification, reduction of withdrawal to the solid state and the expansion coefficient.). It is used for complex shapes, to requirements of mechanical strength and maximum thicknesses which are very low ($\sim 3mm$).

2 Problematic

The unalloyed aluminum with mechanical properties very reduced, leading to add two items of very low density with 13% silicon and traces of magnesium less than 1% ($\leq$ 0, 1% Mg) which is the lightest of all metals capable of stable industrial employment to improve their properties and obtain an alloy AlSi12 super lightweight. The alloy foundry ultimate AlSi12 governing our study is an alloy with a set of properties that in many circumstances make it an irreplaceable material. Among these include the addition of a high percentage of silicon and a low percentage of magnesium to aluminum as the main potential agents of improvement largely mechanical properties, low density ($\sim$ 26) results in equal volumes of documents about three times less severe than if they were made of steel or copper, combined with very good corrosion resistance and low melting temperature (660 C) facilitating its development in all casting processes. These alloying elements come into solution and may also be present as intermetallic phases. The composition of these phases, but above all their delicacy, their distribution, their consistency vis-Гґ-vis the aluminum matrix, their frailties, their stability as a function of heat treatments are also decisive for the properties of the alloy.

3 Elaboration of alloy studied

3.1 Casting

The melting of the metal takes place in a gas oven production, to tilting of the front to back, comprising a graphite crucible with a load capacity 350Kg is composed of approximately $\approx$ 50% in ingots new AlSi12 of standard dimensions, composition and specified characteristics., delivered by the French company Pechiney and a mixture of jet casting $\approx$ 50% return (appendages supply, drainage, control, defective parts and scrap).
To seek to increase over the characteristics of resistance to state F and obtain substantially large elastic stresses, the stiffness of large modules with small deformations, the material of 44000 numerical designation is subject to specific treatments T46.

3.2 Molding

a Sand: This mold has two halves by the footprints in the sand packed model.

b Shell: In this mode of molding, the mold consists of two steel yokes (5% chromium), which is responsible for maintaining the tracks. These caps, separated by a parting line, possibly to be prepared and heated to a temperature (200div 300)° C. After analysis, the samples cast in sand and metal shell by gravitation have the following chemical composition:

Chemical elements	Fe	Fe	Mg	Mn
% according to analysis	0.64	12	0.08	0.31

Table.1. Results of chemical analysis after control samples cast in sand and shell. This alloy is prepared by two different methods: sand casting and shell casting, considering 05 states, F, T, M0h, M6h and M12h.

4 Experimental procedure

To determine the behavior of the material deal with various stresses it may encounter during use, these solicitations are reproduced using static or dynamic tests, usually conducted on standard specimens in order to know the characteristics Figures of the material. Four techniques are used, namely traction to identify the various constraints, the Brinell hardness HB for the stress field, resilience Kcv us about the mode of fracture, fragility and resistance to shock and metallographic to identify structures.
The specimens are divided into 05 identical batches each consisting of 05 tensile specimens, 05 specimens of resilience and 02 samples for each mode and casting (sand noted: S and shell noted: K). The 1st batch noted: F - crude of casting, - the 2nd lot is designated: T - hardened condition, - the 3rd, 4rd and 5rd batch are rated: M0h, M6h and M12h - maturation time. We will describe in more detail and present in the main mechanical characteristics obtained from the chemical composition of material being AlSi12 purpose of this study.

5 Results obtained and discussion

The mean values вЃКвЃКof tensile mechanical properties, toughness and hardness of the alloy AlSi12 are those given by averaging five identical specimens for each of the respective cases and are represented in Figures 1 to 3 below.
Influence of molding processes in the sand and in the shell for alloy AlSi12 on the characteristics in

