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RESEARCH CONCERNING THE INFLUENCE OF HEAT TREATMENT ON PHYSICAL AND MECHANICAL PROPERTIES OF ALUMINIUM BASED ALLOYS

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ABSTRACT

This work presents the experimental results concerning the behavior on heat treatment of on aluminum based alloy belonging to the class of aluminum alloys deformable and harden by heat treatment.

The laboratory level experiments effected on samples of Al-Zn alloy illustrate the variation of properties depending on the variation of heat treatment technological parameters specific to different variants of heat treatment. In view of the chemical composition of the studied alloy and being aware of the fact that the structure and composition of this type of alloys depend on the proportion Zn/Mg, on the copper and magnesium content as well as on the elements sum(Zn+Mg+Cu), we have experimented more variants of heat treatment in order to establish the optimal variant and to classify the studied alloy according to its use characteristics(high, medium or low strength).

KEYWORDS: heat treatment, quenching in solution and heat ageing, aluminum based alloy.

1. Introduction

Deformable aluminum alloys are alloys containing elements which have a quite high solubility in aluminum (e.g.: Cu; Mg; Zn etc) and the variation of their solubility function of temperature allows heat treatments to be applied.

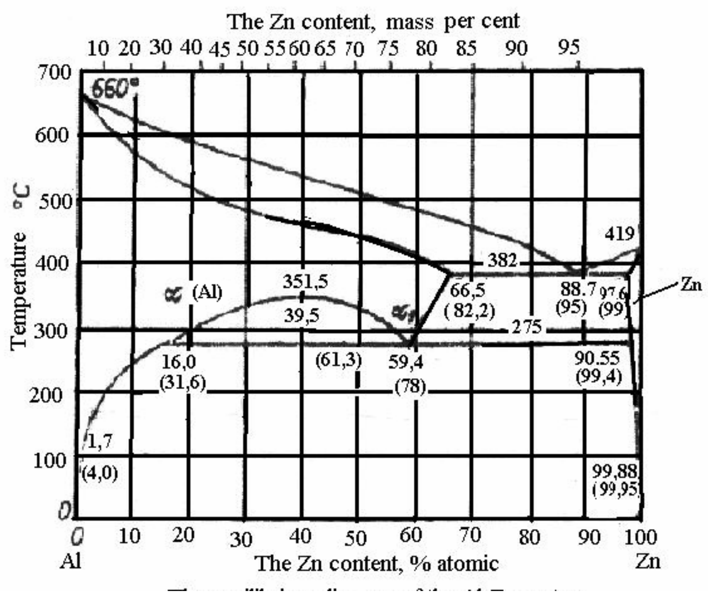

Fig.1. *The equilibrium diagram of the Al-Zn system.*

Among the most used deformable durificable alloys are the alloys in the systems: Al-Cu; Al-Cu-Mg; Al-Mg-Si; Al-Zn-Mg; Al-Zn-Mg-Cu and so on.

The typical representative of these alloys is the Al-Cu alloy containing about 4,0-5.5%Cu and the phenomena accompanying the heat treatments of Al-Cu alloys cam be observed in the case of all aluminum based alloys durificable by heat treatment.

The alloys in the Al-Zn-Mg system belonging to the category of alloys deformable and durificable by heat treatment are characterized by high corrosion resistance.

The structure and the behaviour of these alloys on heat treatment mainly depend on the proportion of the Zn and Mg elements (%Zn/%Mg), its value and the presence of the other alloying or accompanying elements causing the forming of different soluble or insoluble compounds in solid state.

Fig.1. presents the equilibrium diagram of the Al-Zn system.

2. Experimental conditions

The experiments have been made on Al-Zn aluminium alloy having chemical composition shown in table 1.

***Table 1**. Chemical composition of Al-Zn-Mg-Cu(%)*

Cu	Fe	Mg	Zn	Mn	Pb	Si	Al
1,42	0,51	2,32	2,60	0,05	0,05	0,22	Rest

The laboratory experiments have been made of the specific heat treatments: quenching in solution and heat ageing with different parameters (temperature and holding time) in according with table 2.

