APPLICATION PALM KERNEL SHELL CHARCOAL IN STEEL CARBURIZING PROCESS

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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 (Structure and Materials)"

Signature: .....

Supervisor: .....

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: ……..

Date: …….

This thesis is dedicated to my parents who have never failed to give me moral support and also for my supervisor who teaching me that even the largest task can be accomplished if we can apply our logic thinking and also my friends give support and encouragement

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ABSTRACT

Some of new material produce, the several mechanical properties are often is not good where unexpected material occurred during the production. May be the composition is not enough to achieved hardened of that component. Impact of this situation, structural component especially strength and hardening of the material is relatively low. Besides that, it can malleable and very cheap to acceptable for production of mechanical component. Chemical composition can increase and changed in microstructure with through carburizing process. Carburizing is one of heat treatment method where it can improve the mechanical and physical properties of material. Thus, using the supplement material such as organic waste used as raw material as carbon through carburizing process as an additional material to combination another component especially steel. Raw material is palm kernel shell is made through a pyrolysis process and produce charcoal. In the experimental is conducted, with an estimated 21 samples from solid cylinder low carbon steel used for preparation towards carburizing process. The carburizing was conducted with variation of time and temperature to study effect of physical and mechanical properties of steel and also do comparison between before and after carburizing process. Besides that, microstructure testing using XRD and SEM can be analyze where characterization can obtained and knowing new surface of microstructure and also it can be analyze mechanical properties especially for hardness of material using by Rockwell hardness tester. Thus, the chemical compositions are known where the change for carbon content on the specimen. However, palm kernel shell is possibility to become a high potential raw material for use in the carburizing where palm kernel shell has like a same characteristics than current carbon. Therefore, renewable product such as organic waste, it give impact to assist growth in green technology and enhance its contribution to the economy.

ABSTRAK

Pada umumnya dapat dilihat bahawa penghasilan pembuatan produk baru akan menghasilkan sifat mekanik yang kurang baik dan tidak dijangka akan berlaku semasa pengeluaran akhir produk. Kesan daripada keadaan ini, hasil komponen struktur terutama dari segi kekuatan dan kekerasan bahan tersebut amat rendah. Malah komponen tersebut boleh tempa pelbagai bentuk dan amatlah murah bagi pengeluaran komponen mekanikal. Proses pengkarbonan merupakan salah satu kaedah rawatan haba terhadap keluli di mana ia boleh meningkatkan sifat-sifat mekanikal dan fizikal sesuatu bahan. Oleh itu, dengan menggunakan bahan tambahan seperti sisa organik yang dijadikan sebagai karbon neutral, mampu menghasilkan pengeluaran produk akhir yang baik semasa proses pengkarbonan. Bahan mentah seperti isirong kelapa sawit yang boleh menghasilkan serbuk karbon melalui proses pirolisis. Dalam kajian yang dijalankan, sebanyak 21 sampel pepejal silinder keluli karbon rendah disediakan untuk penyediaan ke arah proses pengkarbonan. Pembolehubah ditetapkan sebelum proses dijalankan seperti perubahan masa dan suhu bagi tujuan untuk menentukan kesan daripda sifat fizikal dan mekanikal keluli malah boleh dibuat perbandingan sifat tersebut antara sebelum dan selepas proses pengkarbonan. Selain itu juga, analisis mikrostruktur boleh dihasilkan bagi menetukan pencirian bahan dengan menggunakan penguji mikroskop optik dan juga dapat menganalisis mutu bagi sifat mekanik terutama bagi kekerasan permukaan logam dengan menggunakan penguji kekerasan jenis Rockwell. Walaubagaimanapun, secara keseluruhannya isirong kelapa sawit berkemungkinan mampu menghasilkan bahan mentah yang berpotensi tinggi semasa melalui proses pengkarbonan di mana isirong mempunyai ciri-ciri yang hampir menyamai sifatnya dengan karbon semasa. Oleh itu, produk yang boleh diperbaharui seperti sisa organik dapat memberi impak untuk membantu pertumbuhan dalam teknologi hijau dan mampu meningkatkan sumbangannya kepada ekonomi.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

In generally, carburizing is one of the surface treatment materials have been in use extensively to improve the mechanical properties of materials such as toughness, hardness and wear resistance of materials. A change in mechanical properties is the result of the micro structural changes especially on the steel. Carburizing is the addition of carbon to the surface of low-carbon steels at temperatures within the austenitic region of the steel concern, which generally is between 850°C and 950°C for low carbon steels. Within this temperature range austenite, which has high solubility for carbon, is the stable crystal structure. “According from Krauss.G.(1980), hardening is accomplished when the subsequent high-carbon surface layer is quenched to form martensite so that a high-carbon martensitic case with good wear and fatigue resistance is superimposed on a tough, low carbon steel core”[1].

