EXPERIMENTAL INVESTIGATION OF FRICTION AND WEAR CHARACTERISTIC ON NATURAL OIL-BASED LUBRICANTS

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DECLARATION

I declare that this project report entitled "Experimental investigation of friction and wear characteristic on natural oil-based lubricants" is the result of my own work except as cited in the references.

Signature : ………………………………

Name : YONG KAI FANG

Date : 20/6/2016

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal-Fluid).

Signature	: ……………………………
Name of Supervisor	: DR. TEE BOON TUAN
Date	: 20/6/2016

DEDICATION

To my beloved mother and father

ABSTRACT

Friction and wear are one of the main factors that affect the efficiency, performance, quality and life span of machinery system. The purpose of this study is to determine the friction and wear properties of natural oil-based lubricant which consist of refined glycerin, crude glycerol and oleic methyl ester to compare with the friction and wear properties of commercial lubricant. Four ball tester experiments are carried out based on ASTM standard to evaluate the tribology properties of lubricants. The measurements of Coefficient of Friction and Wear Scar Diameter are taken at bearing ball for different types of lubricants. The difference in coefficient of friction and wear scar diameter for lubricant with and without additive and different temperature are being investigated. The results obtained from physical measurement and analysis is compared with coefficient of friction and wear scar diameter of commercial lubricants. The average coefficient of friction obtained from analysis for refined glycerin and crude glycerol with and without additive show lower reading compared to commercial lubricant. Lubricant with Carbon Nano Tube as additive show more preferred result compare to lubricant without additive in term of coefficient of friction. With the increase in temperature, the coefficient of friction for lubricant for both with and without additive increased. For wear scar diameter, performance of natural oil-based lubricant with and without additive, high and low temperature show better result compare to commercial lubricants. Overall, for coefficient of friction, at temperature of 75◦C refined glycerin shows the most preferable result and at the temperature of 85◦C, crude glycerol without additive shows the most preferable result. For wear scar diameter, at low and high temperature, refined glycerin without additive show the smallest reading compare to other. Based on the result, recommendations and suggestions are made to improve the accuracy of tribology test and tribology properties of lubricants.

ABSTRAK

Geseran dan haus adalah salah satu faktor utama yang memberi kesan kepada kecekapan, prestasi, kualiti dan jangka hayat sistem jentera. Kajian ini dijalankan untuk menentukan sifat geseran dan haus yang berasaskan pelincir minyak semula jadi yang terdiri daripada gliserin ditapis, gliserol mentah dan oleik methyl ester untuk membandingkan sifat-sifat geseran dan haus dengan pelincir komersial. Eksperimen empat penguji bola dijalankan berdasarkan standard ASTM untuk menilai sifat-sifat tribologi pelincir. Pengukuran Pekali geseran dan diameter haus parut diambil pada bearing bola untuk pelbagai jenis pelincir. Perbezaan dalam pekali geseran dan diameter haus parut untuk pelincir dengan dan tanpa bahan tambahan dan suhu yang berbeza turut dikaji. Keputusan yang diperolehi daripada pengukuran fizikal dan analisis dibandingkan dengan pekali geseran dan diameter haus parut pelincir komersial. Purata pekali geseran yang diperolehi daripada analisis untuk gliserin ditapis dan gliserol mentah dengan dan tanpa bahan tambahan menunjukkan bacaan yang lebih rendah berbanding dengan pelincir komersial. Dari segi pekali geseran, pelincir yang dicampurkan dengan Karbon Nano Tiub sebagai bahan tambahan menunjukkan hasil lebih memuaskan berbanding dengan pelincir tanpa bahan tambah. Dengan peningkatan suhu, pekali geseran untuk pelicir dengan dan tanpa bahan tambahan meningkat. Dari segi diameter haus parut, prestasi pelincir berasaskan minyak semula jadi dengan dan tanpa bahan tambahan, pada suhu tinggi dan rendah, semuanya menunjukkan keputusan yang lebih baik berbanding dengan pelincir komersial. Secara keseluruhan, untuk pekali geseran, pada suhu 75◦C gliserin ditapis menunjukkan hasil yang paling baik dan pada suhu 85◦C, gliserol mentah tanpa bahan tambahan menunjukkan hasil yang paling baik. Di suhu rendah, gliserin ditapis tanpa bahan tambahan menunjukkan bacaan yang paling rendah untuk diameter haus parut berbending dengan yang lain. Berdasarkan keputusan yang diperolehi, penambahbaikan dicadangkan untuk meningkatkan ketepatan kajian tribologi dan sifat-sifat tribologi pelincir.

