OPTIMIZATION OF TRIBO-PERFORMANCE OF OIL-IMPREGNATED PALM KERNEL ACTIVATED CARBON FOR THE PRODUCTION OF AUTOMOTIVE BEARING

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A report submitted in fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

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DECLARATION

I declare that this project report entitled "Optimization of Tribo-Performance of Oil Impregnated Palm Kernel Activated Carbon for Production of Automotive Bearing" is the result of my own work except as cited in the references.

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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 : ....

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Date : 21/9/2020

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DEDICATION

This report is dedicated to my beloved father, my beloved late mother, family members and friends who have supported me throughout my bachelor's program and incredible journey of this 23 years of life. Thank you for making me see this adventure through to the end.

ABSTRACT

Palm Kernel Activated Carbon (PKAC) is one of agriculture wastes that has a huge potential in tribological applications. The objectives of this study are to determine the optimized parameters of oil impregnated palm kernel activated carbon for new automotive bearing formulation using Taguchi Method. the composite were formed into pin shaped sizing of 30 mm height and 10 mm diameter using compaction technique by impregnated the palm kernel in water, palm oil and paraffin oil for certain amount of time. The specimens were impregnated with water, palm oil and paraffin oil before the dry sliding test conducted. Before the dry sliding test is performed, the machine to be set with constant load, sliding distance and sliding speed. The data obtained then analysed through qualitative and quantitative way. Due to composition and temperature of Epoxy bond, the coefficient of friction and wear rate of the composite are affected. This is why PKAC-E has the potential to be self-lubricating material.

ABSTRAK

Karbon aktif dari biji kelapa sawit adalah salah satu sisa pertanian yang memiliki potensi besar dalam aplikasi tribologi. Objektif kajian ini adalah untuk menentukan parameter yang optimum dari karbon aktif dari biji kelapa sawit untuk dirumuskan sebagai galas baru untuk automotif menggunakan kaedah Taguchi. Komposit tersedut dibentuk menjadi ukuran berbentuk pin dengan ketinggian 30mm dan lebar 10mm menggunakan teknik pemadatan kemudian merendam pin tersebut didalam air, minyak kelapa dan minyak paraffin untuk jangka masa tertentu. Spesimen akan direndam terlebih dahulu sebelum ujian gelongsor kering dijalankan. Sebelum ujian gelongsor kering dilakukan, mesin akan ditetapkan dengan beban, jarak gelongsor dan kelajuan gelongsor yang tetap. Data yang diperoleh kemudian dianalisis melalui kaedah kualitatif dan kuantitatif. Oleh kerana komposisi dan suku ikatan E-poxy pekali geseran dan kadar kehausan komposit terjejas. Inilah sebabnya mengapa PKAC-E berpotensi menjadi bahan pelincir diri.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

PKS	-	Palm Kernel Shell
COF	-	Coefficient of Friction
PKAC	-	Palm Kernel Activated Carbon
PKAC-E	-	Palm Kernel Activated Carbon Epoxy
ASTM	-	American Society for Testing and Material

LIST OF SYMBOLS

D	-	Distance of slide, m
r	-	Radius wear track, m
N	-	Sliding speed, rpm
t	-	Time, min & sec
F	-	Frictional force, N
W	-	Applied load, N
Vloss	-	Volume loss, mm3
a	-	Wear scar radius, mm
h	-	Wear depth, mm
L	-	Sliding distance, mm

CHAPTER 1

INTRODUCTION

1.1 Background

Renewable waste such as composite material has been utilized effectively into wealth. Hence, the existence of this waste motivates us to investigate the potential of renewable waste such as activated carbon. This renewable waste being made into use of derived from one of the largest waste palm oils called palm kernel to be a new tribological materials. Activated carbon can be used to treat poisonings, overdoses, used in water filtration systems and also in agriculture. What makes activated carbon being used in tribological field is because it has a large surface area due to high porosity. Globally, Malaysia is one of the largest producers and exporters of palm oil, accounting for 11% of the world's oil and fat production, and 27% of the export trade of oils and fats. The palm oil industry generates a large quantity of waste consisting of approximately 10% of palm oil (Yahya, 2015).

In this studies, PKAC is the best material that can be used to discover the friction coefficient and wear of an activated carbon-epoxy composite derived from palm kernel under dry sliding conditions.

The PKAC, also called as palm oil extraction wastematerial, is composed of a carbonaceous, highly porous adsorptive medium with similar atomic structure as graphite, but in a disorganized form (Tahir, 2016).

