THE CORRELATION BETWEEN MECHANICAL CHARACTERISTICS AND TECHNOLOGICAL PARAMETERS IN HEAT TREATMENTS APPLIED TO MOULDING ALUMINIUM LIKE ATSi5Cu1

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ABSTRACT

The paper contains an experimental study of colligating the technological parameters of the artificial aging operation namely time and soaking temperature with hardness and mechanical strength properties gained after the treatment. The tests were made on a moulding aluminum alloy like ATSi5Cu1 by using moulded test bars in metallic shell. There were realized metallographic photographs and strength tests.

KEYWORDS: aging, aluminum alloy, solution quenching, strength tests

1. Introduction

Solution heat treatment is used to alloys that present a solubility variation in solid state and have a biphasic structure before treated α + precipitate (biphasic structures are fragile, they don't plastically deform). The treatment consists in total or partial dissolve of the precipitate followed by a blast cooling to maintain the monophasic structure that gives the material a better workability through plastic proceedings.

Partial solution quenching apply to the alloys that have secondary precipitates and primary precipitates; through dissolving the secondary ones the solution heat-treated material become softer and easier to machine.

Aluminum alloys that accept solution heat treatment is grouped in two categories:

I – alloy without eutectic, deformable

II – alloy with eutectic, alloy for pieces casting

The main structural characteristic of aluminum alloys is the presence of some complex eutectics within a matrix of α solid solution based on aluminum.

By choosing the heat temperature in solution quenching, it must be assure on one hand a certain solid solution enriching with alloying elements so that through blast cooling the material reach a supersaturated degree and on the other hand to prevent melting the complex eutectics that brings to oxidations and the continuity loss of the metallic material. The structure and the chemical composition of complex eutectics are determined by the chemical composition of liquid alloys and by piece casting conditions, solidification and cooling that are influenced by its geometry and formation technology.

The objectives of applying ageing treatment to aluminum alloys establish and realize according to the obtain pattern of those products: plastic deformation or casting.

Die casting pieces or in moulding sand pieces have after cooling a structure made from solid solution with a certain supersaturated degree because of the fact that cooling speed after solidification is big for preventing the separation of secondary phases in equilibrium proportion. The possibility to adjust the values of mechanical characteristics through choosing the correct temperature and heating time is determined by the kinetics of transformation processes of the supersaturated solid solutions in cast alloys and solution heat-treated. The structures of aluminum alloys cast and heat-treated pieces are stable in heating. This happens because these alloys have a considerable eutectic proportion that links a part of the alloying elements and they form from hard soluble phases heating in solution heat treatment. In cast, structures the secondary phases have big dimensions and are uniformly distributed then in cold reduction and warm plastic deformation structures. That is why the temperature and heating period in solution quenching is higher and the temperature and heating period in ageing treatment is higher. In solution treatment, it is desired the dissolving of a bigger part of secondary phases and in ageing treatment, it is desired the precipitation of secondary phases from solid solution.

If we raise the heat temperature to the superior limit and increase the maintain period to this temperature the transformation processes of the solution treatment structure develop entirely by accomplishing a complete supersaturated solid solution and raises through coalescence the precipitated crystals of hardened phases. These transformations determine a drop of the mechanical characteristics values, a raise of the plasticity values and a dimensional stability of the pieces.

2. The purpose of the paper

As it was presented in specialty literature, there are no data to specify the technological parameters (temperature, time) to which the artificial ageing heat treatment must be done for the ATSi5Cu1 alloy cast pieces so that the alloy could gain hardness and mechanical resistance properties to the exploitation demands. Therefore, it is imperious to find a compromise solution, to determine a heating temperature and a maintain time so that the mechanic resistance and the hardness to have optimum values.

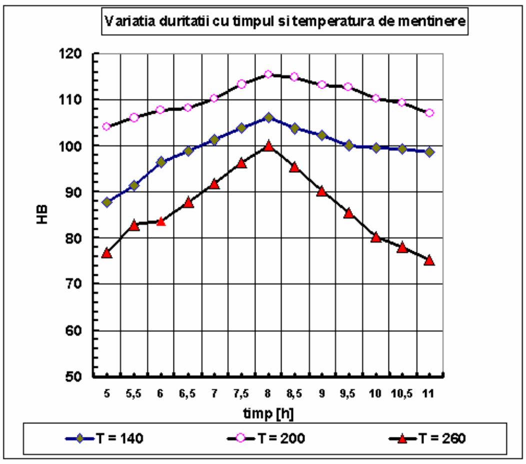
3. Experimental results

Some standard traction specimens were used and the solution heat treatments was made by heating at 550°C, maintain for 8 hours and water cooling and at the ageing treatment the temperature and maintain times varied into a certain interval. For the experiment it was used an cast aluminum alloy ATSi5Cu1 with the following chemical composition Al 92,2%, Cu 1,1%, Fe 0,6%, the rest being neglecting elements. There were made determinations of mechanical resistance and hardness on cast specimens from ATSi5Cu1 in different temperatures and maintain time, T = 140-260°C and t = 5÷11 h.

