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MICROSTRUCTURAL CHARACTERIZATION AND MECHANICAL PROPERTIES OF Al 6061 SUBJECTED TO HEAT TREATMENT UNDER T6 CONDITIONS

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Abstract - *Aluminum alloy 6061 is one of the most extensively used of the 6000 series aluminum alloys. Aluminum in its purest form is too soft and reactive to be of structural use. However, its alloys such as 6061-T6 alloy, makes it structurally stronger. In the present investigation typical commercial grade Al6061 alloy obtained from leading professional environments would be the test materials for investigations. The Al6061 alloy has been subjected to solutionizing treatment at a temperature of 540◦C for 2 hours followed by quenching in water. The quenched specimens are subjected to artificial ageing. Micro structural studies were carried out to understand nature of structure. Tensile test, wear test and hardness tests have been conducted on the specimens subjected to heat treatment. It has been observed under identical heat treatment conditions adopted, Al6061-subjected to heat treatment under T6 conditions exhibited a significant improvement in hardness when compared with Al6061 before heat treatment*

Key Words: Solutionizing, Ageing, Quenching, Microstructure, Hardness, Wear

1.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. This light weight also made 6061-T6 best choice for the famous gold anodized plaques that were mounted on board of the 1972 pioneer 10 and 1973 pioneer 11 spacecraft. The present investigation is aimed at studying the effect of quenching and ageing duration on the hardness of Al6061 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 unheated Al6061 specimens.

2. 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. Microstructure, tensile strength, wear test and hardness test were carried out on both unheated and heat treated specimens

2.2 Microstructure

Microstructure studies are conducted on both heat treated and unheated Al6061 specimens. The specimens were ground with the emery papers from 400 to 3000 grit and polished with the diamond paste. For the characterization the scanning electron microscope was used.

2.3 Hardness Test

Hardness measurements were carried out on the specimens of heat treated in order to compare with the unheated Al6061. Round specimens of 20 mm in diameter were prepared. The prepared specimens were tested using the Rockwell hardness tester. A load of 500kgf is applied for a period of 30 seconds.

2.4 Tensile Test

Tensile strength measurements were carried out on the test specimens of heat treated in order to compare with the

Al6061 unheated test specimens. Tensile strength has been measured using the tenso meter instrument.

2.5 Wear Test

Wear resistance studies are conducted on both heat treated and unheated Al6061 specimens. Tube shaped specimens of 6mm in diameter were prepared. The specimens are tested for wear resistance using pin on disk apparatus for varying load and varying speed conditions.

3. RESULTS AND DISCUSSIONS

3.1 Hardness

The variation of hardness with increase in the ageing hours is shown in the figure 1. It is observed that with increase in the ageing duration there is a significant improvement in the hardness of the alloy

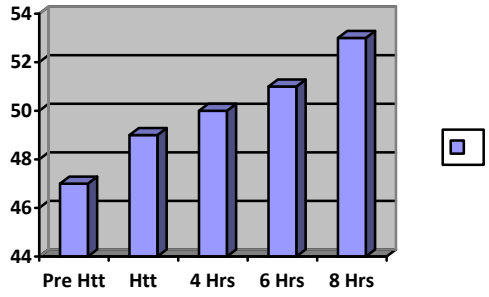

Fig 1: Variation of hardness with increase in ageing hrs.

3.2 Tensile Strength

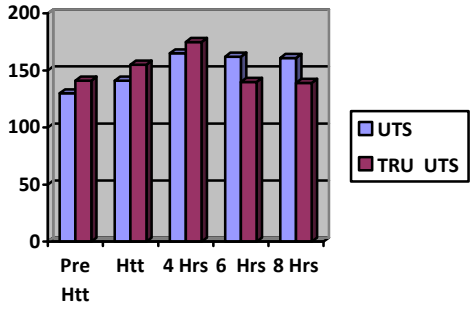

Figure .2.variation of tensile strength with ageing time.

The variation of the tensile strength of the heat treated Al6061 with increase in the ageing hours is as shown in the figure2. It is observed that tensile strength of Al6061alloy is found to be increased after heat treatment and ageing.

3.3 Wear rate

The variation of wear behavior of the heat treated Al6061 alloy with increase in ageing time is as shown in the figure 3. It is observed that the wear rate of heat treated Al6061 goes on decreases with the increase in the ageing time period.