In order to find the optimal temperature for quenching in solution of the studied alloy six experimental regimes have been effected observing the influence of the quenching in solution temperature on hardness for the same maintaining time and also for the some cooling speed cooling (medium).

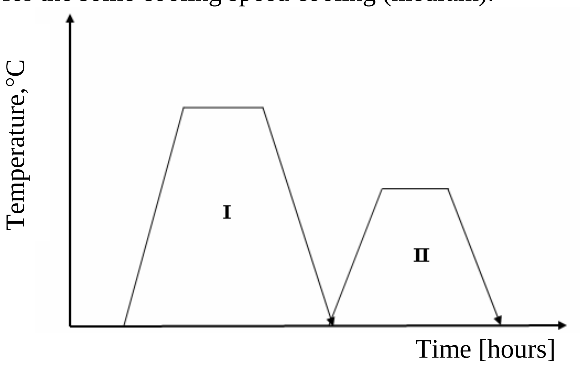

***Fig.2.** The cycle of experimental variants of heat treatment applied on Al-Zn-Mg alloy.*
I-quenching in solution; II-heat ageing.

Considering as optimal temperature for quenching in solution the temperature at which the maximum value of hardness is obtained nine more experimental regimes have been effected with a view to establishing the optimal technological parameters for artificial ageing (temperature, maintaining time) for samples of the studied alloy which were in the state of being quenched in solution at a temperature value of 470°C with 1 h maintaining time and cooling in water.

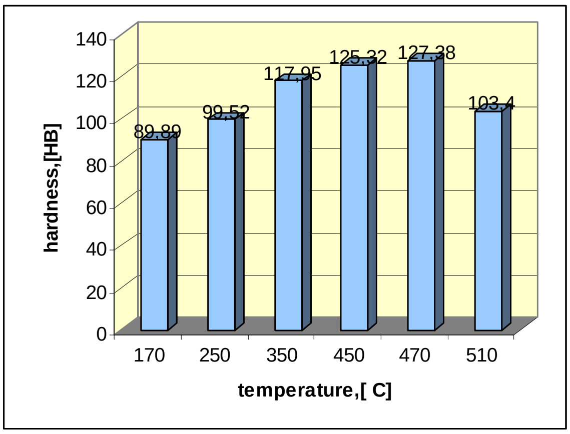

***Fig.3.** The influence of the quenching in solution temperature on the hardness of Al-Zn-Mg.*

Table 2 presents the experimental regimes during which there temperature values were tested (120;150;200) each of them having three maintaining time values(1; 3; 6).

***Table 2**. The experimental working conditions*

Experimental variant number	Quenching in solution		Heat ageing	
	Heating temperature	Hours holding	Heating temperature	Hours holding
	[°C]	[h]	[°C]	[h]
1	470	1	120	1
2	470	1	120	3
3	470	1	120	6
4	470	1	150	1
5	470	1	150	3
6	470	1	150	6
7	470	1	200	1
8	470	1	200	3
9	470	1	200	6

