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CONSIDERATION REGARDING THE HEAT TREATMENT OF SHEETS AND STRIPS FROM ALUMINUM ALLOY 5052 TYPE

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ABSTRACT

The paper extends the laboratory investigations performed on samples taken from industrial production to the current technologies, the solutions proposed forming a fundamental change in the thermal treatment regimes by varying the temperature / time parameters. The aluminum alloys have outstanding physical and mechanical properties: specific gravity of small electrical conductivity and excellent heat resistance to corrosion and aggressive chemicals.

KEYWORDS: aluminum alloy, mechanical properties

1. Introduction

In the recent years, weight reduction has become a key issue for automotive manufacturers. For this reason, aluminum magnesium (Al-Mg) alloys (5XXX series) have great attention in automotive industry due to their excellent high strength to weight ratio, corrosion resistance, weldability and recycling potential.

Therefore, aluminum alloys could replace heavier materials in the automobiles to reduce the automobile weight. Requirements for fuel consumption, environmental laws, and global warming issues have significant influence on the choice of the materials 5XXX series alloys are mostly used for inner panel applications because of the stretcher lines problem on the product surfaces. These surface defects are limiting the usage of the Al-Mg alloys in the outer panel applications. Forming of these alloys at warm temperatures is quite attractive, since undesirable stretcher lines, which often appear on the surface of the sheets during the cold forming operations, will disappear at high temperatures. Al-Mg alloys show less ductility at room temperatures. In the literature, there are several investigations which have pointed out that the poor room temperature ductility can be improved by changing the forming temperature and the strain rate.

2. Characteristics of the analyzed alloy

The 5052 alloy is part of a group of deformable aluminum alloys and has magnesium as a main alloying element. The chemical composition of 5052 alloy is according to current norms (EN-485 / 2).

The alloy belongs to the group Al – Mg rolling alloys. The presence in the chemical composition of magnesium and chromium leads to a hardening, an increase in breaking strength up to values of 260 MPa and to an increase of yield to values of 125-130 MPa. From the analysis of thermodynamic equilibrium diagram of Al - Mg it results that the solubility of the magnesium in aluminum varies strongly with temperature.

Table.1. *Solubility variation of Mg in Al with temperature*

Temperature, [°C]	450	400	350	300	250	200	150	100	20
Solubility, [%]	17.5	13.5	9.9	6.5	4.4	3.1	2.3	1.9	0.8

Being a magnesium-based alloy, corrosion resistance and tensile strength are high because of α solid solution that best resists to the chemical agents action.

Al-Mg foundry alloys have a good fluidity than cutting machinability, high mechanical strength and corrosion. Instead, these alloys always have a tendency to porosity and microretasures formation which lead to the cracks formation, heat in the castings pieces.

In the case of rolled alloys, additions of Mn and Cr lead to hardening and an increased resistance to breakage. Titanium and vanadium, in small quantities, have the role decreasing and finishing the grains, fact that leads to the growth of mechanical characteristics. 5052 alloy has a specific gravity of 2.68 g/mm^2.

Table 2. *Mechanical characteristics required for the 5052 alloy for thickness between 0.5 to 1.5 mm*

State	**R_m,** MPa	**$Rp_{0,2}$,** MPa	**A_{min},** %	**Hardness** HBW
H22/H32	210 - 260	min 130	12	61
H24/H34	230- 280	min 150	9	67
H26/H36	250-300	min 180	9	74

3. Experimental researches

Analyzing the current technology of roll of sheets and strips from 5052 alloy it was suggested the modification of the heat treatment technology for monitoring the influence of heat treatment on physical and mechanical characteristics, depending on the delivery status.

Table 3. *Chemical composition of the alloy analyzed, %*

Si	**Fe**	**Cu**	**Mg**	**Mn**	**Cr**	**Ni**	**Zn**	**Ti**	**Other elements**	**Al**
0.23	0.28	0.08	2.64	0.07	0.22	-	0.05	-	0.12	rest

We also wanted to find a technology for obtaining optimal physical and mechanical characteristics delivery for those states in a more restricted range.

Program for the tests:

- samples of 5052 alloy sheets were treated having 1 mm thickness at all combinations of temperatures: 150, 160, 160, 170, 180, 190, 200, 210, 220, 230 and respectively 240°C for maintenance times: 2, 4 and 6 hours.

-for each combination every three samples were taken;

-treated samples were tensile tested, determining the tensile test, and yield strength, respectively, elongation;

-treatment of samples was done in a calcination furnace can ignite with scheduling tests, with an accurate temperature control of ± 0.5°C.

Results from tensile testing are presented in Tables 4-6 (selective values).

Table 4. *Values of tensile test for some tested proves*

Code	**Alloy type**	**Temperature**	**Maintaining time**	**Thickness**	**R_m pr.1**	**R_m pr.2**	**R_m pr.3**
		[º C]	[h]	[mm[	[MPa]		
2- 1	5052	**150**	**2**	1	231	232	232
	5754			1.5	148	249	248
	5251			0.95	238	230	237
2- 2	5052	**150**	**4**	1	231	230	231
	5754			1.5	249	248	248
	5251			0.95	240	240	239
2- 3	5052	**150**	**6**	1	231	230	233
	5754			1.5	247	248	247
	5251			0.95	244	242	243

Table 5. *Values of yield strength test for some tested proves*

Code	Alloy type	Temperature	Maintaining time	Thickness	$R_{po.2}$ pr.1	$R_{po.2}$ pr.2	$R_{po.2}$ pr.3
u.m		[º C]	[h]	[mm[	[MPa]		
2- 1	5052	150	2	1	167	168	167
	5754			1.5	182	185	183
	5251			0.95	193	187	192
2- 2	5052	150	4	1	165	166	166
	5754			1.5	184	182	184
	5251			0.95	193	193	193
2- 3	5052	150	6	1	165	165	167
	5754			1.5	181	183	182
	5251			0.95	197	196	197

Table 6. *Values of elongation test for some tested proves*

Code	Alloy type	Temperature	Maintaining time	Thickness	A pr.1	A pr.2	A pr.3
u.m		[º C]	[h]	[mm[	[%]		
2- 1	**5052**	**150**	**2**	1	15	13	16
	5754			1.5	14.8	12.8	14.2
	5251			0.95	10	9	10
2- 2	**5052**	**150**	**4**	1	15	15	16
	5754			1.5	13.4	14.3	14.5
	5251			0.95	10	10	9
2- 3	**5052**	**150**	**6**	1	16	16	15
	5754			1.5	14.3	13.1	13.8
	5251			0.95	10	10	9

4. Results and discussion

Time-keeping influence is reduced in the range of values in which the experiment was done.

-Values for heat treatment performed at 190°C do not fall within the range required. However, the temperature of 190°C ensures a minimum value for tension and stress, but not a minimum value for the yield stress, respectively, the maximum for elongation. The latter are supplied at a temperature of 220°C for H22/H32-H24/H34 states.

R_m-values which can be obtained systematically are between 222 and 233 are MPa.

$R_{p0.2}$-values that can be systematically obtained are between 150 and 170 MPa.

The A%-values which are systematically obtained are between 13 to 21%.

5. Conclusions

After the research the heat treatment procedure has been optimized:

-it was established a maintenance period of 4 hours, to ensure optimal characteristics with respect to time;

-the temperature of heat treatment has to be correlated with the delivery status of the material as follows:

• for H22/H32 delivery states, T=150°C

• for H24/H34 delivery states, T=140°C (to achieve only the minimum value in case of tensile test);

• for H26/H36 delivery states none of the tested temperature, may have minimum values required by this state.

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