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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this report and in my opinion, this report is adequate in terms of scope and quality for the award of the degree of Bachelor of Manufacturing Engineering with honors.

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STUDENT'S DECLARATION

I hereby declare that the work in this report is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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STUDY THE EFFECT OF MARTENSITE- FERRITE CONSTITUENTS PHASE OF THE PLAIN MEDIUM CARBON DUAL PHASE (DP) STEEL ON THE MECHANICAL PROPERTY AND CORROSION BEHAVIOR

MAISALSADILA BINTI ISMAIL

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ABSTRAK

Kajian dibuat bagi menilai kesan asas fasa ferrite-martensite terhadap keluli karbon sederhana yang melalui proses rawatan haba yang telah diubahsuai terhadap tiga sampel kumpulan dan satu kumpulan sampel yang tidak dirawat di dalam asid hidroklorik 1M. Setiap kumpulan sampel tersebut telah dilabel sebagai kumpulan A (bagi sampel yang tidak dirawat untuk dijadikan sebagai rujukan), B, C and D. Pada permulaan proses, Keluli karbon sederhana kumpulan C dan D akan dipanaskan sehingga suhu 950 °C supaya mencapai paras austenite yang sebenarnya (γ-fasa) dan kemudian disejukkan di dalam air manakala sampel kumpulan B akan dipanaskan sehingga suhu 750 °C bagi menghasilkan dua fasa ferrite-martensite dan seterusnya direndam di dalam air bagi proses penyejukan. Kemudian, keluli kumpulan C dan D akan dipanaskan kembali sehingga suhu 750 °C seperti keluli kumpulan B iaitu bagi menghasilkan dua fasa ferrite-martensite dan seterusnya keluli tersebut direndam di dalam air bagi proses penyejukan. Keluli karbon tersebut kemudian dipanaskan sekali lagi pada suhu yang lebih rendah iaitu 480 °C. Ciri-ciri hakisan yang berlaku pada keluli karbon yang direndam di dalam 1M asid hidroklorik (HCL) telah dikaji dengan mengukur kadar penurunan berat setiap sampel tersebut. Bagi Keluli karbon sederhana yang tidak dirawat, kehilangan berat adalah antara 0.003g – 0.022g manakala keluli karbon sederhana haba yang dirawat pula kehilangan berat adalah antara 0.004g – 0.167 g. Ujian mekanikal telah dijalankan ke atas sampel kumpulan A, B, C dan D. Keputusan yang diperolehi menunjukkan bahawa kekerasan sampel itu bergantung pada kadar jumlah martensite yang hadir di dalam setiap sampel yang mempunyai dua fasa iaitu ferrite-martensite.

ABSTRACT

The investigation was carried out to study the effect of martensite-ferrite constituent phase on the medium carbon steels that undergo modified heat treatment process for three groups of samples and a group of untreated sample on corrosion test 1M hydrochloric acid. Each of the group samples were labeling with group A (untreated sample act as reference), B, C and D. The medium carbon steels for samples group C and D were heated to a temperature of 950 °C for completely austenite (γ-phase) while samples group B were heated until temperature 750 °C to form ferrite-martensite dual phase region and then quenched in water. Then, group C and D steels were reheated until temperature 750 °C of ferrite-martensite dual phase region and rapidly quenched in water. Next, the steels were tempered at a temperature of 480 °C. The corrosion behavior of the carbon steel in 1M hydrochloric acid (HCL) was studied by measuring the weight loss of the steels. For untreated medium carbon steel, the weight loss is between 0.003g – 0.022g while for heat treated medium carbon steel, the weight loss is between 0.004g – 0.167g. The mechanical test was carried out on the samples of group A, B, C and D. The results obtained indicate that the specimen hardness is proportional to the amount of martensite in dual phase steel.