Automobile components, gear, spring and other component steel which require high fatigue resistance, are normally case hardened by carburizing. Palm kernel shell is one of the subjects in the study will be discussed in this project. In generally, palm kernel has one good criteria for used during the process hardening of the surface component. Palm kernel refers to the part of the structure of the oil palm fruit. We know that oil palm is a major source of edible oil which is extracted from its fruits. In production of cooking oil from palm fruit, the palm kernel shell and fibres' has separated during pressing process and then discarded as wastes. Therefore, the resulting waste will steadily increase and potentially contribute to environmental pollution. "A current data from the PORLA (1988), large amount of these wastes are generated annually, especially from Malaysia which is the world largest palm oil producer. Malaysia produces 4.2 million tonnes of palm oil annually from 280 mills and 36 operating refineries"[2]. "In research by Lua, A. C. and Guo, J (1998), it has been estimated that about 2.52 million tonnes of extracted fibre and 1.44 million tonnes of palm shells are produced as wastes annually. Due to the abundant supply of these solid wastes, they may be used as precursors for the preparation of carbon"[3].

The most favourable use the palm kernel shell it can process to become a charcoal. They are light and natural size and they are ideal for mixtures with steel and can be used as potential in the carburizing. The major influencing parameters in carburizing are the carbon potential as from palm kernel shell, holding time and carburizing temperature. The aim of research is focused on optimizing carburizing temperature and holding time on the properties of steels with use palm kernel shell as a charcoal during the carburizing process.

1.2 PROBLEM STATEMENT

In rapid development at present, activities such as recycling is given attention and emphasis to be renewed for each country. Recycling occurs when materials are processed and produce the same product. Recycling materials that change should be the waste of valuable resources. Palm kernel shell is one material that can be applied again to be a particularly important material for the industry that it can increase the potential to conserve and minimize the impact to the environment. Other than that, it can reduces the consumption of raw materials and use less energy than processing of natural resources. Even the existing carbon used in the laboratory is far more expensive than using recycled waste such as palm kernel shell.

Other than that, the content at low carbon steel is very low. Therefore, steel has relatively low tensile strength, low hardness surface and also low mechanical properties of steel. Accordingly, this research introduced pack carburizing process which uses palm kernel shell as a charcoal. Palm kernel shell is usually produced by pyrolisis method. In this process used to achieve different properties in steel component depend on the temperature and time especially in the hardness of the component.

1.3 OBJECTIVES

1. To produce charcoal from palm kernel shell.
2. Characterization of raw materials and steel product.
3. Physical and mechanical testing of carburizing product.

1.4 RESEARCH SCOPES

1. Manufacturing charcoal from palm kernel shell with pyrolisis method.
2. Steel carburizing process.
3. Characterization and testing of physical and mechanical properties of steel product before and after carburizing process.

1.5 IMPORTANT OF PROJECTS

1. Introducing the production of carburizing towards low carbon steel by using palm kernel shell as a source of carbon.
2. Promote the resources that are renewable such as palm kernel shell.
3. To assist growth in green technology and enhance its contribution to the economy.
4. Provide value addition surface hardening on the low carbon steel as well as that, study a rate surface hardening depends on time and temperature.

CHAPTER 2

LITERATURE REVIEW

Literature review is collective of data gather from reading, reference and also information from expert relating to the projects which will be review in this chapter. Other than that, literature review are secondary source, be organized around and relayed directly research for development of project. From here, it can be understand the purpose of the project and how are going to achieve the result. So it is very important to review the information to gain and make sure it will be useful for development of this research.

2.1 STEEL

Steel is the commonly name from iron stage, most of steel made a 95 % iron and it also perhaps a large family of iron alloys which can easily malleable after the molten stage. Steel can increase 0.10 – 0.25 percent carbon posses high strength and

toughness value. It can increase the carbon content in addition to which the mechanical properties will also be increased during the carbonation process.

Above the carbon level, casting is about the only way that a useful shape which is reheated and hot worked into wrought shape such rolling, forming, and shearing or other fabrication techniques. For steel forging the most common engineering materials used, and it comes in many forms and different properties. From **Table 2.1** below shows the chemical composition of steel, steel can be classified into three main groups, including carbon steel, alloy steel and stainless steels.

Table 2.1: Chemical composition of standard steel

Steel	**Composition**
1. Carbon Steels	The chemical is an alloying elements do not exceed these limits: around 1% of carbon, 0.6% copper, 1.65% manganese, 0.4% phosphorus, 0.6% silicon, and 0.05% sulphur .
2. Alloy Steels	Steels that exceed the element limits for carbon steels. Also includes steels that contain elements not found in carbon steels such as nickel, chromium (up to 3.99%), and certain cobalt elements.
3. Stainless Steels	It contains at least 10% chromium, with or without other elements. Based on the structures of steel, stainless steels can be divided into three grades there include austenite, ferrite and martensite.

