MICROSTRUCTURE ANALYSIS ON HEAT TREATED CARBON STEEL MATERIAL SUBJECTED TO EXTERNAL FLAME HEATING PROCESS (DUE TO WARPAGE CONTROL)

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive)"

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Date	: 26th June 2012

PENGAKUAN

Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya telah jelaskan sumbernya”

Tandatangan :…..……………………

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Tarikh :…....…………………

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: ....

Date: ....

Specially dedicated to my beloved and very important person in my life;

Yahani Bin Yusoff

Mazmoon Binti Daud

All my family and friends

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ABSTRAK

Tesis ini berkaitan tentang kajian dan analisa terhadap perubahan keatas struktur dalaman keluli carbon yang telah menjalani proses rawatan haba dan kemudiannya dikenakan pula proses pemanasan luaran. Besi keluli yang telah menjalani rawatan haba boleh meleding kerana banyak faktor seperti variasi suhu, pemanasan/penyejukan rawak dan sebagainya akibat daripada suhu melampau semasa proses rawatan haba. Keluli yang meleding tidak boleh diproses pada peringkat seterusnya dan perlu dibaik pulih terlebih dahulu. Sesetengah kilang keluli menggunakan teknik pemanasan nyalaan luaran untuk meluruskan balik bahagian keluli yang telah meleding. Tetapi proses berkenaan menggunakan suhu yang sangat tinggi dan boleh mengakibatkan perubahan pada struktur dalaman keluli berkenaan. Jadi tujuan tesis ini adalah untuk menganalisa perubahan struktur mikro pada keluli yang telah diluruskan. Bahan yang digunakan untuk projek ini adalah keluli karbon (AISI 1025) dan keluli berkenaan telah menjalani proses rawatan haba sehingga meleding dan kemudian diluruskan balik menggunakan proses pemanasan nyalaan luaran. Keluli karbon yang diluruskan tadi kemudiannya diperiksa menggunakan mikroskop dan struktur mikro dibandingkan dengan keluli karbon yang meledeing tetapi tidak diluruskan

ABSTRACT

The thesis is about to study and analyze the change of internal structure of heat treated carbon steel that have been subjected with external flame heating process. The heat treated carbon steel can warp because of many factors such as temperature gradient, rapid heating /cooling and else as a results of extreme temperature during heat treating process. The warped steels cannot proceed to further production stage and need to be repaired. In some steel factories, external flame heating process is used to straighten back the warped parts. But the process required high temperature and the internal structure of steel can be change. So, the purpose of this thesis is to analyze the microstructure change of straightened steel. The material used for this project is carbon steel (AISI 1025) and the carbon steel have been undergone heat treatment process until warped and then be straighten back using external flame heating process. The straightened carbon steel is examined using microscope and the microstructure is compared with non-straighten warped carbon steel.

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LIST OF SYMBOLS

SAE	=	Society of Automotive Engineering
AISI	=	American Iron and Steel Institute
ASTM	=	The American Society of Testing and Material
UNS	=	United Numbering System
C	=	Carbon
Mn	=	Manganese
P	=	Phosphorus
S	=	Sulfur
BCC	=	Body- Centered Cubic
FCC	=	Face-Centered Cubic
Fe	=	Iron
Cu	=	Copper
T	=	Thickness
L	=	Length
W	=	Width

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Heat treatment is a controlled heating and cooling of metal in order to alter their physical and mechanical properties without changing the product shape. The processes required extreme temperature to achieve desired results such as hardening, softening, magnetizing and improve brittleness.

There are eight reasons why steel parts can warp during heat treatment process which are rapid heating, overheating, non-uniform heating, non-uniform cooling, non – uniform agitation, water contamination in oil, large change of mass and section and asymmetric features.

In order to reduce and repair the warped parts, external flame heating process can be used to straighten back the warped hardened parts. Flame heating process is based on principle that metals expand when heated and contract when cooled. But extreme temperature used during the process may cause the internal structure of the steel parts change hence changes their physical properties.

