"I hereby declare that I have read this report 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 (Thermal-Fluid)"

Signature : .....

Name of Supervisor : Mr. Safarudin Gazali Herawan

Date : 15 December 2005

ALLOY MATERIAL WITH CARBON CONTAIN FROM COCONUT SHELL MATERIAL FOR SEAL

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This report submitted to Faculty of Mechanical Engineering in fulfillment of the requirements for the award of the Bachelor of Mechanical Engineering (Thermal-Fluids)

Faculty of Mechanical Engineering
Kolej Universiti Teknikal Kebangsaan Malaysia

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I declare that this report entitled "ALLOY MATERIAL WITH CARBON CONTAIN FROM COCONUT SHELL MATERIAL FOR SEAL" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Mohd Shahrizal Bin Abd Latif

Date : 15 DISEMBER 2005

Dedicate to b*oth my parent and my loving family. Thank you for all your support.*

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ABSTRACT

Coconut shell is an agricultural waste material found abundantly in Malaysia. Conversion of this material to use products, such as handicraft, charcoal, and activated carbon, has been reported. Since the characteristics were shown too able to produce good carbon, it is also predicted that there is a potential for producing carbon from the same precursor. This thesis therefore attempts to produce and characterize the material seal concerned.

From the project, Selection on the best material for carbon from the waste material and alloy material to use in new material is the priority in this project to produces seal and studies the mechanical characteristics for that material. In this project, coconut shell is material for carbon from the waste material. Than mixture contain with alloy for row material is iron, silicon carbide, mild steel and resin that wants to use in seal. Also learn the characteristic for new material seal. The process involved interior to earning the new material seal from the raw material to produce the new seal. The author select the powder metallurgy to produce the seal before do the test. It include learn the process and procedure the carbon from the coconut shell.

Hardness and tensile studies were made to show the effects on performance of percentage and characteristic of carbon from the coconut shell to compare with other carbon in seal materials.

ABSTRAK

Tempurung kelapa merupakan bahan sisa pertanian yang amat banyak di dapati di Malaysia. Penukaran bahan ini kepada produk berguna telah di laporkan seperti bahan kraftangan dan karbon teraktif. Oleh kerana ciri-ciri yang di tunjukkan mampu untuk di gunakan dalam bahan untuk membuat penutup kedap(seal). Justeru itu, tesis ini merupakan langkah awal untuk hasilkan bahan penutup kedap(seal).

Dari projek ini, pemilihan yang bijak perlu di lakukan dalam memilih bahan campuran untuk membuat penutup kedap(seal). Untuk itu, tempurung kelapa telah di pilih sebagai karbon yang akan di hasilkan.Yang mana karbon yang di gunakan adalah daripada bahan terbuang yang akan di campurkan dengan bahan daripada aloi iaitu iron, silicon carbide, keluli lembut and resin. Setelah itu, sifat-sifat mekanikal itu perlu di kaji. Selepas mengetahui sifatnya, kenalpasti proses yang akan terlibat atau yang akan digunakan dalam menghasilkan penutup kedap(seal) dari bahan mentah. Oleh itu, serbuk metalogi di pilih untuk hasilkan seal. Ini termasuk mengenali proses dan prosedur yang perlu di lalui untuk hasilkan karbon dari tempurung kelapa sebelum di gunakan dalam bahan penutup(seal).

Selain itu, mengkaji kekeraan yang berlaku untuk memperlihatkan kesan ke atas sifat karbon dari tempurung kelapa yang di gunakan untuk di bandingkan dengan karbon yang sedia ada.

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C	Celsius
G	Gram
N/mm^2	Newton millimetre square
m2/g	Meter square per gram
psi	Pascal
F	Fahrenheit
$g./cm^{-3}$	Gram per centimetres
MPa	Mega Pascal
API	Academic Performance Index
SiC	Silicon Carbide
CVD	Chemical vapour deposition
WC	Tungsten carbide
EPR	Ethylene propylene
EPDM	Ethylene propylenediene
AISI	The American Iron and Steel Institute
OD	Outer diameter
ID	Inlet diameter
C/min	Celsius per minutes
L/min	Liter per minutes
HRC	Rockwell hardness

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CHAPTER 1

1.1 Introduction

Over the past 50 years mechanical seals have evolved from specialty item into standard components produced in large numbers. The designs of commercially available seals are many. However the essential elements in all seal designs are similar. These consist of flat stationary face and a flat rotating face and a flat rotating annular face held together by spring and fluid pressure forces. One face is usually made of some hard material while the other face is often made of graphite-carbon impregnated with metal, plastic, metallic salt or some secret proprietary compound.

