UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FUNDAMENTAL STUDY OF NATURAL OIL-BASED LUBRICANT FOR ENGINEERING PURPOSE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Structure and Material Engineering (Mechanical) with Honours.

By

MUHAMMAD IRFAN RAFIQ BIN AZMI

FACULTY OF MECHANICAL ENGINEERING

2014

FUNDAMENTAL TRIBOLOGY STUDY OF REFINED GLYCERINE, OLEIC METHYL ESTER AND CRUDE GLYCEROL FOR ENGINEERING PURPOSE

MUHAMMAD IRFAN RAFIQ BIN AZMI

B041110011

BMCS

Email: epear_09@yahoo.com

Draft Final Report

Projek Sarjana Muda II

Supervisor: Dr. Nor Azmmi Bin Masripan

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

JUNE 2015

FUNDAMENTAL TRIBOLOGICAL STUDY OF REFINED GLYCERINE, OLEIC METHYL ESTER AND CRUDE GLYCEROL FOR ENGINEERING PURPOSE

MUHAMMAD IRFAN RAFIQ BIN AZMI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FUNDAMENTAL TRIBOLOGICAL STUDY OF REFINED GLYCERINE, OLEIC METHYL ESTER AND CRUDE GLYCEROL FOR ENGINEERING PURPOSE

MUHAMAD IRFAN RAFIQ BIN AZMI

This thesis is submitted in partial

fulfillment of the requirements for the award

Bachelor of Mechanical Engineering (Structure & Materials)

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

JUNE 2015

SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of
Bachelor of Mechanical Engineering (Structure & Materials)"

Signature : .....
Supervisor : DR.NOR AZMMI BIN MASRIPAN
Date : 15 JUNE 2015

FUNDAMENTAL TRIBOLOGICAL STUDY OF REFINED GLYCERINE, OLEIC METHYL ESTER AND CRUDE GLYCEROL FOR ENGINEERING PURPOSE

MUHAMMAD IRFAN RAFIQ BIN AZMI

This thesis is presented as a part of requirement for the award of the degree of Bachelor of Mechanical Engineering (Structure and Materials)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

JUNE 2015

DECLARATION

I hereby declare that this thesis is written by me and is my own effort and that no part has been plagiarized without citations except as cited in references.

Signature : ……

Author's Name : MUHAMMAD IRFAN RAFIQ BIN AZMI

Date : 15 JUNE 2015

This dissertation is dedicated to my beloved parents Azmi Bin Che Min and Zakiyah Binti Idris, who always supporting and encouraged me in this study. Also to my supervisor, Dr. Nor Azmmi Bin Masripan, who introduces me to this topic as well for the support on the way.

ACKNOWLEDGEMENTS

I would like to thank and express my gratitude to my Projek Sarjana Muda supervisor Dr. Nor Azmmi Bin Masripan for his technical guidance, constant encouragement, suggestion and valuable time in assisting me in the accomplishing this project. I also would like to thank the Universiti Teknikal Malaysia Melaka (UTeM) for giving me the opportunity to involve in this thesis.

Final love and thanks to my family and friends, who have provided me with joyful, support and welcome breaks after each day's work. I had immensely enjoyed and benefited during this thesis development.

ABSTRACT

The advantageous of natural oil-based lubricant are sustainability and eco-friendly. It is important to study their tribological properties in order to replace mineral oils as lubricant. The student is required to perform the experiment in order to study tribological properties of natural oil-based lubricant. Tribology are the science and engineering of interacting surfaces in relative motion. It includes the study and application of the principles of friction, lubrication and wear. Tribology is a branch of mechanical engineering and materials science. To study and identify the best natural oil-based lubricant is the target. Three natural oil based has been used in this experiment to study their coefficient of friction and wear analysis. They are refined glycerine, oleic methyl ester, and crude glycerol. At the end of the result, the crude glycerol that surpass those two lubricants and give the best result. Crude glycerol obtained average coefficient of friction μ, of 0.03 and 0.05 which is the lowest for 500 N and for 1000 N.