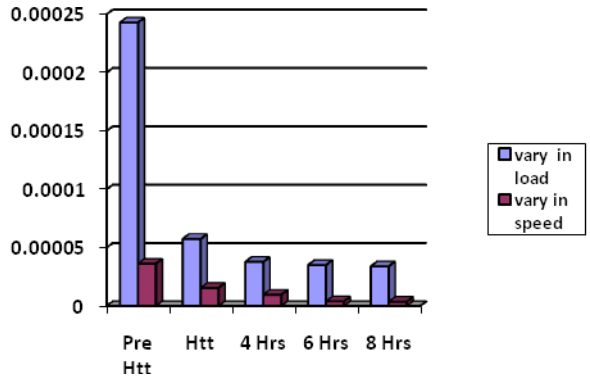

Fig. 3: Variation of wear rate with ageing time.

3.4 Microstructure

The optical micrograph of both unheated and heat treated Al6061 are shown in figures 3a, 3b, 3c, 3d and 3e. The micrograph clearly reveals boundaries and grain size

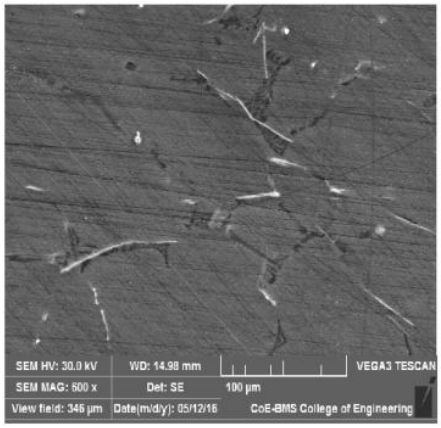

Fig. 3a: Microstructure of Al 6061 Pre treated

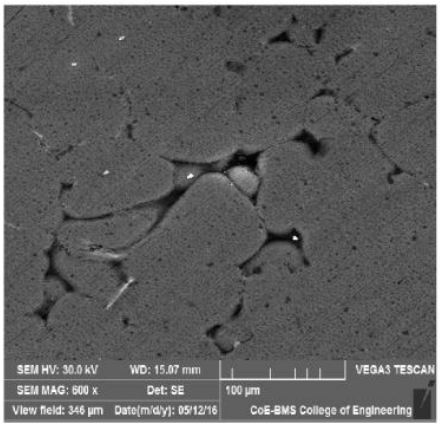

Fig. 3b: Microstructure of Al 6061 heat treated

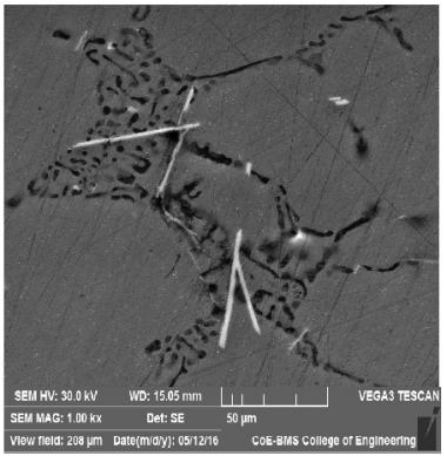

Fig. 3c: Microstructure of Al 6061-ageing for 4hours

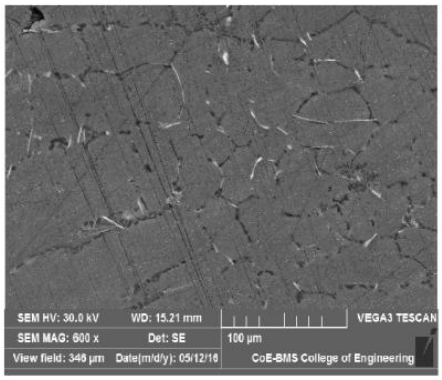

Fig. 3d: Microstructure of Al 6061-ageing for 6 hours

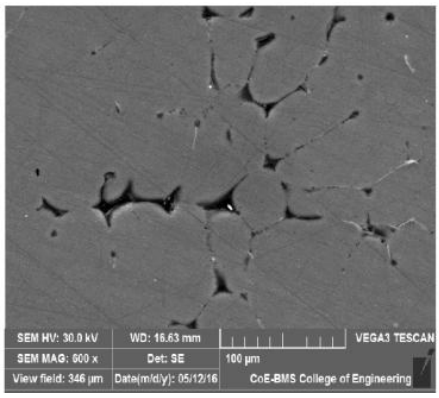

Fig. 3e: Microstructure of Al 6061-ageing for 8 hours

4. CONCLUSIONS

The mechanical and structural properties of Al6061are improved after heat treatment. Tensile strength and hardness of Al6061 is increased with the increase in the ageing time. Wear rate decreased with the increase in the ageing time. Microstructure shows 'α' grain with silicon and eutectic at the grain boundaries at pre heat treatment. Precipitating Mg-Si at the grain boundaries are observed after solutionazation. Particle sizes at grain boundary is completely small at crystalline matrix single Si wheel and hull Mg particles are notified after aging for 6 hrs.Clear boundaries are visible with increase in grain sizes after ageing for 8 hrs.

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