

The Effect of Heat Treatment on Tensile Hardness and Wear Properties of Al 6061 under T4 and T6 Condition

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Abstract:-- Modern Industry uses Aluminum alloys extensively of the 6000 series. Aluminum in its purest form is too soft and reactive to be of structural use. However, its alloys makes it structurally stronger. In the present investigation typical commercial grade Al 6061 alloy obtained from leading professional environments would be the test materials for investigations. The Al 6061 alloy has been subjected to solutionizing heat treatment at a temperature of 540°C for 2 hours followed by quenching in water. The quenched specimens are subjected to Natural ageing and Artificial ageing. Tensile test, Hardness test and Wear tests have been conducted on the specimens subjected to heat treatment. It has been observed under identical heat treatment conditions adopted. Al 6061-subjected to heat treatment under T4 and T6 conditions exhibited a significant improvement in tensile strength, hardness and wear resistance when compared with Al 6061 before heat treatment.

Index Terms— Ageing Natural Ageing, Artificial Ageing, Hardness, Quenching, Solutionizing, Tensile Test, Wear Test

I. INTRODUCTION

Al6061 is a versatile heat treatable extruded alloy with medium to high strength capabilities. Aluminium alloys are divided into casting alloys and wrought alloys, and are best suited for different applications. Wrought aluminium alloys, such as the 6061 alloy, are worked by extruding, rolling or forging them into specified shapes. Some alloys can be heat treated or cold worked by different methods to increase their strength and hardness, corrosion resistance, ease of fabrication and other advantages. Alloy 6061 can be easily welded and joined by various commercial methods. Since 6061 is heat treatable alloy, strength in its T6 condition can be reduced in weld region.

6061-T6 aluminum is structurally stronger and more useful in manufacturing of durable products. It is commonly used in aircraft construction. The present investigation is aimed at studying the effect of quenching and ageing duration on the hardness of Al 6061 alloy. Heat treatment is an operation in the fabrication of an engineering material system. The main objective of heat treatment is to make the material system structurally and physically fit for engineering application. Solution heat treatment of aluminium alloys allows the maximum concentration of hardening solute to dissolve into solution.

This process is carefully carried out by heat treatment of an alloy to a temperature at which one single solid phase exists. Quenching is a process of rapid cooling of material system to room temperature. The cooling rate needs to be fast enough to prevent solid state diffusion and precipitation of the phase. The rapid quenching creates saturated solution and allows for increased hardness and mechanical properties of the material system. In this investigation the ageing behavior of both heat treated and un heat treated Al6061 specimens.

II EXPERIMENTAL

2.1 Heat treatment

The both heat treated and unheated Al 6061 alloy specimens were subjected to heat treatment at a temperature of 540°C for a period of 2 hours using a furnace, followed by quenching in water medium. Artificial ageing treatment was carried out for 4 hour to 8hour in step of 2 hours. Natural ageing treatment was carried out for 75 days. Tensile test, hardness test and Wear Tests were carried out on both unheated and heat treated specimens.

Although the term heat treatment is often used to describe the procedures required to achieve maximum strength in any suitable composition through the sequence of solution heat treatment, quenching, and precipitation hardening, The heat treatment comprises all thermal

practices intended to modify the metallurgical structure of products in such a way that physical and mechanical characteristics are controllably altered to meet specific engineering criteria.

2.2 Hardness Test

Hardness measurements were carried out on heat treated specimen and unheated 6061 alloy. Round specimens of 20 mm in diameter were prepared. The prepared specimens were tested using the Rockwell hardness(R_B) tester. A minor load of 10 kgf and a major load of 100 kgf is applied.

2.3 Tensile Test

Tensile strength measurements were carried out on the test specimens of heat treated in order to compare with the Al 6061 unheated test specimen. Tensile strength was measured using the tensometer instrument.

2.4 Wear Test

Wear resistance measurements were carried out on the test specimens in order to compare with the Al 6061 unheated test specimen. Wear test was measured using a Pin on Disc instruments for both constant load and constant speed.

III. RESULTS AND DISCUSSIONS

3.1 Hardness

The variation of hardness different conditions is shown in the figure 1. It is observed that hardness increased in T6 condition

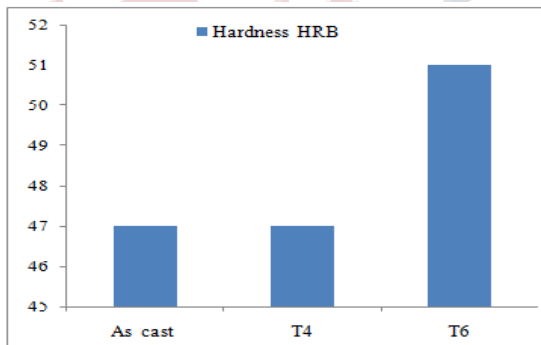


Fig 1: Variation of hardness As cast , T4, T6 conditions

3.2 Tensile Strength

The variation of the tensile strength of the heat treated Al 6061 with increase different heat treatment conditions is as shown in the figure 2. It is observed that tensile strength of Al 6061 alloy is found to be increased T4 and T6 conditions.