"According to Kenneth and Michael (2010), the steel is an alloy of iron and carbon but this statement must be qualified by placing limits on carbon content. When iron-carbon alloys have less than 0.05% they considered to be pure iron. From commercial standpoint, steels have a low carbon limit of approximately 0.06% carbon. Thus, steels are alloys of iron and carbon, with carbon limits between approximately 0.06% and 2.0%. These materials are put into the blast furnace. The result in pig iron where occurred composition between iron and carbon. Other than that, addition a several material such as silicon, sulphur, phosphorous and manganese is to make high carbon content. Thus, to make steel from pig iron, a number of other impurities besides carbon also must be removed. The oxygen must be used to remove the carbon in the iron. In the molten state, the carbon in solution in the iron readily combines with the oxygen that is introduced as air or pure oxygen to form CO once again. Therefore, the oxygen as well as additional fluxing ingredients, reduces the level of the other impurities in the pig iron"[4].

2.2 CARBON STEEL

Carbon steel as known plain carbon steel is one of steel which it contain main alloying element is carbon. We know that, the most of plain carbon steel produced a generally a lower carbon content. Mostly of the steel produced now a days is plain carbon steel. It is divided into 4 types depending upon the carbon content:

1. Dead or mild steel (up to 0.15% carbon)
2. Low carbon steel (0.15% - 0.45% carbon)
3. Medium carbon steel (0.45% - 0.8% carbon)
4. High carbon steel (0.8% - 1.5% carbon)

"Recent research from O.O. Daramola, B.O. Adewuyi and I.O. Oladel (2010), steel with low carbon content has properties similar to iron phase. As the carbon content increases the metal to become harder and stronger but less ductile and more difficult especially for weld working. For the higher carbon content, it has a

lowers the melting point and its temperature resistance carbon content cannot alter yield strength of material"[5].

2.2.1 Low carbon steel

Low carbon steel it defined the carbon content in steel is lower in general. Then, it is one of group of low alloy steel structure and divided into two type one is plain and high strength, low alloy. Besides that, low carbon steel at the **Figure 2.1** has carbon content of around 2.0% until to 4.5%. Then, it is the most common type of steel as its price is relatively low while it provides material properties that are acceptable for many applications especially in the industry. Besides that, the price for low carbon steel is relatively low while provides material properties that are acceptable for many applications. In fact, due to the low carbon content and also has a low tensile strength, the characteristics which are inherent in low steel is ductile and brittle and also malleable.

Figure 2.1: Low carbon steel

"According to Callister Jr. W.D. & Rethwisch D.G. (2008) **,** generally contain less than about 0.25 wt% carbon and are unresponsive to heat treatments intended to form martensite, strengthening is accomplished by cold work. Microstructure consists of ferrite and pearlite constituents. As a consequence, these alloys are relatively soft and weak but there have ductility and toughness, in addition they are machinable, weldable and of all steels are the least expensive to produce"[6]. The most applications include automobile body component panel, structural shapes such I-beams and channel, buildings, bridge and also tin cans. From **Table 2.2** below represent the composition of several plain low carbon steel.

Table 2.2: Chemical composition of low carbon steels (Source: Callister Jr. W.D.,2008)

Designation		**Composition** $(wt\ \%)^b$		
AISI/SAE or ASTM number	**UNS Number**	**C**	**Mn**	**Other**
1010	G10100	0.10	0.45	-
1020	G10200	0.20	0.45	-
A36	K02600	0.29	1.00	0.20 Cu (min)
A516 Grade 70	K02700	0.31	1.00	0.25 Si

2.3 BIOMASS

Biomass is often used as the starting material for use as raw materials. In addition, it is material from waste as the plant or residues left from processing plants. Overall, the material is a high potential of biomass and can be reused to influence a quality product. Therefore, most biomass materials used as raw material in the study

to be carried out and perform characterization of physical properties and mechanical products.

2.3.1 Palm Kernel Shell

Palm kernel shell at **Figure 2.2** below show, it is one part of the oil palm trees. Besides, it is part of the hard shell of the oil palm seed is used to extract palm oil. The kernel of the fruit and its surrounding fibre (mesocarp) are used for oil extraction. Besides that, oil palm shell and extracted fibre are then discarded and to become as waste material. Palm Kernel Shells can be considered a natural and solid pellets which are renewable resources by burning through the pyrolysis method and obtain high grade materials will be produced.

Figure 2.2: Palm kernel shell

"Recent research from Yaacob A.R., Majid Z.A., Dasril R.S.D and Inderan V (2008),palm kernel shell is proposed to be used as a prospective starting material for

carbon because of its relatively high fixed carbon content (about 18 %w/w), low ash content (less than 0.1 % w/w) and the presence of inherent porous structures"[7]. Therefore, due to the low ash and high carbon content, the palm kernel shell generally to be a source of high potential to make quality grade coal as well as being used for the carburizing process in this study. **Table 2.3** below shows the composition chemical of palm kernel shell.

Table 2.3: Typical chemical analysis of palm kernel shell (Source: Elham,P. 2001)[8]

Analysis	Palm Shell	Coal
Proximate analysis (%)		
Ash	2.50	4.48
Volatile matter	77.20	20.30
Fixed carbon	35.09	60.43
Ultimate analysis		
Carbon	55.35	83.75
Hydrogen	6.27	5.45
Oxygen	38.01	9.16
Nitrogen	0.37	1.64