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LIST OF SYMBOLS

%	Percentage
α	Alpha
γ	Gamma
δ	Delta
^oC	Degree Celsius
^oF	Degree Fahrenheit

LIST OF ABBREVIATIONS

UTS	Ultimate Tensile Strength
DP	Dual-phase

CHAPTER 1

INTRODUCTION

1.1 Background

The most useful and highly applicable engineering material is a carbon steel which represented around 85% of the aggregate yearly steel generation around the world (Tolulope, Akintoye, Joseph, & Olanrewaju, 2016). It is the major classification of metallic alloys which applied in tonnage and total cost. Corrosion of carbon steel has been an issue of enormous practical significance because of its high cost on the national economy. In spite of its moderately constrained corrosion resistance, carbon steel is utilized as a part on marine applications, pipelines, mining, chemical processing, metal-processing equipment, production and refining of petroleum, chemical processing, pipelines, mining, construction, fossil fuel power and nuclear power plants. However, due to the thermodynamic instability of carbon steels, they are strongly susceptible to corrosion when exposed to aqueous environments. This is more apparent in acidic media as more applications of acid solution in most industrial field. The corrosion issue consists of the major portion of the overall expenditure for petrochemical companies worldwide, occurring whenever stages from down–hole to surface equipment and processing facilities. There are serious economic losses when the corrosion induced as it is usually associated with operational problems and needs maintenance of plants and equipment continuously but under limited or complete process shut- down (Tolulope et al., 2016).

Appropriate corrosion control and prevention methods have been shown to help mitigate against potential disasters that capable causes negative social impacts, environmental pollution and damage to water resource. This is one of the reasons that the iron and steel get a protective system from the existence of entire industries. Historically, corrosion inhibitors have been observed to have excellent anti-corrosive properties; however, a significant proportion of them caused secondary effect, damaging the environment. In order to protect the metals from corrosion in atmospheric conditions, one of the prevention methods that are widely used is organic paint coatings. Thus, as the demand for thermal-resistant coating increases, but there are some questionable about their thermal stability at high-temperature (Nazeri, Suan, Masri, & Alias, 2012).

Generally, the composition of the alloy, heat treatment and mechanical processing are involving much in phase transformation behaviour, mechanical properties, corrosion resistance and processing (Renato et al., 2014). Hence, the corrosion rate of carbon steel is also can be influenced by its chemical composition and microstructure, so that it's not only governed by the electrolyte conditions. Therefore, to correlate the metallurgical concept with the corrosion parameters, the corrosion behaviour of carbon steel and effects of microstructure on such behaviour is still an open field for investigation. Heat treatment condition would have a great effect on the microstructure of the carbon steel and directly connected to the corrosion resistance of the carbon steel. Thus, the purpose of this study is to establish heat treatment conditions that can give optimum microstructure phases which contribute to the least corrosion rate of the carbon steel.

1.2 Problem Statement

Dual-phase (DP) steels are being used in automobile industries for last three decades. DP steels possessing a composite microstructure consisting of hard martensite islands embedded in a soft ferritic matrix have evoked much interest. DP steels possess a number of unique properties such as continuous yielding, low 0.2% offset yield strength, high ratio of ultimate tensile strength (UTS) to yield stress, high work hardening rate, and high uniform and total elongations, which are making them attractive for applications such as very good quality sheet materials for automotive bodies. However, in order to meet other requirements such as durability of sheet metal products over long periods, the corrosion resistance becomes crucial. There is research has studied electrochemical behaviour of micro alloyed DP steels and found that with increase in martensite content and structural refinement, the corrosion resistance decreased. However, there is little work on corrosion behaviour of plain medium carbon DP steels. Further investigations in this direction are necessary to find the effect of martensite volume fraction of plain medium DP steel on its corrosion behaviour. The research investigation deals with the study of mechanical properties (hardness) and corrosion behaviour of medium carbon DP steels with different fractions of martensite and ferrite phase. The constituent phase is controlled by varying the heat treatment process. These results are also compared with the corrosion behaviour of as received steel with ferrite and pearlite as micro constituents.

1.3 Objectives of Research

The main objectives of this project are:

i. To study the effect of heat treatment process on the microstructure of medium carbon steel materials.
ii. To evaluate the effect of microstructure changes on the mechanical property.
iii. To investigate the effect of martensite-ferrite phase on the corrosion behaviour of medium carbon steel.

1.4 Scope of Research

In order to achieve the objectives, the following scopes of studies are performed:

i. The study will conduct annealing, quenching, lamellarizing and tempering of heat treatment process.
ii. The effect of heat treatment on corrosion rate will be varied by testing on 1M hydrochloric acid (HCl) solution.
iii. Mechanical testing including hardness test, corrosion test and microscopic examination will be conducted in this study.

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