3. Results and interpretations

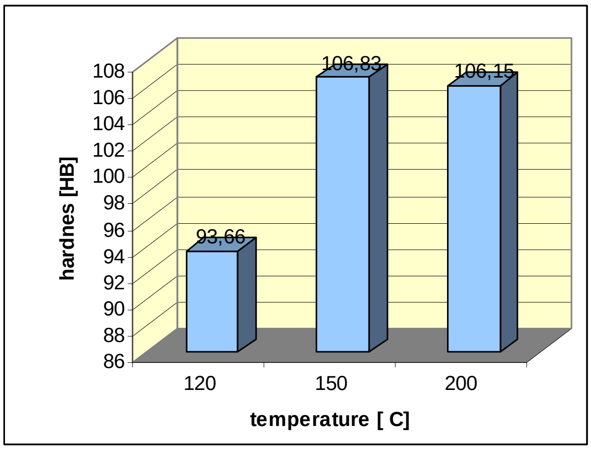

***Fig.4.** The influence of artificial ageing temperature on samples hardness for 1 h maintaining time.*

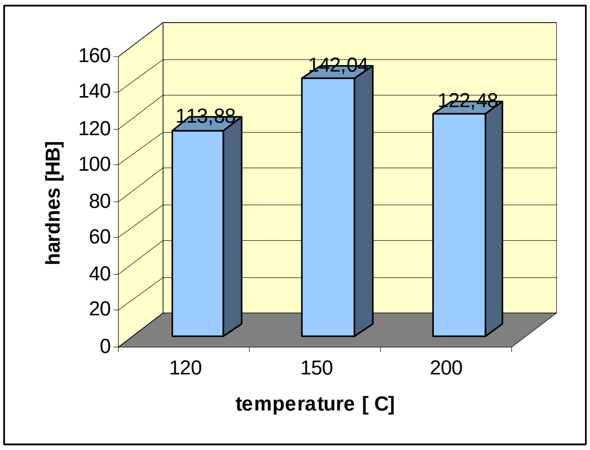

***Fig.6.** The influence of artificial ageing temperature on samples hardness for 6 h maintaining time.*

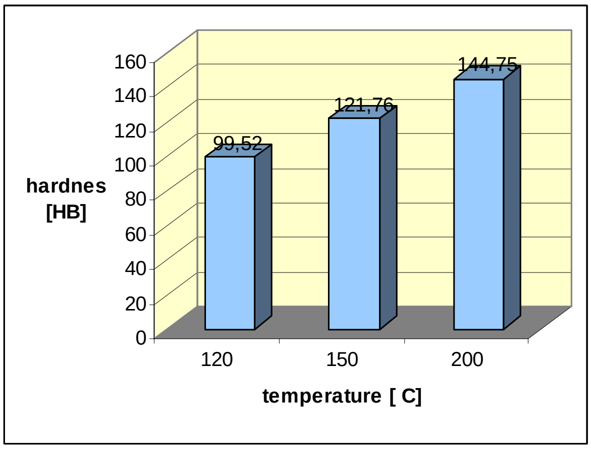

***Fig.5.** The influence of artificial ageing temperature on samples hardness for 3 h maintaining time.*

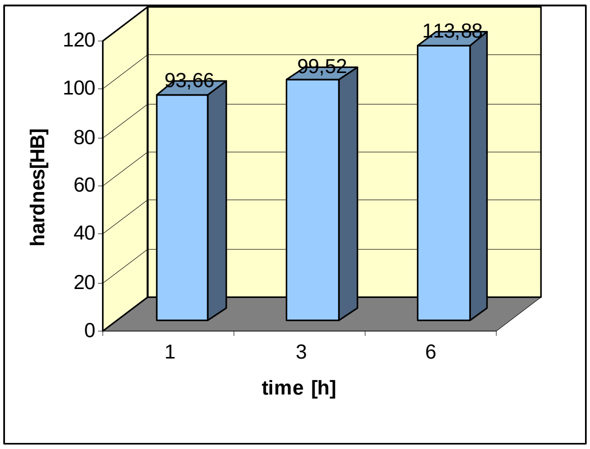

***Fig.7.** The influence of the maintaining time at a 120℃ artificial ageing temperature on samples hardness.*

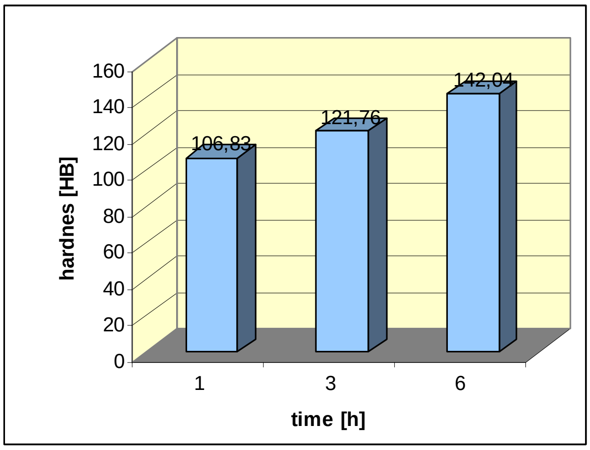

Fig.8. *The influence of the maintaining time at a 150°C artificial ageing temperature on samples hardness.*

