THE EFFECT OF AGING HEAT TREATMENT ON HARDNESS AND MECHANICAL PROPERTIES OF ALUMINIUM ALLOY

NOOR MUHAMMAD JAMALLUDDIN BIN JUSOH

This report submitted in partial

Fulfilment of the requirements for the award of a Bachelor of

Mechanical Engineering (Structure & Materials)

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

"I hereby declared that I have read this thesis, and in my opinion, this thesis is sufficient in terms of scope and quality for achieving award of Degree in Bachelor of Mechanical Engineering (Structure and Material)"

Signature : ....

Supervisor : Dr Mohd Ahadlin bin Mohd Daud

Date : ....

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature: ....

Author : NOOR MUHAMMAD JAMALLUDDIN BIN JUSOH

Date : 26/6/2012

Khas Buat

Ayah dan Ibu Tersayang

ACKNOWLEDGEMENT

First of all, I would like to thank to Allah because I managed to complete the Final Year Project (FYP) report on time without face any difficult problem The immense help and support received from many persons who generously advice and assist me while I was doing my FYP which is compulsory to all Universiti Teknikal Malaysia Melaka (UTeM) students to pass before awarded.

I owe a debt of thanks to all those time, concern and efforts were given during the process of completing this report. Thus, our heartfelt gratitude is extended my beloved supervisor Dr Mohd Ahadlin bin Mohd Daud for giving the support morally and physically and shared his expertise and knowledge with me and also special thanks to my second panel, En Hamzah bin Mohd Dom

I am highly indebted to panels, Dr Nor Salim Bin Muhammad and Puan Anita Akmar Bin Kamarolzaman who have provided me the valuable suggestion and good support during my presentation. I am thankful to everyone who always inspires me directly and indirectly during my FYP.

ABSTRAK

Dalam kajian ini, mekanisme pengagihan semula Mg dan Si atom semasa proses penuaan semula jadi telah dicadangkan. Hasil kajian ini untuk menentukan kesan penuaan rawatan pada kekerasan dan sifat-sifat mekanik Aloi Aluminium 6061 selepas Proses Rawatan Haba. Kesan penuaan semula jadi ditentukan berdasarkan perbandingan di antara medium pelindapkejutan selepas Rawatan Haba Penyelesaian dan Rawatan Penuaan dalam medium Relau dan penyejukan di Udara. Ujian bahan yang telah digunakan adalah berdasarkan kekerasan, tegangan dan analisis mikrostruktur. Tujuan ujian kekerasan adalah untuk mencari bacaan kekerasan untuk semua sampel yang digunakan untuk melihat kesan keretakan yang berlaku selepas membuat merawat proses haba untuk aloi aluminium yang 6061. Daripada ujian tegangan, tujuan adalah untuk mengetahui tenaga tegangan yang diserap untuk mematahkan sampel bahan dan kemudian membuat data perbandingan di antara sebelum dan selepas rawatan haba. Akhir sekali, untuk analisa mikrostruktur ia adalah penting untuk ditentukan kerana untuk melihat kesan proses penuaan dalam mikrostruktur aloi aluminium selepas membuat proses rawatan haba. Daripada data dan hasil yang telah ditentukan, ia menunjukkan hasil positif yang berdasarkan objektif dan skop projek ini.

ABSTRACT

In this study, the mechanism of Mg and Si atom redistribution during the process of natural aging has been proposed. The result of this study to determine the effect of aging treatment on hardness and mechanical properties of Aluminum Alloy 6061 after Heat Treatment Process. The effect of natural aging are determined based on comparison between quenching medium after Solution Heat Treatment and Aging Treatment in medium of Furnace and cooling in Air. The material testing that had been applied is based on hardness, tensile and microstructure analysis. The purpose of the hardness testing are to find out the hardness reading for all samples that used to look fracture effect that occur after make a heat treating process to the aluminum alloy 6061. From the tensile test, the purposes are to know tensile energy that absorbed to fracture the samples of the material and then make a comparison data between after and before heat treatment. Lastly, for microstructure analysis it is important to determine because to look the effect of aging process in the microstructure of aluminum alloy after make heat treatment process. From the data and result that already determined, it shown the positive result based on the objectives and scope of this project.

