Advance Physics Letter

A Comprehensive Study of an Aluminum Alloy AL-5052

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Abstract— In view to the advancements in manufacturing industries which is an essential part of in the development of any economy, we have witnessed that the new and advance materials especially alloys are being used. They have light weight with good strength. The properties which are desired can be obtained with the help of alloys. Various practical aspects like marine application, high temperature exposures etc requires both strength and corrosion resistance property. This paper presents the comprehensive analysis and study of an aluminum alloy AL-5052. The strength alteration behavior is also reported with annealing process.

Keywords: Annealing, Aluminum Alloys, AL-5052.

I. INTRODUCTION

As we have seen in couple of years that the demand of materials with many characteristics have risen. This is due to the fact that in today's world products requirement is high. Also we have seen that people have opened there scope beyond ferrous materials because of its characteristics and properties which are well suited according to the products they need. And the scope of these materials is further expanded with the help of alloys which combines the individual properties of those materials to create properties at par. With this in mind presently there are several alloys been used which gives the required properties. Also these alloys further provide scope to know the mechanics behind them. If we talk about aluminum and magnesium the alloy of which has the properties of both these materials and when annealed give different properties. This paper will make you to understand both about the material which is an aluminum alloy of 5xxx series (AL-5052) and what effect happens when annealed which eventually help to know new materials and related concepts.

II. NON FERROUS METALS

These metals are the ones that do not have iron as the base. These Non-ferrous metals have the unique properties for which they preferred over the ferrous metals as per the requirement of the product [15].But when these materials are used at high temperature their strength decreases and also they undergo hot shortness which is a negative or undesired phenomenon. Basically, Non-ferrous metals possess characteristics like-

a. Corrosion Resistance

b. Heat and Energy Conductivity

c. Light Weight

d. Non Magnetic

e. Attractive Colors

f. Softness and

g. Facility of cold working

h. Good formability

i. Fusibility and

j. Ease of casting

III. ALUMINIUM ALLOYS

Aluminum which is found as a silvery white metal has specific properties which are found in general non-ferrous metals [14].Due to the said properties aluminum is extensively used where a light, non-corrosive metal is necessary as in aircraft, missiles, and automobile parts where the saving of weight is an important advantage. In its pure state, aluminum is weak and soft and so has few applications. Aluminum finds its widest uses when alloyed with small amounts of other metals and then it becomes hard and strong, while still retaining its light weight. In its alloyed state, it machined very easily.

These alloying elements have their own importance in improving the properties of the alloy. Like some increase machinability but decreases its corrosion resistance and some increases mechanical properties but have poor machinability.

Aluminum alloys can be classified as:

a. Wrought Aluminum Alloys:

They have a high mechanical strength comparable to steel. These alloys are further classified as

i. Non Heat Treatable Alloys :

These do not respond to heat treatment, include the Al-Mn alloys containing about 1.3% Mn and Al-Mn-Mg alloy containing about 2.5% Mg and 0.3% Mn. These alloys possess sufficiently high mechanical strength and ductility as well as corrosion resistance and weldability.

ii. Heat treatable Alloys:

These include complex alloy of aluminum with copper, nickel, iron, silicon and other alloying elements.

b. Aluminum Based Casting Alloys:

These contain silicon, copper, magnesium and zinc as the alloying elements. Aluminum alloys containing from 8 to 14% Si are called silumin alloys. Alloys containing from 10 to 13% Si, and 0.8% Cu and alloys containing from 8 to 10% Si, 0.3% Mg and up to 0.5% Mn possess good casting properties and ample ductility and corrosion resistance. The strength of silumin alloys can be substantially changed by adding certain amount of manganese, copper and zinc. Their strengths can also be increased if they modified in the molten condition with a small amount of sodium.

III.1. Designation of Wrought Aluminum Alloys

These are designated by four digits and by a temper designation which shows the condition of the material. The major alloying element is identified by the first digit. For example if the number is 5xxx then the major alloying element is magnesium and this series alloys have good corrosion and weld ability and are non-heat treatable. The second digit indicates modifications of the alloy. The third and fourth digits are for minimum amount of aluminum in the alloy for 1xxx series, for other series these identify the different alloys in the group and have no numerical significance[7].