5.1 Resistances

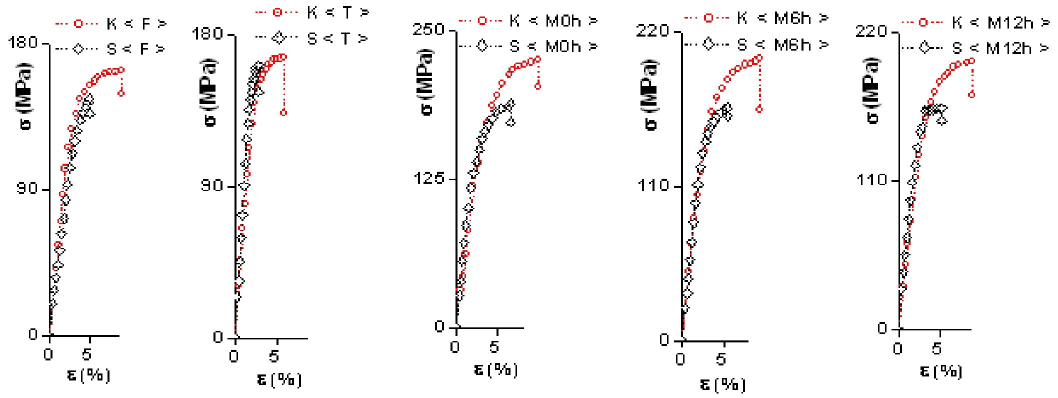


Figure1. Grouping of the mean curves of comparison (mean stress - deformation) of the AlSi12 alloy casted in sand and in shell: a - $K < F > /S < F >, b - K < T > /S < T >, c - K < M0h > /S < M0h >, d - K < M6h > /S < M6h >$ and $e - K < M12h > /S < M12h >$.

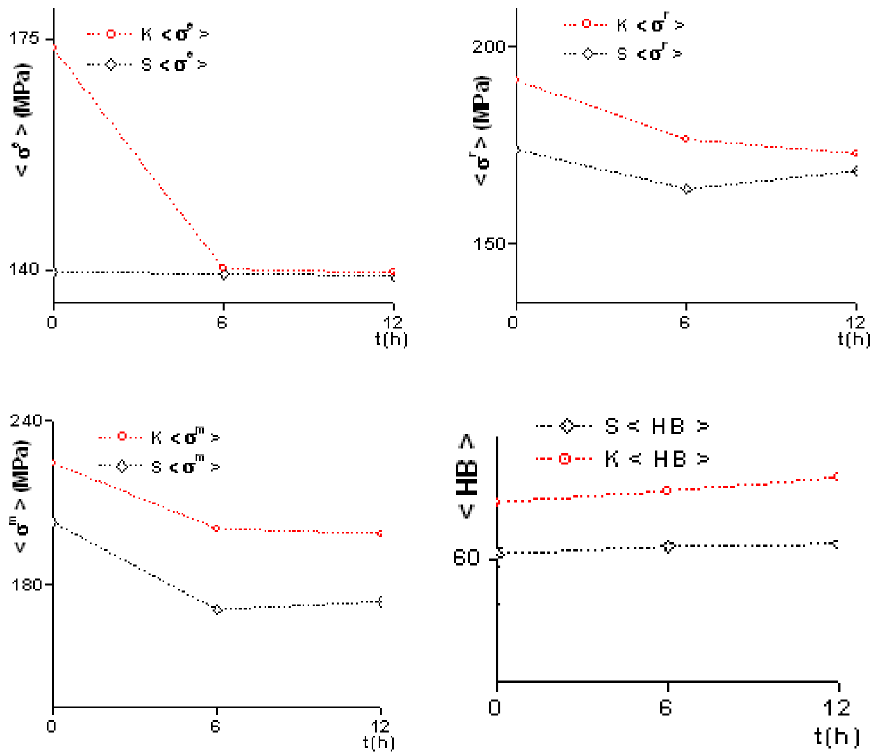
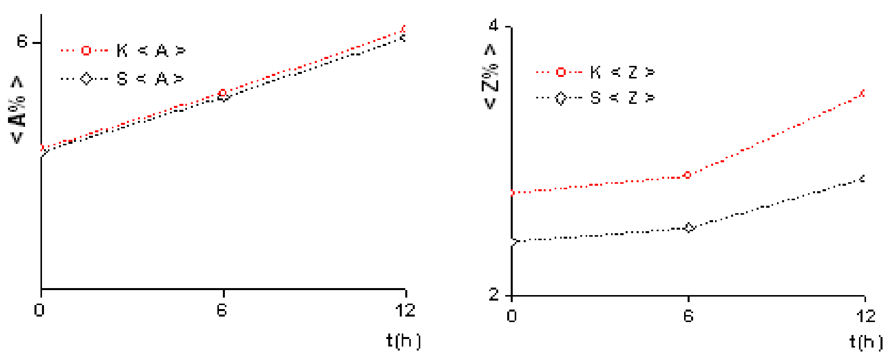


