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HARDNESS AND FLEXURAL
PROPERTIES OF HEAT TREATED SKD61 MEDIUM
CARBON STEEL

HAFIZUDDIN BIN MOHAMAD SHAFIEE

Report submitted in partial fulfillment of the requirements
for the award of the degree of
Bachelor of Engineering in Manufacturing Engineering

Faculty of Manufacturing Engineering
UNIVERSITI MALAYSIA PAHANG

JUNE 2016

SUPERVISOR'S DECLARATION

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ABSTRACT

Nowadays, medium carbon steel is widely used in engineering industry because of their balance properties. To change the mechanical properties of medium carbon steel, it needs to undergo heat treatment process. Heat treatment process is a combination of controlled heating and cooling a metal or alloy to achieve desired physical and mechanical properties. In order to modify the microstructure and desired mechanical properties, there are commonly heat treatments that often been used (annealing, normalizing, hardening and tempering). For this study, the samples are divided into two parts which are untreated and heat treated. For heat treated, the specimens were heating at 900 °C with soaking time 90 minutes and the cooled in different cooling medium which are quenched in water, inside the furnace and air. Then, the hardened specimens were tempered at two different temperatures. Rockwell Hardness test and flexural test are performed to investigate the hardness and flexural properties of the specimens and fractured surface of the specimens is observe using Field Emission Scanning Electron Microscope (FESEM). The result found that the hardness and flexural properties of the specimen is higher when the specimen is quenched in water compare with others cooling medium. Besides that, the hardened steel shows brittle fractured surface which consist of transgranular cleavage. Fractured surface for untreated, annealed and tempered 500⁰C specimen shows ductile failure mode with more plasticity deformation occurred.

ABSTRAK

Pada masa kini, keluli karbon sederhana banyak digunakan di dalam industri kejuruteraan kerana mempunyai sifat dan ciri-ciri mekanikal yang seimbang. Untuk menukar sifat-sifat mekanikal keluli karbon sederhana ini, ia perlu menjalani proses rawatan haba. Proses rawatan haba adalah proses gabungan pemanasan yang dan penyejukan logam atau aloi yang dikawal untuk mencapai sifat-sifat fizikal dan mekanikal diingini. Dalam usaha untuk mengubah mikrostruktur dan sifat mekanik keluli tersebut kepada ciri-ciri yang dikehendaki, terdapat beberapa kaedah rawatan haba yang sering digunakan (annealing, normalizing, hardening, tempering). Untuk kajian ini, sampel dibahagikan kepada dua bahagian iaitu sampel yang tidak dirawat dan sampel rawatan haba. Untuk proses rawatan haba, spesimen akan dipanaskan pada suhu 900 °C dengan masa rendaman selama 90 minit dan disejukkan dalam kaedah penyejukan yang berbeza iaitu menggunakan air, udara dan dibiarkan didalam relau. Kemudian, spesimen yang telah melalui proses pengerasan akan dipanaskan semula pada dua suhu yang berbeza bagi melalui proses rawatan haba pembajaan. Ujian kekerasan Rockwell dan ujian lenturan dilakukan untuk mengkaji kekerasan dan sifat-sifat lenturan spesimen dan patah permukaan spesimen dan seterusnya permukaan patah akan diperhatikan menggunakan Mikroskop Imbangan Elektron. Keputusan menunjukkan bahawa kekerasan dan sifat lenturan spesimen lebih tinggi apabila spesimen disejukkan didalam air berbanding kaedah penyejukan yang lain. Selain itu, keluli keras yang menunjukkan permukaan patah secara rapuh yang terdiri daripada belahan bebutir. Permukaan patah bagi keluli sederhana yang belum dirawat, penyepuhlindapan dan pembajaan pada suhu 500 °C, menunjukkan mod kegagalan secara mulur dengan lebih ubah bentuk plastic berlaku.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Heat treatment is a combination of controlled heating and cooling a metal or alloy to achieve desired physical and mechanical properties such as hardness, ductility, toughness, ultimate tensile strength, yield strength and the percentage of elongation. In order to modify the microstructure and desired mechanical properties, there are common heat treatments that often been used which are annealing, normalizing, hardening and tempering. The purpose of heat treatment process is to increase the strength or hardness of material, increase toughness, improving the ductility and make improvement in machinability.

The most common heat treatment that applied in order to soften the metal is annealing. In annealing, a metal is exposed to an elevated temperature in a certain time for the material structure to transform into austenite. Then, the metal will slowly cooled down to room temperature. The purpose of this type of heat treatment is to increase the softness, machinability and formability, to relieve internal stress and refinement of grain structure.

In normalizing, metal is heated to austenite temperature range and followed by left in air for cooling. The purpose of this treatment is to obtain a mainly pearlite matrix. It usually shows the strength and hardness which is higher than in as received condition. It also used to refine grains and the small grain size structure will improve the strength and hardness of the metal.

For hardening, it consists of heating a metal above the critical temperature followed by quench to a room temperature. The quenching media that often used are water, oil and brine; depend on the cooling rate needed. The main purpose of hardening is to increase the strength, hardness and toughness, wear resistance of the metal. The faster the cooling rate, the stronger and harder the metal, so the brittleness of metal will also increase, due to the martensite structure.

Next, tempering is a process of reheating a hardened metal to impart some toughness. The tempering temperature is depending on the material and it converts martensite to bainite. In the hardened, a metal is not only very hard but also brittle caused by a predominance of martensite. To remove this brittleness, tempering process need to be done to lower the brittleness and give good effect to the other mechanical properties.

In this project, there are four type of heat treatment will be perform which are annealing, normalizing, hardening and tempering. The purpose of using these treatments is to modify the mechanical properties of the metal based on the type of heat treatment performed. For this heat treatment process, the material SKD61 medium carbon steel will be used and it will be heated at austenite temperature and will be cooled in three different cooling medium.

1.2 PROBLEM STATEMENT

There are many previous researches that focus on the heat treatment of the medium carbon steel. Based on the literature review, the common method to improve mechanical properties of metal is by heat treatment process. However, to choose the cooling medium and the tempering temperature to ensure it compatibles with their application still remain a challenge. The quality of heat treatment for the metal parts depends on many factors, including thermal schedule and cooling medium. This research is conducted to study the improvement of mechanical properties after the heat treatment process and observation on hardness and flexural testing.

1.3 OBJECTIVE

The objectives of this research are:

1. To perform heat treatment process on the SKD61 using various cooling medium
2. To investigate the hardness and flexural properties of heat treated SKD61 medium carbon steel through hardness test and flexural test.
3. To observe the fractured surface of SKD61 using Field Emission Scanning Electron Microscope (FESEM)

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