There were few research studies that reported the coefficient of friction of the polymer composite reinforced with PKAC. Based on one of the studies (Abdollah, 2017) the coefficient of friction of the polymer composite reinforced with PKAC can be reduced to 0.1 under condition of dry sliding. The value obtained still slightly near to value of industrial self-lubricating components such as diamond-like carbon (DLC), for which the coefficient of friction is around 0.01 (Mohmad, 2017). This experiment will use lasered specimens as to control friction. This technique is called as suface modification technique. Surface modification technique has shown its ability in improving the tribological performance for many materials for years. By lubrication condition, the dimples produced by the laser surface texture can act as a reservoir which the dimple can stor and supply the lubricant in the reservoir during the dry sliding in the relative motion. Besides, the surface contact area for smooth surface of the PKAC-E specimen is smaller than the textured surface thus can reduce the friction.

As to eliminate or reduce problems of lubricant thinning which is a non-degradable waste, 'bio-tribo-materials' are required with reduced or no outer lubrication or even having abilities of self-lubrication.

This will mainly be required in systems needed to be pre-lubricated, in which the component suffering friction soaks up the lubricant when it flows intermittently and preserves it for a long time (Mohmad, 2017).

Taguchi method is one of the best experimental methodologies used to find the minimum number of experiments to be performed within the permissible limit factors and levels (Jan C. J, 2013). In this case of studies, Taguchi Method is used to discover the optimal test based on 3 independent factors which are lubricant type, impregnation time and powder size and each factor has 3 levels.

The study of renewable waste such as activated carbon is very important to human being and as the technologies goes modern day by day. This is because different kind of independent factors provides different kind of properties in behavior, friction and wear. These situations can be due to inaccurate reading of the substances, the temperature, the size of carbon powder is not precise and others.

Therefore, this experiment will focus on pioneering the possible use of lubricant-impregnated PKAC polymer composite as an innovative bio-tribo-material in mechanisms requiring prior or intermittent lubrication.

1.2 Problem Statement

Device that supports the movement of rotation between stiff part and rotating part is called as bearing. Brass, aluminium, plastic, chrome steel and carbon steel were being used as bearing materials in the automotive industry. These materials are quite expensive compared to useable waste materials such as Palm Kernel Activated Carbon (PKAC). PKAC is considered to replace the material of current bearing due to its lightweight, easy to get, environmental friendly and affordable.

The purpose of this study is to improve the current bearing in the market using renewable waste such as PKAC by determining the lowest coefficient of friction.

1.3 Objective

The objective of the project is to determine the optimized parameters of oil impregnated palm kernel activated carbon for new automotive bearing formulation using Taguchi Method.

1.4 Scope

While running the testing, the specimen might broke due to force, speed or temperature apply to the surface of the specimen. In order to overcome these challenges, several researches have successfully came out with the correct amount of carbon powder and epoxy added as to make a piece of specimen. Other challenges is to discover the best lubricant type and how long the specimen need to be soaked up to get the smallest reading. Thus, this project is to focus on how long the specimen needs to be soaked up in lubricant to achieve desired mechanical properties, friction and wear.

1.5 General Methodology

This section explain on how this project need to be carried out to achieve the objectives of this project. The methodology of the project is summarize in the flowchart in Figure 1.1 below:

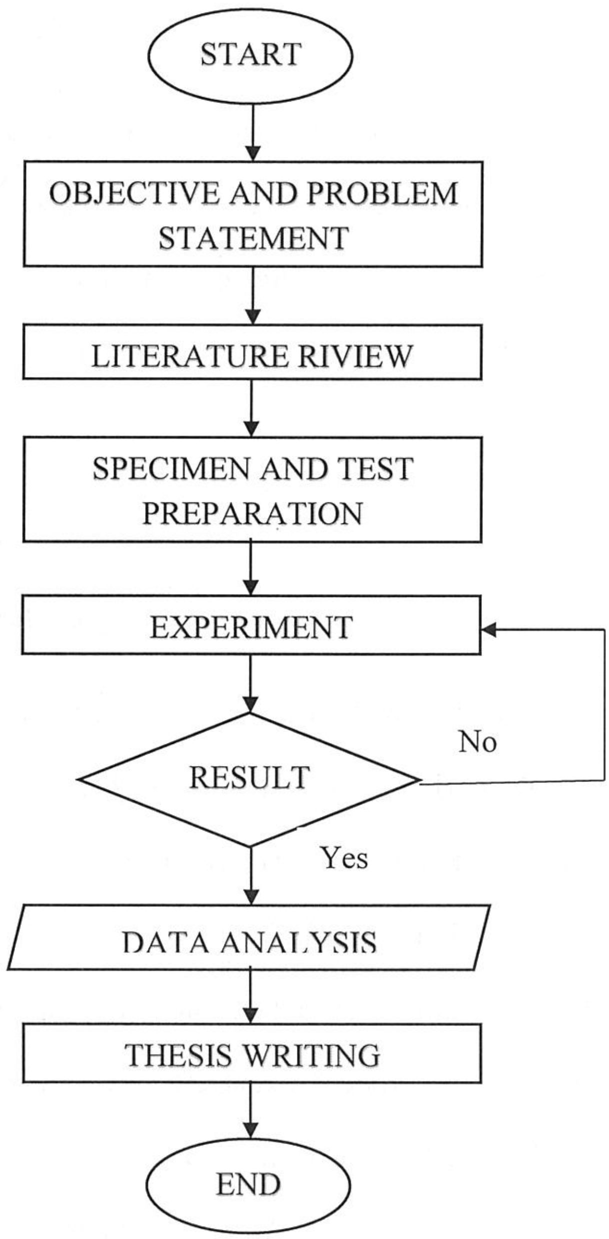

Figure 1.1: Flowchart of the project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Previous research and sources related in this study in form of journals, articles, reports and web sites will be reviewed in this chapter. Extra research need to be done in order to complete this project. Information about tribological studies, PKAC-E and Pin-on-disc test are acquired in order to fulfil the needs of the objectives.

2.2 Tribological study

Based on a landmark report by Jost (2006), the word "tribology' comes from Greek, meaning 'the study of things that rub'. Basically, tribology is a study regarding contacting surfaces of science and engineering in relative motion which includes the study about principles of friction, lubrication and wear. Tribological study comprises of many variables such as type of motion(sliding, rolling), applied load, sliding distance, speed, frequency, duration of applied stress, temperature, lubricating mode, nature of lubricant and many more. Stated by Jan (2013), the main objective of running tribological study is to reduce the friction, wear and heat between interacting surface in relative motion.

2.2.1 Engine tribology

Currently, bearing, pistons, transmissions, clutches, gears and many tribological engine components can provides the reduction of fuel consumption, increased engine power output, reduction of oil consumption, reduce exhaust emissions, improve the durability and reduce vehicle maintenance. The improvement of tribological performance can be done by the tribological properties of materials used as mechanical parts being enhanced, improve tribological behaviour by coating the surface and develop the possible lubricant to improve the tribological behaviour.

2.2.2 Bearing technology

Even though electric vehicles are getting rapidly popular, it still cannot beat the usage of internal combustion engine. Combustion engine consists of several bearing and the one that allows the crankshaft to rotate is called as main bearing or engine bearing. Bearing is one of machine component that can reduce the friction between moving parts and can support the weight rotor and influencing the dynamic behaviour. It also allows one part to bear as the term "bearing" is derived from the verb of "to bear". As for journal bearing, it acts by rolling two or more cylindrical and for ball bearing, it acts by rolling two or more sphere. Friction and wear of the bearing can be reduced by applying lubricant between those surfaces of cylindrical or sphere.

By this application, wear will be reduced due to the reduction of the friction. Development of bearings has been one of the most outstanding steps in the development of human made machines.

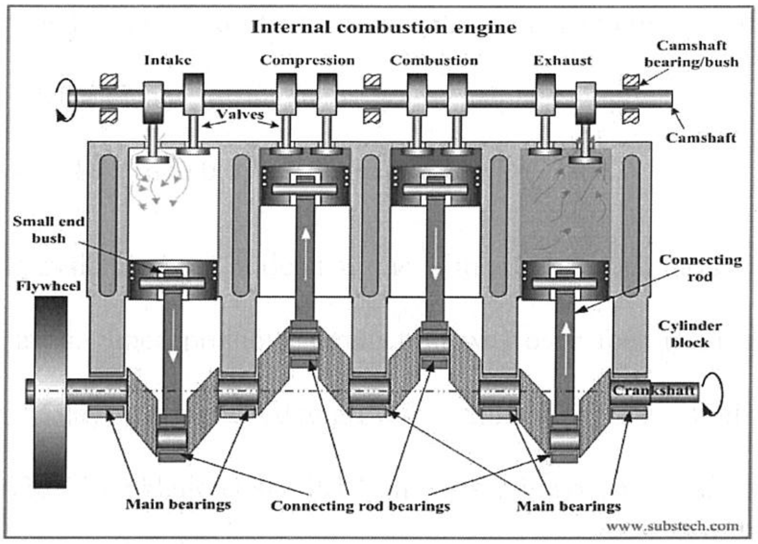

Figure 2.1: Location of an engine bearing in a four cylinder combustion engine.

In an operating engine, camshaft, crankshaft and connecting road were supported by rotating journal in an operational engine. Commonly, oil were used in bearings to smoothen the movement of the engine. Instead of using oil, other possible liquid or semisolid such as water and grease can be used to replace oil. Water is still applicable to use even though its viscosity is lesser than oil.

2.3 Palm Kernel Shell (PKS)

The crushed shells of the palm oil plant are called palm kernel shell. By acid activation method at temperature of 600°C, palm kernel shell can produce activated carbon. Technically, PKAC is a waste from palm oil extraction process which contains carbon properties and residual oils that makes this waste becoming a new self-lubricanting materials (Mat Tahir el al., 2015). PKS waste material can be obtained from agricultural sector. The excellent characteristics of this biomass-based has received so much attention due to its inexpensiveness, good absorption behaviour, potential to reduce a strong dependency towards non-renewable