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TABLE OF CONTENTS

CHAPTER	TITLE	PAGE

CHAPTER	TITLE		PAGE

CHAPTER	TITLE		PAGE

CHAPTER	TITLE	PAGE

LIST OF TABLES

LIST OF FIGURES

NO.	TITLE	PAGE

LIST OF SYMBOLS

°	=	degree
°C	=	degree Celcius
%	=	percentage
μ	=	friction coefficient
F	=	friction force
W	=	normal load
rpm	=	revolutions per minute
mm	=	milimeter
R_c	=	Rockwell
ml	=	mililiter
kg	=	kilogram
K	=	Kelvin
g	=	gram
m	=	meter
Hz	=	Hertz
N	=	Newton
T	=	temperature, °C
wt	=	chemical composition, %
PS	=	palm stearin
sec	=	second
μm	=	micrometer

LIST OF APPENDICES

LIST OF ABBREVIATIONS

HFRR	=	High frequency reciprocating rig
ASTM	=	American Society for Testing and Materials
COF	=	Coefficient of Friction
WSD	=	Wear Scar Diameter
VI	=	Viscosity index
POME	=	Palm oil methyl ester
TMP	=	Trimethylolpropane
OL	=	Pure lube oil
ANSI	=	American National Standards Institute
SAE	=	Society of Automotive Engineers
FSL	=	Fnal seizure load
SEM	=	Scanning electron microscope
RBD	=	Refined Bleached Deodorised
CCD	=	Charge-coupled device
PMO	=	Paraffinic mineral oil
PS	=	Palm stearin
FTP	=	Flash Temperature Parameter
EN	=	Chrome Steel Ball Standard
MWSD	=	Mean Wear Scar Diameter
CNT	=	Carbon Nano Tube
HHT	=	Carbon Nano Fiber

CHAPTER 1

INTRODUCTION

1.1 Overview

The tribology study of metal processing has been emphasized nowadays due to the trend of era is directed toward the machinery world. To increase the life span of machinery system, lubricant is needed. Global environmental awareness encouraged the replacement of mineral or synthetic lubricant with renewable, high biodegradability, sustainability and eco-friendly lubricant. Palm oil based lubricant constitute as one of the natural oil-based lubricant has the potential to replace the mineral lubricant as alternative lubricant for industrial processes. The performance of lubricants is mainly depends on the friction and wear characteristic.

A great friction and wear control for machining process can prevent rapid, wear and failure of machine, hence lubrication of machinery system can considered as vital part of any of the working parts in a machine. In order to reduce the usage of mineral oil, and relieve the amount of the demand on chemical or mineral oils in future, natural oil-based lubricant which is biodegradable source is chosen as study material to provide an alternative to replace mineral oils as lubricant. This project will focus on analyzing the friction and wear characteristic of natural oil-based lubricant – Palm Oil lubricant by conducting four-ball tester (You Bai. 2011).

1.2 Problem Statement

When two or more surfaces have to move in contact or interacting with each other in relative motion, there will have some resistance to movement exit between both surfaces which is friction. Friction will reduce the effectiveness of the equipment itself and at the same time will reduce the life span of equipment through the heat, wear and scar produce during friction occur between surfaces. The amount of friction between surfaces will change according to the various roughness of the surfaces. Friction between two interacting surface can be reduce by using lubricant. But the uses of petroleum based lubricants or mineral oil lubricants can pollute the environment either during or after use. Hence natural oil-based lubricant which has high biodegradability compared to mineral oil is applied to provide an alternative to replace the mineral oil as lubricant.

The tribology properties and effectiveness of the natural oil-based lubricant can be evaluated by using Four Ball Tester equipment by test the friction and wear characteristic for different types of lubricants. Based on the proposed, this project is aimed to investigate the friction and wear characteristic of selected natural oil-based lubricants and make a comparison with the commercial lubricants. Measuring of friction, wear, scar and viscosity of lubricants can be done by using bearings under different lubricants by using Four Ball tester equipment.

1.3 Objectives

The objectives of this project are as follows:

i. To obtain friction and wear characteristics of natural oil-based lubricants which consist of refined glycerin, crude glycerol and oleic methyl ester by conducting four-ball tester experiment.

ii. To compare the friction and wear characteristics between the selected lubricants with commercial lubricants.