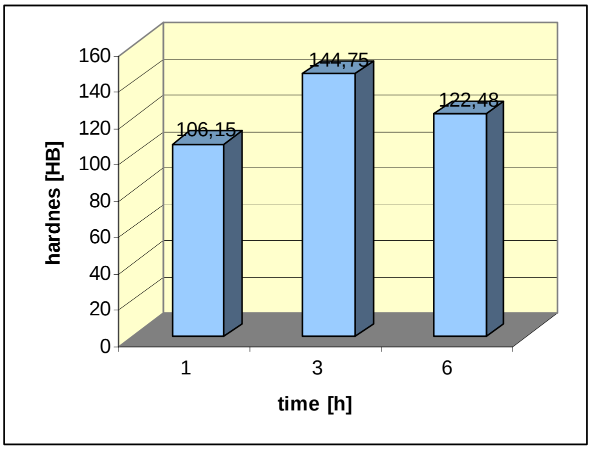

Fig.9. *The influence of the maintaining time at a 200°C artificial ageing temperature on samples hardness.*

4. Microstructural aspects

Fig.10. *The microstructure of the Al-Zn alloy after quenching in solution and natural ageing (x100, attack natal).*

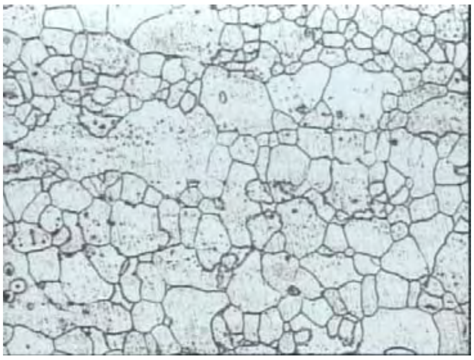

Fig.12. *The microstructure of the Al-Zn alloy after quenching in solution and artificial ageing at 150°C for 6 hours (x100, attack natal).*

Fig. 11. *The microstructure of the Al-Zn alloy after quenching in solution and artificial ageing at 200°C for 3 hours (x100, attack natal).*

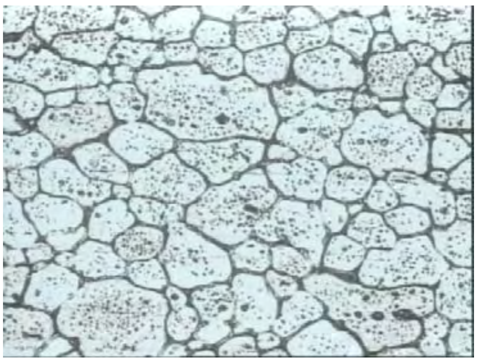

Fig.13. *The microstructure of the Al-Zn alloy after quenching in solution and artificial ageing at 120°C for 6 hours (x100, attack natal).*

5. Conclusion

This work presents some partial experimental results concerning the behavior of the aluminum-based alloy of a given chemical composition (table 1) to heat treatment considering hardness as a measure for the variation of the mechanical properties.

The temperature for quenching in solution was established at the value of 470°C for a 1h maintaining time.

The study of the influence of the technological parameters for artificial ageing shows that:

a) the alloy hardens increases with the increasing of the ageing temperature until reaching the temperature value of 150°C, after which it begins to decrease at about 200°C

b) for the same ageing temperature, at an ageing temperature value of 120°C; 150°C; the alloy hardness increases with the increasing of the maintaining time (fig.7 and fig.8) bat for an ageing temperature of 200°C, the increase of the alloy hardness takes place at the some time with the increase of the maintaining time only until 3 hours, the extending of the maintaining time over this value leading to a decrease of hardness value (fig.9).

c) the maximum value obtaining of the studied alloy hardness is of 145 HB, value obtained during two experimental regimes:

1. t_{qs}=470°C, τ=1h cooling in water
   t_{aa}=150°C, τ=6h cooling in air
2. t_{qs}=470°C, τ=1h cooling in water
   t_{aa}=150°C, τ=6h cooling in air

regime 2 being recommended.

A future work will present the results of the research concerning the evolutions of mechanical properties function of the technological parameters for the hat treatment of other Al based alloys; by comparison the alloy will be classified according to the value range of resistance.

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