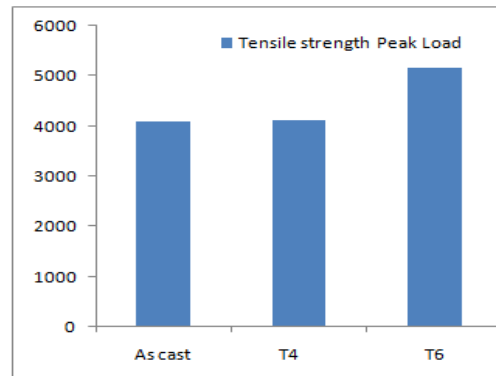


Figure .2. Variation of tensile strength As cast , T4 and T6 Conditions

The variation of peak load increase in the ageing as shown in the figure 2. It is evident that peak load found to be increased after heat treatment T4 and T6 conditions.

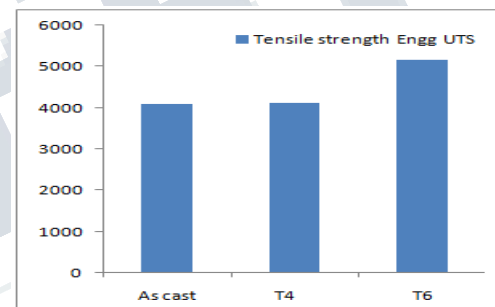


Figure .3. Variation of Engg UTS with As cast, T4, T6 Conditions

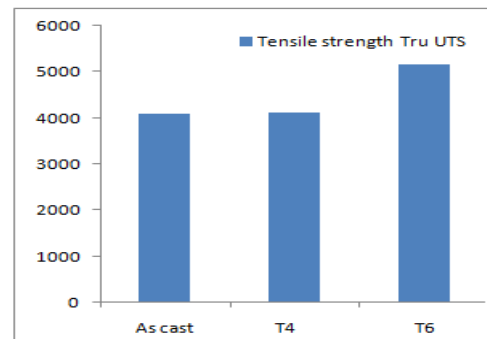


Figure 4. Variation of True UTS in Ascast,T4and T6 specimen

3.3 Wear Resistance

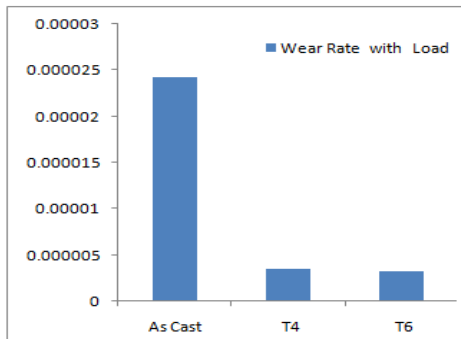


Figure 5. Variation of wear rate with load and time in As cast, T4, T6 specimen

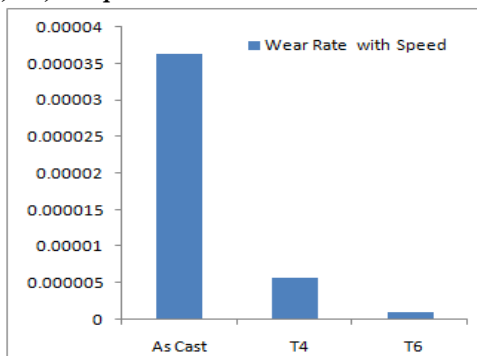


Figure 6. Variation of wear rate with speed time in As cast, T4, T6 specimen

Wear rate increased with increase in load and time. Wear rate decreased with heat treatment. T6 condition specimen exhibited better hardness, tensile and wear properties. The increase in grain size with ageing time in T4 condition could have decreased hardness and tensile strength and wear resistance.

IV. CONCLUSIONS

The mechanical and structural properties of Al6061 are improved after heat treatment. Tensile strength and hardness of Al 6061 is increased with the increase in the ageing time. Wear rate increased with increase in load, time and speed for all the conditions in general. Wear rate decreased with heat treatment. T6 heat treatment condition has shown better mechanical properties and lower wear resistance.

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