The importance of seal design is widely understood in the process, aerospace, automotive and other industries. Often, when a seal fails, a considerable amount of money is involved in replacing it and in the most extreme cases process equipment worth tens of millions may have to be shut down until the seal is replaced. Another important consideration in seal design is energy consumption since the frictional properties of the seal often have a big impact on the amount of power consumed by the machinery on which it is used. In extreme cases, environmental hazards may occur and production equipment worth tens of millions may be shut down in order to replace the seal. Frictional heating, generated at the dynamic seal interface, raises the temperature of the seal significantly. This temperature rise causes, for a variety of reasons, most seal failures.

Mechanical seals are often used to seal fluids in pumps and turbines where the rotating shaft enters an enclosure. The rotating component of the dynamic seal is attached to the shaft, whereas the stationary component is mounted on the housing.

The O-rings (also called the secondary seals) prevent the fluid from leaking between the shafts and rotating component of the seal as well as between housing and stationary component of the seal. Axial loading from the spring and sealed fluid pushes the two components of the seal together. The dynamic seal occurs at the interface of both rotating and stationary component of the seal, where the rotating face slides relative to the stationary face.

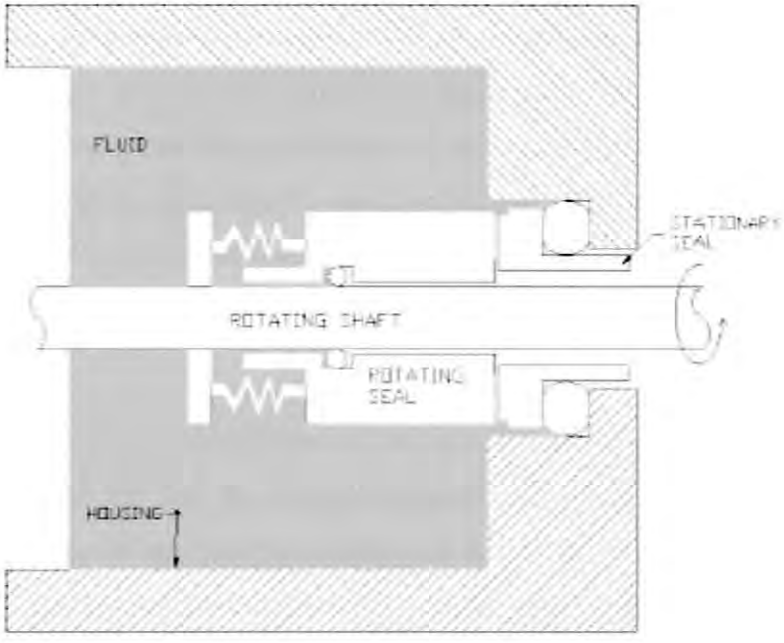

Figure 1.1 : Schematic Representation of a Mechanical Seal Face (Michael Huebner,1982)

When the rotating face slides relative to the stationary face, the rate of heat generated is equal to the frictional force multiplied by the velocity of the rotating face. Quite often this frictional heating results in non-uniform seal temperatures that result in a variety of fatigue problems, ultimately leading to pitting, cracking, and the ultimate failure of the seal. Lowering the operating temperature prevents these physical phenomena and results in lower operating costs, continued production profits, and fewer environmental emissions.

There are four basic classes of seals which cover the vast majority of applications. First is Traditional contact seal that is lubricated by the process fluid flowing through the equipment. Second Seals that are cooled and lubricated by the fluid separated from the process. Third Seals that run dry with the lubricant derived

from the seal material. And last classes of seal are the Seals lubricated by gas which can either come from the process or be introduced externally.

A seal is a device which prevents the passage, flow, or leakage of a gas or fluid. Seals can be divided into two major categories. It is the Static Seals, it is sealing takes place between surfaces which have little or no movement relative to one another. A second category is Dynamic Seals. It sealing takes place between surfaces which have relative movement, like example the rotary movement of a shaft relative to housing. There are also seals which fall between these two categories and do not exactly fit into these basic definitions of static and dynamic seals. Some static seals are designed to accommodate limited movement of the surfaces being sealed, like example, due to pressure and or thermal cycling. These types of seals are sometimes referred to as resilient or semi-static seals.

For every seal application there is an optimal pair of rubbing materials that provides the longest life and the lowest operating cost. This rubbing pair must be selected from scores of seal nose materials and an equally large number of mating face materials. The right choice of materials for the mating pair can easily increase seal life fivefold in those applications where wear is the controlling factor. Seal rings are usually received from the supplier in machined form and face preparation operations are then performed to achieve the required finish. A very flat and smooth finish is normally required to prevent leakage. Depending on the seal type and application, materials such as carbon and silicon carbide are commonly used seal materials.