Figure2. Grouping of the mean Graphs of comparison (mean stress and mean hardness - states) of the AlSi12 alloy casted in sand and in shell:$a - K < e > /S < e >$,$b - K < r > /S < r >, c - K < m > /S < m >$ and $d - K < HB > /S < HB >$.
Discussion The results of these comparative studies show that all curves and all graphs of the shell casting are above those of the sand casting, whatever of the states considered. In addition to the increase in mean values вГКвГКof the characteristics of resistance is he state F to the T state, reaching its maximum value to the state M0h, then decrease to the states and M6H M12h whatever the two modes of elaboration at the expense of ductility, and this is probably due on the one hand, the mode for cooling the molds, on the other hand the addition of alloying elements combined with structural hardening treatment by precipitation.

5.2 Ductility



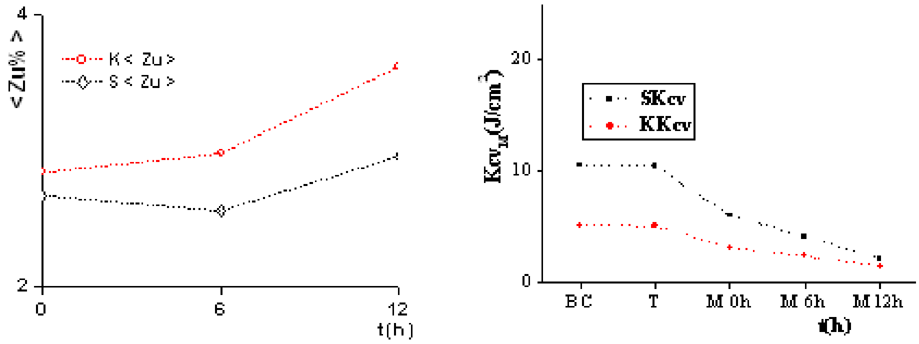


Figure3. Grouping of the mean Graphs of comparison (mean elongation, mean Coefficient and elongation of necking and mean resilience - states) of the AlSi12 alloy casted in sand and in shell $a - K < A > /S < A >, b - K < Z > /S < Z >$ $, c - K < Zu > /S < Zu >$ and $d - K < Kcv > /S < Kcv >$.

Discussion: we see that all curves of sand casting are above those of the shell casting whatever of the states considered. In addition to the increase in mean values of ductility characteristics is the state M0h that of M6h to reach its maximum value at state M12h regardless of the two modes of elaboration to the detriment of the characteristics of resistance.

Notation: $< m >$(MPa) - mean maximum stress(Mega Pascal) ,$< e >$(MPa) - mean elastic stress(Mega Pascal) , $< r >$(MPa) - mean breaking stress(Mega Pascal), Ox (%) - deformation (%), < HB > - mean hardness Brinell HB, < A% > - mean elongation (%), < Z% > - mean Coefficient of necking(%) and < Zu % > - mean elongation of necking(%), F - crude of casting, T - Brhardened, M0h, M6h and M12h - maturation 0h, 6h and 12h, S - Sand and K - shell.

6 Conclusion

The analysis of experimental results show that the best compromise is the method of shell casting followed by maturation of 0 hours (M0h) regardless of the states considered. To meet manufacturers' requirements for a rational use of this material in various mechanisms subjected to mechanical stresses, it is best to develop the different parts for the use of different natures in metallic shells followed by maturation of 0h for spare resistance and inversely.

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