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MPa	=	Unit for Tensile Strength
0°C	=	Celsius
CNC	=	A lathe that is controlled by a computer running Programming driven by numerical data
mm	=	milimetre
%	=	Percentage
Al	=	Aluminum
T	=	Temperature
N	=	Newton
S	=	Second

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In recent years, aluminium alloys have attracted attention of many researcher, engineers and designers as promising structural materials for automotive industry or aerospace applications. Aluminium alloys are alloys in which aluminium is the predominant metal. Aluminium alloys are widely used in engineering structures and components where light weight or corrosion resistance is required. There are many type of aluminium alloy series in it alloy systems which the each series has their own mechanical and physical properties depends on the composition in that alloys. (P.J Gregson and S.J Harris, 2002). Aluminium alloys can be divided into two categories: non-heat treatable and heat treatable. Extensive studies have been done on the 6xxx aluminium alloys because of their benefits compared to the other type of aluminium. It has good mechanical properties and exhibits good weldability. The 6061 aluminium alloys has been used in the automotive industry for the fabrication of several types of automobile parts such as wheel spacers, panels and even in the vehicle structure. Several of aluminium alloy mechanical properties can be change by doing a specific heat treatment. Generally aluminium alloys can be heat treated to increase their mechanical properties especially their strength, hardness and also improves their fatigue resistance.

1.2 PROBLEM STATEMENT

A lot of researches have been done by the researcher all around the world on this aluminium alloy especially for industrial use. They have studied about the strength, formability, weldability and many more. The effect of variation aging time on machinability of 6061 aluminium alloy which has been heat treated to specific temperature has been investigate in this project. The purpose is to see whether the 6061 aluminium alloy mechanical properties is being affected or not by the variation aging time at specific temperature. Then the result is being compared to the result from the previous experiment that has been done by other researchers. Aluminum is one of the most widely used metals and also one of the most frequently found compounds in the earth's crust. Disadvantages of Aluminum is not particularly strong the strongest varieties are around 517 MPa tensile strength, is not very hard and it's easy to scratch. As a result, this project is to try to prove that the hardness after the Heat Treatment larger than before the Heat Treatment. In addition, it also perform microstructure which it described on it behaviours. These could be divided to Mechanical Properties as Young's Modulus, ultimate Tensile Strength, Tensile Strength and Yield Strength. Besides, the strength of material had a difference before and after the Heat Treatment. Nowadays, better and more consistent alloys and composite materials are all contributing to new structural designs [1]. Among the light metals, although aluminium itself is soft and low in strength it can be made stronger by giving proper combination of suitable alloy [2].

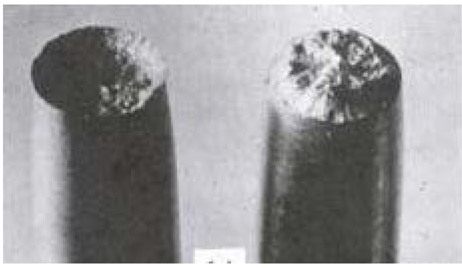

Figure 1.2: Cup and Cone Aluminium Fracture

(Source: H.W. Hayden, W.G Moffatt and J. Wulf , (1945))

1.3 OBJECTIVES

The objectives of the project that need to be achieved are:

1. To study the effect of aging treatment on hardness of aluminium alloy after Heat Treatment in comparison cooling in air and cooling in furnace.
2. To study the effect of aging treatment to mechanical properties of aluminium alloy after Heat Treatment Process in comparison cooling in furnace and cooling in air.

1.4 SCOPES

The focus area will be done based on the following aspect:

1. 6061 aluminium alloy sample preparation.
2. Aging Treatment temperature at 150°C, 200°C and 250°C.
3. Artificial aging of sample at 1 hour, 3 hours and 5 hours.
4. Specimen preparation by using the CNC Lathe machine.
5. ` Microstructure observation by using optical microscope.
6. Tensile Test by using INSTRON Equipment
7. Hardness test by using hardness test machine.

1.5 OVERVIEW OF THE REPORT

This project has been sort into six chapters. The introduction of the project has been show in chapter 1. In chapter 2, the literature review has been explained. Methodology is being told in chapter 3 while in chapter 4 are result, chapter 5 are discussion and lastly chapter 6 about conclusion.

CHAPTER 2

LITERATURE REVIEW

Literature review is a body of text that aims to review the critical points of current knowledge and or methodological approaches on a particular topic. In this chapter, the literature that will give information about this project and what happen during this experiment is being discussed. This project is intended to provide a lot of information about extensive background of Heat Treatment process with detail explanations as a reference for this project. The chapter begins with general overview of Heat Treatment and it types, details about Aluminum and few types of Testing.