1.2 Project objective

i. Study about characteristic the seal using in industry. Also study the how it works in all kind of job as seal.
ii. Select the best material for carbon from the waste material to use in new material for seal and study the characteristics for that material.

iii. Study the mixture contain for new material that wants to use in seal.

iv. Recognize the process involved interior to earning the new material seal from the raw material to produce the new seal.

v. Realization the method to produces the new material seal and proceeds the experimental to get the result that is the new material seal.

1.3 Scope project

Scope project is to create the new material for seal from the waste material for carbon and mixture contain with alloy material for rotating motion seal. The research is focus to the material is want to use to compare with exist material seal is using now. In this project, we must select the best material for carbon from the waste material and alloy material to use in new material for seal and study the characteristics for that material. Study the mixture contain for new material that wants to use in seal. Also learn the characteristic for new material seal.

Research about activities in raw material and the process is involved to create contain for seal to guide the basic for new material seal. It must do the experiment for get the characteristic material seal include the hardness, compression and tensile at new for material seal.

1.4 Problem of statement

In this project, problem of statement is to create the new material for seal with mixture contain from alloy material and carbon for rotating motion seal. Also it must explain here, the carbon want to use must from the waste material. Example the waste material is coconut shell, bamboo, and sawdust. The coconut shell is the waste material selection for carbon in this thesis. In Malaysia, coconut is the familiar food

ingredient to cook the food. We easier to found the coconut shell. It only use for charcoal for BBQ.

1.5 Problem analysis

All type of seal have own problem when doing the job. It can now, when look at the various methods of classifying seals and in the process learn which to specify for application. All seals fail for the same reasons. Like example the reason is the faces open up and allows dirt or solids to penetrate and one of the seal components has been damaged by the product, heat, or a cleaner used to flush the system. After the failure has occurred you will frequently get a chance to analyze the failed components.

Several problems can see in several things. The first problem it can see is corrosion. It happen when the seal is touching another component when it working. The seal will corrosion and it will be leakage if function use involve with fluid. It can damage the system and another component. Wear pattern also can be damage the seal went the seal is not function because the seal is in high pressure and can't take absorb the pressure. Seal is not rubbing or wear on those components that should not be in contact. When it contact another part, it gift impact to seal or part. It can change the structure of part and affect the function.

Also it can see the discoloration of any of the seal components, especially the metal parts. It is because the metal part always increases with temperature. Seal always fail if the part is missing. Like example, springs, set screws and drive lugs. If the springs is not fix at the right place, maybe the can make vibration and the seal will rubbing or corrosion. Product is attaching to a rotating component. Carefully inspect the impeller and rotating part of the seal.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discuss about the earlier research for this project. It covers for material to produce and study characteristic seal to compare with an exist seal in industry. The importance of seal design is widely understood in the process, aerospace, automotive and other industries. Often, when a seal fails, a considerable amount of money is involved in replacing it and in the most extreme cases process equipment worth tens millions may have to be shutdown until the seal is replaced.

In many applications, a mechanical seal provides a safeguard against hazardous materials escaping into the environment. Another important consideration in seal design is energy consumption since the friction properties of the seal often have a big impact on the amount of power consumed by the machinery on which it. The selection of materials becomes import. It is important not only to the seal faces but to all of the components in a seal that contribute to its ability to maintain an acceptable fluid film. In this paper the author will divide the seal into three major categories of components, the seal faces, secondary sealing elements and major metal components.

Mechanical seal are constructed of a wide range of materials including metals, elastomers and ceramics. Each of these materials plays an important role in

the operation of seal. Seal manufacturers have narrowed the list of available material through year of successful filed experience. Still, the selection of the correct materials remains a critical step in the successful application of a mechanical seal.

2.2 Element Carbon

The word carbon is derived from the latin "carbo", which to the romans means charcoalor ember. In the modern world, carbon is of course, much more than charcoal. From carbon come the highest strength fibers, one of the best lubricants (graphite), the strongest crystal and hardest material (diamond) an essentially non-crystalline product (vitreous carbon) one of the best gas absorbers (activated charcoal) and one of the best helium gas barriers (vitreous carbon). A great deal is yet to be learned and new forms of carbon are still being discovered such as the fullerene molecules and the hexagonal polytypes of diamond (Bansal, D.C., Donnet, J.B. and Stoeckli, H.F., 1988).

2.2.1 The element carbon on earth

The element carbon is widely distribution in nature. It is found in the earth's crust in the ratio of 180 ppm, most of the form of compounds (Sutcliffe.B.,1992). Many of these natural compounds are essential to the production of synthetic carbon materials and include various coals (bituminous and anthracite), hydrocarbons complexes (petroleum, and asphalt) and the gaseous hydrocarbons (methane and others). Only two polymorphs of carbon are found earth as minerals. It is natural graphite and diamond.