The experimental data were put into table 1.

Table 1. *The experimental data*

t [h]	T = 140 [ºC]		T = 200 [ºC]		T = 260 [ºC]	
	HB_{mediu}	R_m [daN/mm^2]	HB_{mediu}	R_m [daN/mm^2]	HB_{mediu}	R_m [daN/mm^2]
5	87,6	21,3	104,06	20,78	76,8	18,5
5,5	91,3	24,6	106,1	21,3	82,9	19,6
6	96,5	25,72	107,7	24,2	83,6	20,43
6,5	98,7	25,98	108,1	23,8	87,8	21,8
7	101,2	26,45	110,2	24,9	91,8	23,4
7,5	103,9	26,73	113,4	25,5	96,3	24,6
8	106,1	27,8	115,5	25,21	100,1	25,5
8,5	103,8	27,02	114,9	25,9	95,5	24,6
9	102,2	25,6	113,2	25,85	90,1	23,1
9,5	100,1	24,7	112,8	25,8	85,6	22,8
10	99,5	23,45	110,2	26	80,16	22,27
10,5	99,3	22,9	109,2	25,8	78,2	21,8
11	98,6	21,54	107	25,81	75,3	19,9



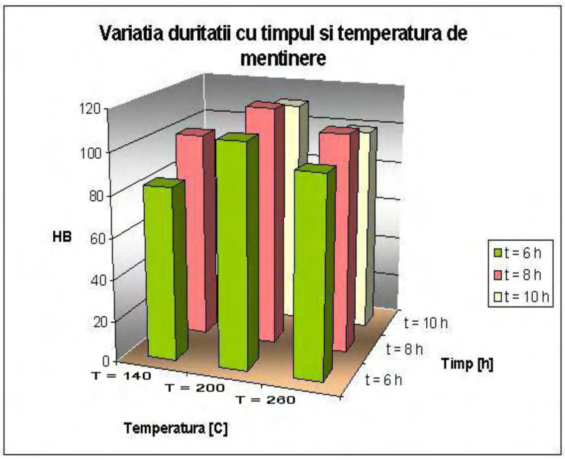


Fig. 1. *Variation of Vickens hardness with maintain time, when temperature is constant T_1 = 140 °C, T_2 = 200 °C şi T_3 = 260 °C.*
Maximum hardness appears in 200°C for a 8 hours maintain time.

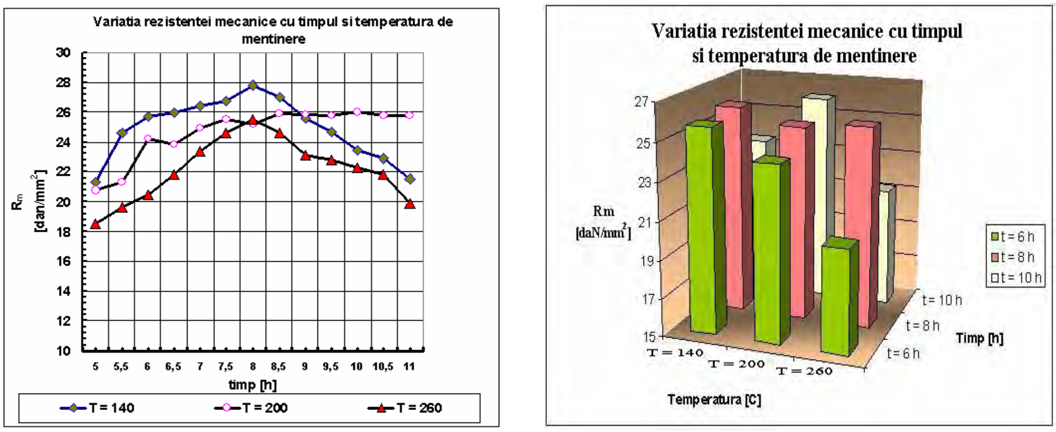


Fig. 2. *Variation of ultimate strength with maintain time when temperature is constant T_1 = 140°C, T_2 = 200°C şi T_3 = 260°C.*
Maximum ultimate strength appears for 6 and 8 hours maintain time and 200°C.