ABSTRAK

Kelebihan pelincir berasaskan minyak semula jadi adalah kelestarian dan mesra alam. Adalah penting untuk mengkaji ciri-ciri tribological mereka untuk menggantikan minyak mineral sebagai pelincir. Pelajar dikehendaki untuk melakukan eksperimen untuk mengkaji ciri-ciri tribological daripada berasaskan minyak pelincir semula jadi. Tribologi adalah sains dan kejuruteraan berinteraksi permukaan dalam gerakan relatif. Ia termasuk kajian dan penggunaan prinsip-prinsip geseran, pelinciran dan haus. Tribologi adalah satu cabang kejuruteraan dan bahan sains mekanikal. Mengkaji dan mengenalpasti pelincir berasaskan minyak semulajadi yang terbaik adalah sasaran. Tiga minyak semula jadi berasaskan telah digunakan dalam eksperimen ini untuk mengkaji pekali mereka geseran dan memakai analisis. Mereka adalah gliserin halus, oleik metil ester , dan gliserol mentah. Pada akhir keputusan, gliserol mentah yang melepasi kedua-dua pelincir dan memberikan hasil yang terbaik. Gliserol mentah diperoleh pekali purata geseran μ , sebanyak 0.03 dan 0.05 yang adalah yang paling rendah untuk 500 N dan untuk 1000 N.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBRIVATION

PSM - Final Year Project

LCC - Lower Cycle Life Cost

PAO - Polyalpha Olefins

SAE - Society of Automotive Engineers

VI - Viscosity Index

SN - Solvent Neutral

BS - Brightstock

STLE - The Society for Tribology and Lubrication Engineers

ASTM - American Society for Testing and Materials

WSD - Wear Scar Diameter

TEM - Transmission Electron Microscope

XPS - X-Ray Photoelectron Spectroscope

TABLE OF CONTENT

CHAPTER 1

INTRODUCTION

1.1 Overview

These days, characteristic oil-based is tremendously coveted for its application as an oil in metal framing procedures, on the grounds that it is a renewable asset and has high biodegradability contrasted with mineral oil. The properties that outcome from the unsaturated fat compasotion of normal oil-based ointment add to a superior lubricity and viability as against wear compound than mineral.

The worthwhile of characteristic oil-based ointment are manageability and eco-accommodating. It is vital to study their tribological properties so as to supplant mineral oils as grease. The examination about the properties of tribological will give the outcome that which can be finishing up as the best grease.

Tribology is the science and designing of connecting surfaces in relative movement. It incorporates the study and use of the standards of rubbing, oil and wear. Tribology is an early lunch of mechanical building and materials. The best grease will give us the best properties which is incorporate the correct execution

in running a procedure or testing taking into account the parameter that had been set to get the examination of oil-based ointment.

1.2 Problem Statement

Lubricants have an important role in world industrial and economic development, mainly by reducing friction and wear in mechanical contacts. Future lubricants have to be more environmentally adapted, have a higher level of performance, and lower total life cycle cost than presently used lubricants.

In the last 25years, there has been an increasing interest in the use of biodegradable products. Natural oil-based are potential substitutes for petroleum-based oils; not only they are environmentally friendly, renewable and less toxic, but also they have excellent lubricating properties such as high viscosity index, high lubricity and low volatility. For these reasons, natural oil-based lubricants are being actively demanded form any green industrial activities.

The advantageous of natural oil-based lubricant are sustainability and eco-friendly. It is important to study their tribological properties in order to replace mineral oils as lubricant. The student are required to perform the experiment in order to study tribological properties of natural oil-based lubricant.

1.3 Motivation

The motivation for study the trobological properties in natural oil-based will be important in sustainable and eco-friendly. Other than that, it is important to study their tribological properties in order to replace mineral oils as lubricant. The amphiphilic properties that result from the fatty acid composition of natural oils-based contribute to a better lubricity and effectiveness as anti-wear compounds than mineral or synthetic lubricant oils.

1.4 Objective

There are several objectives that need to be achieved in order to make this project successfully.

1) To perform the experiment in order to study tribological properties of natural oil-based lubricant.
2) To study the coefficient of friction and wear of the oil based lubricant.

