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STUDIES ABOUT AlCu2Mg1,5Ni BEHAVIOR AT HEAT TREATMENT

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Introduction

This paper presents a wrought aluminum alloy, AlCu2Mg1,5Ni that is used for aeronautical parts. This alloy is heat treated in order to establish the optimum mechanical properties, and we are referring especially at stress, tensile strength and elasticity. So, we took 10 parts, of identical dimensions made of this alloy and have applied the final heat treatment. At the end we were studying the mechanical properties, in order to establish the optimum technology.

We have made experiments in the same conditions of furnace preheating, and used the same equipment for the stress measurement.

Experimental results

In order to obtain a mathematical model for the final heat treatment for AlCu2Mg1,5Ni alloy, we will present the experimental results in table 1. This table is the base for obtaining the tridimensional diagrams for stress variation. These diagrams help to establish the regression equations that will describe the process of final heat treatment.

Comparing test results for treated and untreated parts, it can be observed the opportunity to apply these heat treatments (table 1). Also, it can be observed the increasing of the stress for the heated parts.

In these cases, the regression is a polinom with m degree and the variable is stress (y_1).

With the results, using 3^k factorial experiment model and with a specific computer program we obtained the regression equation that describes the process:

$$y_1 = 286,88 + 71,927x_1 + 96,02x_2 + 6,71x_1x_2 - 10,693x_1^2 - 31,276x_2^2$$

Table 1. Experimental results for AlCu2Mg1,5Ni alloy

Experiment	Code	Quenching temperature	Aging temperature	Stress
	Test part			260,065
1	211	525	190	123,945
2	212D	525	200	114,201
3	222	525	210	312,081
4	311	530	190	163,685
5	221	530	200	297,706
6	222D	530	210	336,696
7	312	535	190	169,734
8	321	535	200	427,347
9	322	535	210	384,709

The changing parameters x_1 and x_2 are given in table 2.

On the basis of these experiments and the regression obtained we made a theoretical study regarding the establishing heating parameters for quenching and aging in order to obtain a certain stress, needed in service for this alloy.

Theoretical contributions regarding variation of stress with the heat treatment for AlCu2Mg1,5Ni alloy.

Table 2.The experimental matrix for k = 2

Experiment	Quenching temperature, T_c,°C	Variation, x_1	Aging temperature, T, °C	Variation, x_2
1	525	–1	190	–1
2	525	–1	200	0
3	525	–1	210	+1
4	530	0	190	–1
5	530	0	200	0
6	530	0	210	+1
7	535	+1	190	–1
8	535	+1	200	0
9	535	+1	210	+1

So, we have chosen the equation, referring to the stress that is a major characteristic for an aluminum alloy.

Replacing the variation parameters with the temperature from table 2, we obtain:

$$R_m = -127689{,}8 + 440{,}928T_c + 63{,}58T + 0{,}134T_cT - 0{,}0427T_c^2 - 0{,}312T^2$$

For this theoretical study we consider two cases:

– stress and quenching temperature are fixed and we determine aging temperature;

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Case I: quenching temperature T_c is known and we obtain the variation of the aging temperature T with the stress R_m,

3. $x_1 = -1$, $T_c = 525$°C

$$T = 214{,}27 - \sqrt{856{,}8 - 3{,}1R_m}\ .$$

This equation has a limiting condition: $R_m < 276{,}404$ MPa.

2. $x_1 = 0$, $T_c = 530$°C

$$T = 215{,}35 - \sqrt{1152{,}8 - 3{,}1R_m}\ .$$

This equation has a limiting condition: $R_m < 371{,}88$ MPa.

3. $x_1 = 1$, $T_c = 535$°C

$$T = 216{,}42 - \sqrt{1382{,}7 - 3{,}1R_m}\ .$$

This equation has a limiting condition: $R_m < 446{,}038$ MPa.

The relations are shown in figure 1 and represent the variation of the aging temperature of Al-Cu2Mg1,5Ni alloy with stress.

