SLIDING FRICTION PERFORMANCE OF DRY AND OIL IMPREGNATED PALM KERNEL ACTIVATED CARBON POLYMERIC COMPOSITE

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This report is submitted
in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled “Sliding Friction Performance of Dry and Oil Impregnated Palm Kernel Activated Carbon Polymeric Composite” is the result of my own work except as cited in the references

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this project 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.

Signature :.....
Name of Supervisor :.....
Date :.....

DEDICATION

To my beloved parents, family and friends

ABSTRACT

Management of organic waste is one of the main problem in this era. A lots of study had been done to reuse the organic waste in order to reduce the cost to dispose the waste. At the piston ring also have a high energy losses due to the friction which is 20% of losses. This thesis is about the coefficient of friction performance of palm kernel activated carbon polymeric composite during dry and oil impregnated condition. The composite will have 3 different composite that will undergo three different sets of test. The composites will be test at original state, impregnated into oil which is mineral oil, semi-synthetic oil and fully synthetic oil for a day, and then the composite will be leave inside the box for a day without further impregnation. This test to see any changing of coefficient of the composite if the composite undergo three different condition. The ball-on-disc tribometer test will be used in this study. Basically, the composite were formed into disc shaped using hot compaction technique. When the composite were ready, basic mechanical test were done. Then the composite were tested through ball-on-disc tribometer. The results show that the coefficient of friction of mineral oil and semi-synthetic oil one day without further soaking composite gives the lowest value. This behaviour shows that the effect of coefficient of friction is also depend on the viscosity of lubricants and any others. In addition, the effect of impregnation time are not really significant in friction. The lubricant quickly fully absorb when the composite impregnated for a long time. In conclusion, the result of coefficient of friction of PKAC-E composite that one day left without further soaking gives the lowest result which is between 0.115 to 0.118.

ABSTRAK

Pengurusan sisa organik adalah salah satu masalah utama dalam era ini. Banyak kajian telah dilakukan untuk menggunakan semula sisa organik untuk mengurangkan kos untuk membuang sampah. Di cincin omboh juga terdapat kerugian tenaga yang tinggi akibat geseran yang 20% kerugian. Tesis ini adalah tentang pekali prestasi geseran polimer karbon polimer diaktifkan kernel sawit semasa keadaan kering dan minyak. Komposit akan mempunyai tiga komposit yang berbeza yang akan menjalani tiga ujian yang berlainan. Komposit-komposit akan diuji pada keadaan asal, dirombinasikan ke dalam minyak iaitu minyak mineral, minyak semi-sintetik dan minyak sintetik sepenuhnya selama satu hari, dan kemudian komposit itu akan meninggalkan di dalam kotak selama satu hari tanpa penomboran lanjut. Ujian ini untuk melihat apa-apa perubahan koefisien komposit jika komposit itu menjalani tiga keadaan yang berbeza. Ujian tribometer akan digunakan dalam kajian ini. Pada asasnya, komposit itu terbentuk ke dalam cakera berbentuk menggunakan teknik pemadatan panas. Apabila komposit telah siap, ujian mekanikal asas telah dilakukan. Kemudian komposit itu diuji melalui tribometer. Keputusan menunjukkan bahawa pekali geseran minyak mineral dan minyak semi-sintetik pada suatu hari tanpa komposit rendaman terus memberikan nilai terendah. Tingkah laku ini menunjukkan bahawa kesan pekali geseran juga bergantung kepada kelikatan pelincir dan mana-mana yang lain. Di samping itu, kesan masa impregnasi tidak begitu penting dalam geseran. Pelincir dengan cepat menyerap sepenuhnya apabila komposit itu diresapi untuk masa yang lama. Kesimpulannya, hasil koefisien geseran komposit PKAC-E yang satu hari ditinggalkan tanpa perendaman lanjut memberikan hasil yang paling rendah antara 0.115 hingga 0.118.

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LIST OF ABBREVIATION

FRP	Fiber Reinforced Polymer
PKAC	Palm Kernel Activated Carbon
MMC	Metal Matrix Composites
CMC	Ceramic Matrix Composites
PMC	Polymer Matrix Composites
PRP	Particle Polymer Reinforced
IUPAC	International Union of Pure and Applied Chemistry
COF	Coefficient of Friction
PRC	Particulate Reinforced Composite
SAE	Society of Automotive Engineers

LIST OF SYMBOL

wt%	=	Weight Percentage of Fiber Composition
COF	=	Coefficient of Friction
W	=	Weight
F	=	Frictional Force

CHAPTER 1

INTRODUCTION

1.1 Background

A lot of studies about the solid lubricant had been done for the tribological application purpose (Donnet & Erdemir, 2004). Due to the global demand for light weight, simpler process, environment sustainability, high performance, eco-friendly and cost, a lot of research had been done for the composite material (Chin & Yousif, 2009; Friedrich et al., 2018; Tahir et al., 2018). Natural resources are easy to get such as palm kernel and palm wood and the price also not expensive, it will be reducing the cost and lead to zero waste. That is why natural resources reinforced composite had been studied.