2.2.2 The element carbon in the universe

The elements carbon is detected in abundances in the universe, in the sun, stars, and comets in the atmosphere of the planets. It is the fourth most abundant element in the solar system, after hydrogen, helium and oxygen and is found mostly in the form of hydrocarbon and other compounds. The spontaneous generation of fullerene molecules may also play an important role in the process of stellar dust formation. Carbon polymorphs, such as microscopic diamond and lonsdaleite, a form similar to diamond, have been discovered some meteorites (Saksi, Soumitra Biswas & S Mahajan.,1996).

2.3 Carbon terminology

The carbon terminology can be confusing because carbon is different from other elements in one important respect that is it is diversity. Unlike most elements, carbon has several material forms which are known as polymorphs or allotropes. They are composed entirely of carbon but have different physical structures and uniquely to carbon, have different physical structures and uniquely to carbon, have different names such as graphite, diamond, lonsdalite, fullerene and other (Michael Huebner.,1982).

In order to clarify the terminology, it is necessary to define what is meant by carbon and its polymorphs. When used by itself, the term "carbon" should only mean the element. To describe a "carbon" should only mean the element. To describe a "carbon" material, the term is used with a qualifier such as carbon fiber, pyrolytic carbon, vitreous carbon and others. This carbon material s has sp^2 atomic structure and is essentially graphitic in nature.

2.4 Type of Carbon

. The wear properties of five different base grades of carbon, with and without phenol formaldehyde resin impregnation, were determined at 260°C. Runs were made against both 347 stainless steel and chromium plated steel (Michael Huebner.,1982). Three of the materials, two impregnated grades and one not imprecated are used in the manufacture of sliding seals for aircraft turbines. Two of the grades were cured at the special high temperature of 315.5°C. The usual cure for phenol formaldehyde resin impregnants involves temperatures from 176.6°C to 204.4°C.

With two materials the presence of the impregnant caused significant reduction in wear against stainless steel. The high-temperature cure (315.5°C) of the resin gave wear similar to that of the standard-cure (176.6°C to 204.4°C) material. The effect of both the type of carbon and the phenol resin impregnant on total wear was less with chromium-plated steel than with Type 347 stainless steel. The total effect of carbon was reduced by running with chromium-plated steel. With chromium-plated steel, in regnation gave slightly increased wear rather than the expected wear reduction. It was observed that, in general, the phenol resin impregnation did reduce friction. Friction of phenol resin impregnated grades was more erratic with the base carbon of low porosity.

One of the problems reported with seals in turbine-type engines is the formation of resinous films on the mating metal surface. In some cases the resinous films are reported to have occurred with no lubricant present; in others it was definitely formed by coking the lubricant. In these experiments carbons impregnated by phenol resin were the only materials that produced resinous films on the mating metal surface. High-temperature cures seemed to reduce the tendency for resin film formation. However, the resin film obtained with carbons having phenol resin impregnation was not considered objectionable. The types of carbon discussed herein are mixtures of carbon (high percentage) and graphite (Low percentage). Because graphite has a higher oxidation temperature and also gives lower friction than

amorphous carbon, materials with high graphite seals, even though content should be considered for high-temperature graphite is mechanically weaker than amorphous carbon.

2.5 Carbon Procedure

Coconut shell were used a starting material for preparing Material for seal by crushing and sizing them to form shell granules having a size suitable for use in seal material (Auvil, Shork and Srinivasan,1993). Granules were heated in a flowing stream of inert gas at an average temperature ramp rate of about 2°C – 10°C per minute until a peak temperature was reached in the range of 775°C - 825°C. The sample was held at the peak temperature for a period of time so that the total heating and holding steps were not less than 1 hour or not more than 8 hours to produce granular char. Then the char was cooled in an inert gas atmosphere. The char had an oxygen volumetric capacity at least 10.0 cc/cc at 20°C and 1 atmosphere, which applied for air separation in pressure swing adsorption.

Manufactures coconut shell can make good carbons because they have the following advantages over many other types of carbon (Sutcliffe.B., 1992):

- High hardness levels and low dust levels which improves material handling characteristics and is especially important where carbon fines cannot be tolerated.
- High surface area, up to 1500 m^2/g. This allows for long life and high adsorption capacity.
- High retentively, preventing unwanted adsorptions of adsorbed species. Large fraction of microspores (< 20 Angstroms). This is important for removal of low-molecular-weight organics and for removal of trace levels of contaminants.
- Low ash. Fewer impurities.