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Review Article

A STUDY ON MECHANICAL PROPERTIES ON ALUMINUM ALLOYS – A REVIEW

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ABSTRACT
The mechanical properties of aluminum alloy are purely dependent on the rate at which the part is heated and quenched. The commercially available aluminum alloys has potential applications in the field of aircraft. Making modern aircraft is intended primarily to achieve a lightweight structure moving at high speeds without involving more cost; hence the choice of material is an important factor and is directed in two ways: discovery of new material and other improving the property of the existing ones. This paper deals with the investigation of different types of aluminum alloys subjected to heat treatment were discovered. The different aluminum alloys which are considered here include AA6066, Al6061-TiO_2, Al-Cu-Mg alloy and nickel-aluminum bronze alloy. Two different types of heat treatment namely solutionizing and ageing were employed in order to enhance their effects on the mechanical properties such as hardness, tensile strength and compression strength. This paper gives out collective survey of enhancement of heat treatment made on different types of aluminum alloys.

Keywords: *Aluminum alloy, Heat Treatment, Hardness, Age hardening, Tensile strength, Hardness*

INTRODUCTION

The application of aluminum alloys in the field of aerospace and marine technology has tremendously increasing nowadays. It is on urge to make use of aluminum alloys in a different manner to increase its mechanical properties. Hence, here we have made a deep study on the enhancement of mechanical properties due to heat treatment. In the view of heat treatment, there is an increasing strength in the properties of aluminum alloy. Normally aluminum has lack of strength in its pure form. Due to heat treatment, there is increasing in the hardness of aluminum alloy (Tan and Ogel, 2007). Through the analyses and investigations made on the aluminum alloy we have determined from the macroscopic point of view, there is an increasing mechanical property in aluminum alloy.

The physical and mechanical properties of aluminum alloys, which represent a wide family of constructional materials, whose mechanical properties cover the range offered by the common mild steels, are the basic reasons of their success as constructional material (Bharathesh *et al.,* 2013). Among the main prerequisites, particular attention must be paid to the following: 1) the high corrosion resistance, which does not require any protection coating, even in aggressive environments; 2) the lightness, producing advantages in weight reduction, even if it is partially offset by the necessity to reduce deformability, which provides a high susceptibility to buckling phenomena; 3) the low susceptibility to brittle fracture, even though particular attention should be paid to those problems where a high ductility is required; 4) the extrusion fabrication process, allowing to produce individually tailored shapes according to the requirements which are designed for; 5) the large choice for the connection systems (bolted, riveted and welded) without any difficulty involved.

Heat Treatment on Aluminum Alloys

The heat treatment applied to the aluminum alloys includes solutionizing and age hardening. Heat treatment involves the use of heating or chilling, normally to extreme temperatures, to achieve a desired result such as hardening or softening of a material. Heat treatment techniques include annealing, case hardening, precipitation strengthening, tempering and quenching. The main objective

of heat treatment is to make the material system structurally and physically fit for engineering application. Heat treatment was done to access their effects on the mechanical properties e.g. tensile strength and ductility. Normally solutionizing temperature was carried out depends upon the alloy in which they use. Solutionizing is made at the temperature high enough to put in solution the alloying elements and obtain a supersaturated solid solution at the range of 510 to550^{o}C (Girisha and Sharma, 2013). The increase in the mechanical property having high hardness, a phenomenon called as age hardening. In the second step of heat

The treatment, it includes the natural ageing or artificial ageing, whereas the natural ageing takes more time to modifying the mechanical properties. Hence it is replaced with the artificial ageing (Nigam and Jain, 2013).

The heat treatment involved in the up stated aluminum alloy AA6066 includes the annealing followed by solutionizing and ageing (Tan and Ogel, 2007). It also includes the water quenching after the solutionizing. The solutionising temperature was made at between the ranges of (510^{o}c -550^{o}c). It was made at the period of 12 hrs in order to investigate the effect of soaking time on hardness. After solutionizing, it was taken for water quenching followed by ageing. Quenching was done in order achieve homogeneity in temperature. Finally, after quenching ageing was done at three different temperatures 150,175 and 200^{o}C (Tan and Ogel, 2007).

The second material Al6061-TiO_2 composites achieve the heat treatment using electrical furnace controlled by the temperature controller. It also made solutionizing heat treatment followed by quenching and ageing (Bharathesh *et al.*, 2013). The solutionizing was carried out at the temperature of 530^{o}c for a period of 2 hrs followed by ice quenching. At last artificial ageing was carried out at the temperature of 175^{o}c.