Natural resources have potential for self-lubricating. Not only that, it shows that natural resources have low density, higher stiffness and high wear resistance. Besides, it is renewable and sustainable (Gomes et al., 2001). Fibre-reinforced polymer (FRP) composite is used in the mechanical component such as gears, cams and seals. These components are used in aerospace and automotive application. These components are safe to be use because it is not harmful and will not cause pollution. There are two types of composite which is dry and wet condition. Composite that soak into oil can produce longer durability compared to the dry condition (Akpan et al, 2018). This is because more absorption of the composite the due to the pore content in the composite. The highest amount of pore the higher the absorption and the durability will higher.

1.2 Problem Statement

Management of solid waste is one of the biggest problems in this era. Since the population keep increasing year by year, waste product also keeps increasing. Waste product need to be disposed according to the law that state by the country, but this also gives a big problem because some of the waste need to be pays in order to dispose it. This causes a lot of open burning. A research shows that the organic waste gives the highest percentage of waste product which is 48.26% to be dispose (Pokhrel & Viraraghavan, 2005). In order to reduce the waste product, a few researches had been done to replace the ceramic and metal-based and metal material to the natural resources. This is because it will reduce the organic waste and also it is renewable and sustainable (Chin & Yousif, 2009; Friedrich., 2018)

There are two types of natural resources which are renewable such as tree and non-renewable are fuels and petroleum. Carbon is one of the products from the natural resources. Tree also can be transforms into carbon after undergoing certain processes. Carbons are used for filtration and purification. Palm kernel also changed into carbon which is PKAC for the same purpose. In order to enlarge the usage of the PKAC, a few researches had been done regarding to the PKAC. The effect of operating conditions on tribological had been researched before. However, for the palm kernel activated carbon, not so many researches had been done and there is not research about the palm kernel activated carbon impregnated to the car engine oil.

1.3 Objective

The objective in this project is to determine the friction performance of dry and oil impregnated palm kernel activated carbon.

1.4 Scope of Project

In this study, the materials that going to be use are PKAC, PKAC as reinforcement, 206 Hardener and West System 105 Resin as Epoxy. The test will use load at 49.05 N (5 kg), speed at 500 rpm, temperature at 27°C and time at 30 minutes. The material will transform into disc and the disc will be test under ball bearing SKD-11 using ASTM G99-95a. The disc will be soaking for one day into three different type lubricants which are Semi-synthetic Car Engine Oil Fully Synthetic Car Engine Oil and Mineral Engine Oil.

1.5 General Methodology

To achieve the objective of the study, actions need to be carried out as listed below. Figure 1.1 shows the flowchart of the methodology.

1) Literature Review

   Articles, books or any material that related to the study will be review.

2) Design of Experiment

   The experiment that will be conduct later must be design based on the objective. Tables will be used because of the a few types of data will be collect.

3) Sample Preparation

PKAC will be mix well with the epoxy before putting it in the mould. After that, the composite will be compress using hot pressed machine at certain temperature to get a disc shape of composite. The composite will be cure for a week before soak into oil for a day.

4) Tribology Test

Composite that ready to be test will be place at the ball-on-disc tribometer. Ball bearing will slide on the disc for certain time. If the test shows a bad result while doing the test, the test will be carrying out again.

5) Data Analysis

Data output from the test will be analysed.

6) Discussion

Data taken must be discuss and compare and come out with the conclusion.