The temper designations are as follows:

- F : as fabricated;
- O : annealed;
- H : strain hardened by cold working;
- T : heat treated;
- W : solution treated only

IV. ALUMINIUM-5052 ALLOY

This alloy of aluminum belongs to the family of 5xxx series which has magnesium as the major alloying element. Aluminum alloy 5052 is a non-heat treatable alloy and hardened for higher strength by cold work. Alloy 5052 has excellent characteristics with a high fatigue strength it is used for structures which are subject to excessive vibrations [8]. It is about mid-way through the series of aluminum magnesium alloys for alloying content and strength. The resistance of 5052 to corrosion in marine atmospheres is excellent, exceeding that of 5005 and is therefore commonly used in boats, marine components, fuel and oil tubing. 5052 is readily machined by conventional methods. Woodworking machinery may be suitable for short runs. The standard chemical composition limits of aluminum alloy AL-5052by (wt %) is given as follows-

Table: 1 Standard Chemical Composition Limits of aluminum alloy AL-5052 by (wt %) according to ASTM [1]

Alloy	Mg	Cr	Cu	Fe	Mn	Si	Zn	Other Elements	Al	
								Each	Sum	
Al 5052	2.2- 2.8	0.15- 0.35	0.1	0.4	0.1	0.25	0.1	0.05	0.15	Reminder

Every constituent element in the alloy has their own characteristics which makes the alloy favorable. In this Magnesium retards formability and Zinc increases cast ability and strength. And Iron and silicon increases re-crystallization temperature and improves fluidity respectively, again copper reduces the pitting effect. Chromium and Manganese increases strength and corrosion resistance respectively [12, 16].

IV.1. Annealing of AL-5052

The standard temperature for Annealing of AL-5052 is 350 ºC. The process consists of heating the sample to the re-crystallization temperature. It is followed by holding it at this temperature for some time but it's not necessary and then cooling it down to the room temperature at a rapid rate but rate is not important [3].

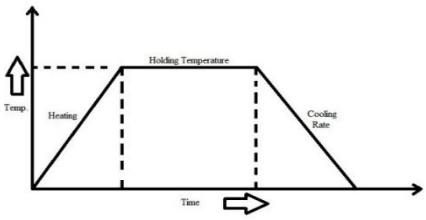

Figure: 1 Annealing Curve

V. CASE STUDY

In the present study Tensile strength property of Al-5052 with cold working has been chosen. The tensile strength alteration of Al-5052 has been observed after annealing at 350 ºC. The experimental data from ASM Hand Book [8] which is as follows:

Table: 2 Tensile Properties of AL-5052 H32 according to ASM Hand Book [8]

Material	Annealed Temperature	Ultimate Tensile Strength	Yield Strength
AL-5052 H32	0 ºC	228MPa	193MPa
AL-5052 H32	350 ºC	193MPa	89.6MPa

From the mentioned data the following graph has been prepared which shows the strength alteration with annealing process. The graph shows that the annealing at 350ºC corresponds to both yield strength and ultimate tensile strength decrement, which shows that the strength reduction with annealing.

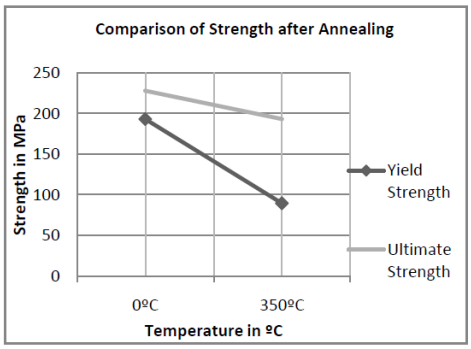

Figure: 2 Strength Comparison after annealing

Also from figure-2 it is observed that, there is a greater decrement in the yield strength as compared to corresponding ultimate tensile strength of Aluminum alloy Al-5052 when annealed at 350 ºC.

VI. CONCLUSION

From the above discussion, the following conclusion has been made:

- The material Al-5052 has very good corrosion resistance.
- The material aluminum alloy Al-5052 has scope in general metal work.
- It has very good formability and ductility.
- The strength decreases as the material is annealed.

Basically if we want to increase the formability of the material then we have to look into its ductility and as we know that AL-5052 has good ductility and also we have seen that after being annealed the strength decrease. These all makes it easy to find out the appropriate application of AL-5052 aluminum alloy.

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