The heat technology involved in the third alloy – aluminum copper magnesium alloy was solution treatment followed by age-hardening. It was made for the Al_2Cu hardening content. This solutionizing heat treatment was made mainly in the alloy with higher concentration of magnesium in order to make strengthening precipitate (Girisha and Sharma, 2013). Similarly, the aim of ageing is to form the increasing number of fine precipitates as a result to increasing the strength of alloy. The temperature heated was 550^{o}c for this alloy. Quenching was made after the solution heat treatment in order to prevent the slow precipitation and to form a super- saturated solution.

The final composite in aluminum alloy is nickel aluminum bronze. It also follows the heat treatment in order to improve the bonding of particles. It undergoes the solutionizing treatment and ageing in order to strengthen the material. Solutionizing temperature was 850 and 900^{o}c for various time periods of 1, 1.5 and 2 hrs respectively. It was then followed by water quenching. The last treatment for this alloy includes ageing at the temperature of 400 and 500 ^{o}c. Thus, heat treatment was made in order to strengthen the composite. Quenching was made in order to stabilize the material to ambient temperature.

DISCUSSION

The various results have been obtained due to the heat treatment process. There was an increase in mechanical properties like hardness, ultimate tensile strength etc...Due to heat treatment made in the various aluminum alloys, it results in the forming of strengthen material and also no grain boundaries have been formed. Due to the solutionizing of alloyAA6066 the hardness increased from 130 to144 (Tan and Ogel, 2007). The hardness was measured by Brinell hardness with the ball diameter of 2.5mm. As temperature increases the more solid dissolves and hence mixed with matrix to form the super saturation. As deformation amount increases grain size got smaller, enhancing the strength and hardness in AA6066.

In the second material investigation Al6061-TiO_2, as 8% wt of TiO2 plays a major role in the increasing the hardness. Usually hard reinforcement in a soft material like aluminum increases the hardness of the matrix alloy. The entire heat treated aluminum alloy with TiO2shows the higher hardness value with fine state of dispersion. The increased hardness was mainly due to the higher ageing time duration. As time duration increases for the age hardening, it results in the increase in the hardness (Bharathesh *et al.*, 2013).

Table 1: Alloys and their hardness before & after heat treatment

Alloy	**Hardness before heat treatment**	**Hardness after heat treatment**
Al 6066 –T6	120(BHN)	128 – 140 (BHN)
Al6066-T4	95(BHN)	100-103 (BHN)
Al 6061 alloy	65 (VHN)	85 (VHN)
Al 6061 –T6 8% wt TiO2	80 (VHN)	110 (VHN)
Al – Cu – Mg With 1% increase in mg	57.9 (BHN)	84.4 (BHN)

From the table, it is clearly known that the hardness value increases for the heat-treated aluminum alloys. In the material Al-Cu-Mg alloy, there was an increase in the hardness value with the increasing ageing time period (Girisha and Sharma, 2013). For ageing temperature 170^{o}c, there was higher alloy stability in the alloy and hence increases its hardness with increasing ageing hours.

Table 2: Alloys and their tensile strength after heat treatment

Alloy	**Ultimate tensile stress (Mpa)**
Al 6066	220-223
Al 6066 –T6	461 - 445
Al – Cu – Mg	312 1% increase in Mg
Ni – Al – Bronze	450 (cast) 740 (Aged) 620 (Solutionized)

CONCLUSION

Experimental study reveals the study of the mechanical properties of the aluminum alloys of the heat treatment applied in enhancing the performance of the alloys in their various applications. The various aluminum alloy studied subjected to the heat treatment (solutionizing followed by quenching and age hardening) makes superior mechanical characteristics and also need of further investigations on it.

REFERENCES

Bharathesh TP, Ramesh CS, Verma SM and Keshavamurthy R (2013). Influence of heat treatment on tribological properties of hot forged Al6061-TiO2 composites. *International Journal of Emerging Technology and Advanced Engineering* **3**(6) 103-111.

Girisha HN and Sharma KV (2013). Influence of process parameters on mechanical properties of heat treated aluminum copper magnesium alloy. *International Journal of Innovative Research in Sciences, Engineering and Technology*, **2**(1) 125-130.

Nigam Pravven Kumar and Jain Prakash (2013). Effect of heat treatment on tensile and compressive strength of nickel aluminum bronze. *Achieves of Applied Science Research*, **5** (1) 224-230.

Smeada Mihaela and Stoicanescu Maria (2013). Enhancement on Mechanical Properties of Aluminum alloys, *Review of the Air Force Academy*, **23**(1) 345-350

Tan Evren, Ogel Bilgehan (2007). Influence of heat treatment on the mechanical properties of AA6066 alloy, *Turkish Journal of Engineering and Environmental Sciences* 31(8) 53-60.