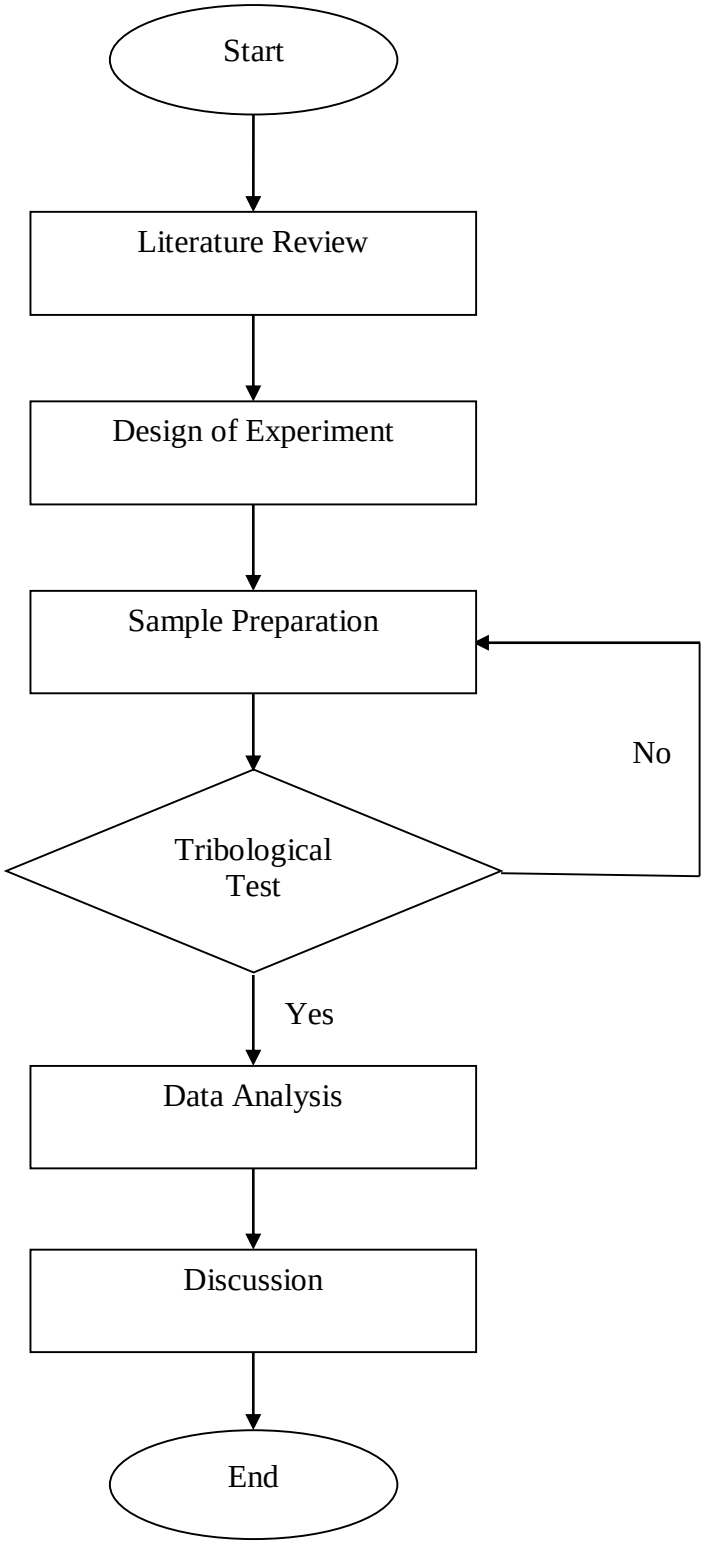

Figure 1. 1 Flow Chart of the Study.

CHAPTER 2

LITERATURE REVIEW

2.1 Palm Kernel Shell

Palm oil became the most sought-after commodity during the industrial revolution because it was used as an industrial lubricant for machinery. Palm oil was widely used in the production of soap and the first pioneers were the brothers Lever, now known as the Unilever (Sawe, 2018). Table 2.1 shows the top 6 palm oil producing countries in the world.

Table 2. 1 Top 6 Countries Producing Oil Palm.

Rank	Country	Production (in metric tons)
1	Indonesia	36,000,000
2	Malaysia	21,000,000
3	Thailand	2,200,000
4	Colombia	1,320,000
5	Nigeria	970,000
6	World	58,800,000

Table 2.1 shows that Malaysia is one of the world's top palm oil producers with a current planting area of about 4.5 million hectares. This proved that the abundance of palm oil produces a large amount of palm oil biomass. The biomass of the oil palm can be reused

by adding additive that produces seven good added value products. The oil palm core shell (endocarp) is an example of oil palm biomass.

The oil palm core shell can be used for activated carbon production. The selection of the oil palm kernel shell for the activated carbon must be based on the shell thickness; endocarp. The oil palm kernel shell must also be obtained from 8-year - old palm oil trees to ensure that the endocarp is sufficiently thick. The thickness of the endocarp varies with dura types with thick endocarp and less mesocarp shows in Figure 2.2, and Tenera types the opposite shows in Figure 2.1. The activated carbon can be better in quality by choosing the Dura types of the oil palm kernel shell. By using this palm oil biomass, the profits for the oil palm sector can be doubled and the Malaysian economy can directly be generated. Table 2.2 and 2.3 shows the oil palm origin characteristics which contribute to the selection of the oil palm kernel shell.

Table 2. 2 Characteristic of Tenera Oil Palm.

Features	Percentage
Mesocarp	60-96%
Thickness of the Shell	3-20%
Thickness of the Seed	3-15%

Table 2. 3 Characteristics of Dura Oil Palm.

Features	Percentage
Mesocarp	20-65%
Thickness of the Shell	20-50%
Thickness of the Seed	4-20%

Figure 2. 1 Tenera Oil Palm Fruit.

Figure 2. 2 Dura Oil Palm Fruit.

2.2 Overview of the Composite

The composite material is produced by mixing two or more different elements to make the resulting material with superior parental properties. There are two composite parts, matrix and filler / fibre which is reinforcing phase. We can be strengthened in the form of fibres, sheets or particles at different phases. It is surrounded by the matrix phase of other materials. Metal, ceramic, non-metal and polymer material may be used in the development of composites as a reinforcing element and matrix material. The fibre / filler used in the composite is more rigid and stronger than the matrix material (continuous phase), which acts as load carrying elements. Continuous phase (matrix) of the composite acts as a means of transferring the load between fibres. The matrix has ductile properties over the fibres and therefore acts as a source of composite strength (Mathur & Bairwa, 2017).