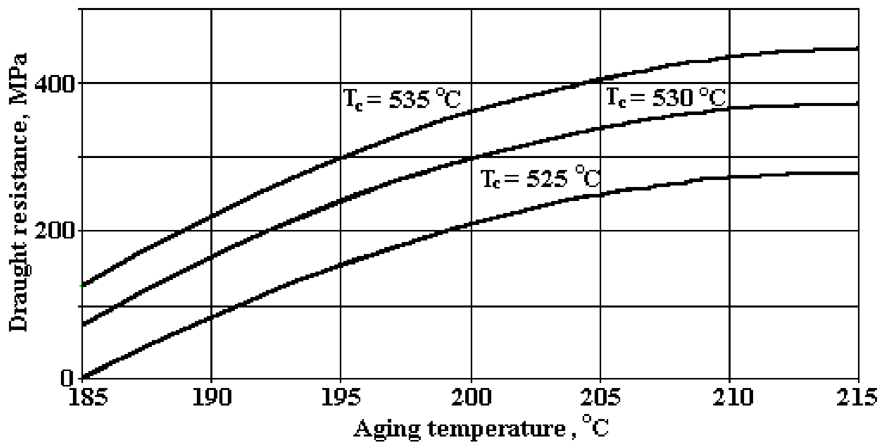

Figure 1. Graphical determination for the aging temperature for AlCu2Mg1,5Ni alloy

Case II: aging temperature T_t is known and we obtain the variation of the quenching temperature T_c with the stress R_m,

4. $x_2 = -1$, $T = 190$°C

$$T_c = 545{,}225 - \sqrt{604{,}9 - 2{,}325R_m}\ .$$

This equation has a limiting condition: R_m < 260,17 MPa.

5. $x_2 = 0$, $T_{\cdot} = 200$°C

$$T_c = 546,815 - \sqrt{953,475 - 2,325 R_m} \; .$$

This equation has a limiting condition: R_m < 410,103 MPa.

6. $x_2 = 1$, $T_{\cdot} = 210$°C

$$T_c = 548,385 - \sqrt{1160,075 - 2,325 R_m} \; .$$

This equation has a limiting condition: R_m < 498,963 MPa.

The relations are shown in figure 2 and represents the variation of the quenching temperature of AlCu2Mg1,5Ni alloy with stress.

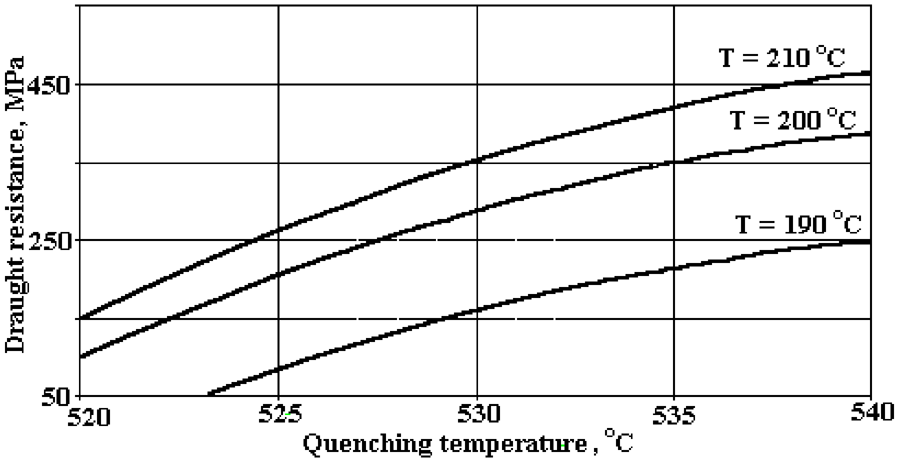

Figure 2. Graphical determination for the quenching temperature for AlCu2Mg1,5Ni alloy

Conclusions

With the results, using 3^k factorial experiment model and with a specific computer program we obtained the regression equation that describes the process. These equations help to determine certain mechanical characteristics that are needed in the service of the parts and also to determine accurately the optimum temperatures for the final heat treatment.

Also, we have to mention that the determined temperatures should be in the limits that are recommended in the material standards.

Also, studying these diagrams it can be observed a maximum limit of 460 MPa for AlCu2Mg1,5Ni stress.

As a conclusion, the paper presents the algorithm for applying the optimum heat treatment in order to obtain the necessary properties for the working parts.

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Summary

This paper presents a study of a wrought $AlCu_2Mg_{1,5}Ni$ aluminum alloy, that is used for aeronautical parts. This alloy is heat treated in order to establish the optimal mechanical properties, and we are referring especially at microhardness, tensile strength and elasticity. So, we took 13 parts of identical dimensions made of this alloy and applied the final heat treatment. At the end we were studying the microhardness and mechanical properties in order to establish the optimal technology. This paper contains a study regarding the improvement of heating furnaces, which determine a better heat treatment technology for aluminum alloys and low energy consumption. We have made experiments in the same conditions of preheating for the furnace and used the same equipment for the stress and microhardness determinations. With the results, using 3^k factorial experiment model and with a specific computer program we obtained the regression equation, that describes the process. As a conclusion, the paper presents the algorithm for applying the optimum heat treatment in order to obtain the necessary properties for the working parts.