1.5 Scope Of Project

The scope of this project is to propose and investigate the tribological characteristics of oil based lubricant. The material is prepared based on each lubricant viscosity.The tribological performance of the lubricants was investigated in term of its wear and friction characteristics. Several friction tests are performed over a broad range of applied loads and temperature using four-ball tester. Wear diameter is measured using the inverted microscope and the result is used to determine the wear volume losses. The result of the experimentation procedure is analyzed using the graphical and analytical approach in order to determine the impact of applied loads and temperatures on friction and wear characteristics. This study excludes the used of different concentration of banana peel broth in paraffin oil for testing purpose and applications of proposed material to the real product.

1.6 Summary

This section explains the objective as well as the scope of the project in order to give an insight and the sense of direction of this project. The next subsequent chapter will be literature review section, discussing on the research works previously done by other researchers concerning on the performance of tribological properties in natural oils-based.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter will cover on the research finding about the performance of thetribological properties. There are many techniques or methods that can be used to conduct the experiment in order to study the performance of tribological properties. In this report the method that has been chosen is four ball-testers. This method will be investigated the physical properties of ball bearing that been used in the experiment. Furthermore, theory about the natural oil-based performance also will be discussed in this chapter.

2.2 Natural Oil-based Lubricant

Lubricant must be more environmentally influenced, level of performance must be higher, and total life cycle cost must be lower than already lubricant present. For that lubricant to be formulated, we have to know very well the properties of those based fluid. The formulated lubricant that has been influenced by based fluid properties, have three different divided groups.

Physical, chemical, and film formation properties, these are the groups. An investigation of the properties from all the group must be done to make sure that information about their influenced on based fluid overall performance. Base fluid available for formulation of lubricant will be influenced environmentally wether high or lower value. Mineral, semi-synthetic, and synthetic fluid, these are the group that have been divided in order to compared their properties. Synthetic fluids could be of different types: polyalpha olefins (PAO), synthetic ester, polyglycols, and others.

2.3 Based oil Group

1) Group I – 150SN (solvent neutral), 500SN, and 150BS (brightstock), these are the common of Group I based oil.
2) Group II – Since virtually all hydrocarbon molecules are saturated, group II based oil lubricant has superior anti-oxidation properties. It also has water-white colour**.**
3) Group III – Dewaxing process can produce base oil or oil slax and these two can be manufactured.
4) Group IV – Polyalphaolefins (PAO)
5) Group V – Naphthenics and others are not included.

2.4 Biolubricants Made From Vegetable Oils And Other Natural Sources.

Plant and animals is derived to produced the primarily triglyceride esters. Vegetables derived materials for lubricant base oil used are preferred. High oleiccanola oil, palm oil, sunflower seed oil and rapeseed oil from vegetables and tall oil from tree sources, all these are the common one found in research. To subsequently combined selectively to form specialist synthetic esters, vegetables oil from many resources are almost always hydrolyzed to yield the acids. Lanolin is the example of other naturally derived lubricant that is common used. In research with some uses up to the latter part of

the 20th century as a fiction modifier additive for automatic transmission fluid, it is proved that the whale oil was histotically important lubricant.

(Source: Lubricant Additives: Chemistry and Applications, Leslie R. Rudnick, CRC Press.)

2.5 Properties of a Good Lubricant.

A good lubricant obtained the following properties in order to give a better performance;

1) high boiling point and low freezing point (in order to stay liquid within a wide range of temperature)
2) high viscosity index
3) thermal stability
4) hydraulic stability
5) demulsibility
6) corrosion prevention
7) high resistance to oxidation.

2.6 Fundamental of Tribology.

Science and engineering of interacting surfaces in relative motion are the combination called Tribology. Study and application of principles of friction, lubrication and wear, these are the things that it discuss in tribology. Materials science and mechanical engineering, are the brunch that have in tribology that we can discuss.

Result in loss of materials from the surface will be obtained if the tribological interactions of solid surfaces exposed face with interfacing materials and environment. “Wear” is called the process leading to loss of materials. There are many types of major wear such as abrasive wear, friction (adhesive and cohesion), erosion, and corrosion. Modifying the surface properties of solids by one or more of “surface engineering” process (also called surface finishing) or by use of lubricant