2.1 ALUMINIUM

Aluminium, symbol Al, the most abundant metallic element in the Earth's crust. The atomic number of aluminium is 13; the element is in group 3 of the periodic table. Pure aluminium has a face centred cubic crystal structure.

Aluminium is a very light metal with a specific weight of 2.7 kg dm^{-3}, about a third that of steel. For example, the use of aluminium in vehicles reduces dead-weight and energy consumption while increasing load capacity. Its strength can be adapted to the application required by modifying the composition of its alloys and by various thermal and mechanical treatments.

Aluminium naturally generates a protective oxide coating and is highly corrosion resistant. Different types of surface treatment such as anodising, painting or lacquering can further improve this property. It is particularly useful for applications where protection and conservation are required.

Aluminium is an excellent heat and electricity conductor and in relation to its weight is almost twice as good a conductor as copper. This has made aluminium the most commonly used material in major power transmission lines.

Aluminium is a good **r**eflector of visible light as well as heat, and that together with its low weight makes it an ideal material for reflectors in, for example, light fittings or rescue blankets.

Aluminium is ductile and has a low melting point and density. In a molten condition it can be processed in a number of ways. Its ductility allows products of aluminium to be basically formed close to the end of the products design.

Aluminium foil, even when it is rolled to only 0.007 mm thickness, is still completely impermeable and let's neither light aroma nor taste substances out. Moreover, the metal itself is non-toxic and releases no aroma or taste substances which make it ideal for packaging sensitive products such as food or pharmaceuticals.

Aluminium is 100% recyclable with no downgrading of its qualities. The re-melting of aluminium requires little energy: only about 5% of the energy required to produce the primary metal initially is needed in the recycling process

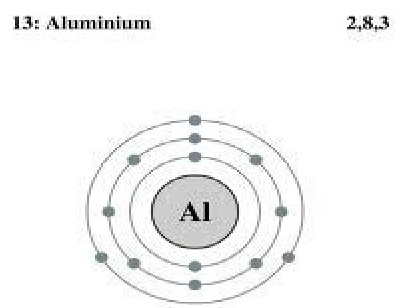

Figure 2.1: Element of Aluminium

(Source: Greg Robson)

2.2 ALUMINIUM ALLOY

Aluminium alloys are alloys in which aluminium is the predominant metal. Typical alloying elements are copper, zinc, manganese, silicon, and magnesium. About 85% of aluminium is used for wrought products, for example rolled plate, foils and extrusions. Cast aluminium alloys yield cost effective products due to the low melting point, although they generally have lower tensile strengths than wrought alloys. The most important cast aluminium alloy system is Al-Si, where the high levels of silicon (4-13%) contribute to give good casting characteristics. Aluminium alloys are widely used in engineering structures and components where light weight or corrosion resistance is required.

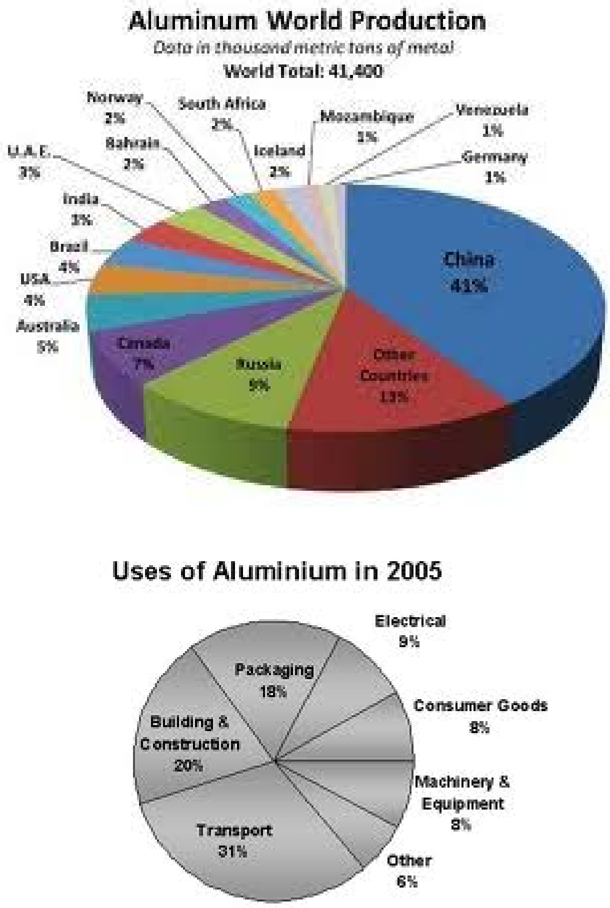

Figure 2.2: Production