Microstructure analysis can be used to observe and analyze the internal structure of metals. By comparing the microstructure of straighten parts and non-straighten warped parts, the differences of internal structure because of external flame heating process can be determined.

1.2 PROBLEM STATEMENT

Temperature variation can change the internal structure or microstructure of steel resulting change in its properties. The usage of external flame heating process to repair the warped part may change the internal structure because of high temperature applied to heat the warped parts during process. Further microstructure analysis can determine the differences on straighten warped steel's microstructure with non-straighten warped steel's microstructure.

1.3 OBJECTIVES

i. To study and make some research about warpage on heat treated carbon-steel material
ii. To understand the effect of external flame heating process on the microstructure o carbon steel
iii. To analyze the microstructure of heat-treated carbon steel subjected to external flame heating

1.4 SCOPE

The study will focus on analyzing the microstructure change on heat-treated carbon-steel that have been subjected with external flame heating. The material for this project is Carbon Steel. All the process of producing the sample will be done in faculty according to what has been practiced by the industry.

CHAPTER 2

LITERATURE REVIEW

2.1 CARBON STEEL

The definition of carbon steel is an alloy of iron having carbon as its main alloying element. They can be categorized according to the percentage of carbon (P. Pohanish 2003). Low carbon steel having percentage of carbon below 0.15%. Mild carbon steel contains percentage of carbon between 0.15% and 0.3%. Mild steel have good weldability but poor hardness and usually used as sheets, pipes, and wires. Medium steels have 0.3-0.8% carbon and used widely for rails, boilers, plates, axles, and building main structure. Due to the presence of higher carbon, medium steel is harder than mild steel. High carbon steel contains 0.8-1.5% carbon and used for surgical instruments, springs, cutlery, and razor blades. High carbon steel has low formalibility and toughness but higher hardness and wear resistance compare with other type of carbon steel (S.K Sharma 2011).

The other elements that usually exist on carbon steel are sulfur, manganese and phosphorus. The standardization and development about the composition of iron steel has been established by the Society of Automotive Engineers (SAE) and American Iron and Steel Institute (AISI) (Dosset, Boyer and howard 2006).

Table 1 shows the types and approximate elements in standard carbon steels according to their series.

Table 1: Types and approximate percentage of identifying elements in standard carbon steels

(Source: Practical Heat Treating, (2006))

Series Designation	Description
10XX	Nonresulfurized. 1.00 manganese maximum
11XX	Resulfurized
12XX	Rephosphorized and resulfurized
15XX	Nonresulfurized, over 1.00 manganese

The American Society for Testing and Materials (ASTM) has designed the United Numbering System (UNS) for standard carbon and alloy grades. Table 2 shows the UNS numbers and composition for selected AISI-SAE carbon steels.

Table 2: UNS number and composition of selected nonresulfurized carbon steels (1.0%Mn). (Practical Heat Treating, (2006))

Steel Designation (AISI-SAE)	UNS No.	Chemical Composition %			
		Carbon, C	Manganese, Mn	Phosphorus, P (Maximum)	Sulfur, S (Maximum)
1008	G10080	0.10 max	0.30-0.50	0.04	0.05
1012	G10120	0.10-0.15	0.30-0.60	0.04	0.05
1015	G10150	0.13-0.18	0.30-0.60	0.04	0.05
1018	G10180	0.15-0.20	0.60-0.90	0.04	0.05
1020	G10200	0.18-0.23	0.30-0.60	0.04	0.05
1022	G10220	0.18-0.23	0.70-1.00	0.04	0.05
1025	G10250	0.22-0.28	0.30-0.60	0.04	0.05
1029	G10290	0.25-0.31	0.60-0.90	0.04	0.05
1030	G10300	0.28-0.24	0.60-0.90	0.04	0.05
1035	G10350	0.32-0.38	0.60-0.90	0.04	0.05

The UNS number is the combination of a single letter followed by 5 numbers. For standard carbon steels and alloys grade, the single letter is denoted by G and for other metals and alloys the different single letter have been used to denote them (ASTM E-527, 2003). The first four digit of the UNS number based on AISI-SAE designation and the last digit (except zero) is to denote the additional composition requirement.