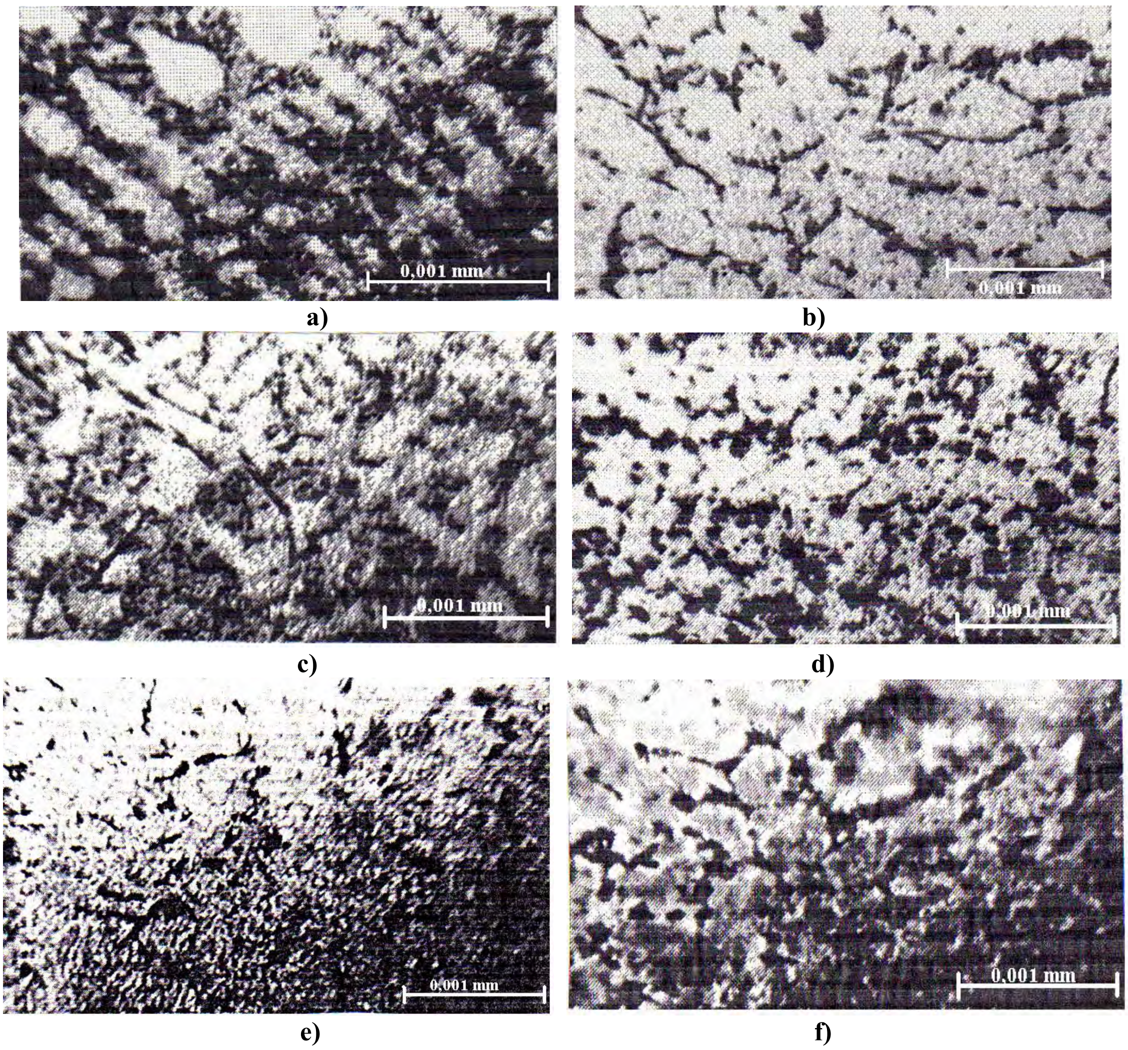


Fig. 3. *The microstructure of the specimens after solution quenching and artificial ageing. Obtained microstructures after 20% NaOH attack of ATSi5Cu1 aluminum alloy*
a) cast test; b) solution treated test at 550°C, maintained for 8 hours and water cooled at 60°C; c) solution treated and aged test at 140°C and maintained for 6 hours; d) solution treated and aged test at 200°C and maintained for 5 hours; e) solution treated and aged test at 260°C and maintained for 6 hours; f) solution treated and aged test at 200°C and maintained for 11 hours.

Studying the microstructures from figure 3, we notice a white structure of the solid solution and black colored eutectic. In a) we notice the denditric form of the cast structure; in b) the black colored eutectic is scattered at the grains boundaries of white solution; in c), d), e) and f) we notice an uniform distribution of the eutectic, acicular form, and it differs only straggling degree depending on temperature and maintain time. If the temperature and maintain time are bigger the eutectic distribution is smaller and more uniform.

4. Conclusions

1. We notice by studying the graphics that depending on the realized experiments we have a maximum for hardness in all three temperatures (140, 200, 260) and for 8 hours maintain time.

2. We notice from maintain temperatures point of view that maximum hardness is riched to 200°C maintain temperature.

3. We notice that from mechanical resistance point of view the maximum riches at 140°C and 8 hours maintain time.

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