TRIBOLOGICAL BEHAVIOUR FOR REFINED, BLEACHED AND DEODORIZED OF PALM OLEIN AND PALM STEARIN USING FOURBALL TRIBOTESTER

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DEDICATION

To my parents…

And beloved wife…

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ABSTRACT

Vegetable-based lubricants are much more biodegradable compared to lubricants produced from mineral oil. Due to the increasing concern about health and environmental damage caused by mineral-oil based lubricants, there is a growing worldwide trend for promoting the use of vegetable oil as lubricants in a number industries, Nowadays, vegetable oil is viewed as having the potential to substitute the conventional mineral-oil based lubricating oil due to its environmental friendly properties such as being biodegradable and non-toxic. In this research, refined, bleached and deodorized (RBD) palm olein and palm stearin were used as lubricants to evaluate their tribological behaviors using four-ball tribotester. The objectives of this research are to determine the friction value and wear characteristics of RBD palm olein and palm stearin using fourball tribotester. The experiments were run under various loads, sliding speeds and lubricant temperatures for one hour as recommended by the American Society for Testing and Materials (ASTM). The results focused on the friction result obtained and observation of wear scar image on the sliding surface which was compared with the results of paraffinic mineral oil. The result shows that friction value for RBD palm olein is lower than RBD palm stearin. However, both RBD palm olein and RBD palm stearin give lower friction compared to paraffinic mineral oil. Thus, RBD palm olein and RBD palm stearin can be used as lubricant in mechanical system in terms of friction reduction.

ABSTRAK

Minyak pelincir berasaskan tumbuhan adalah lebih mudah boleh biorosot berbanding pelincir yang berasaskan minyak galian. Dari perningkatan kebimbangan tentang kerosakan kepada kesihatan dan alam sekitar yang disebabkan oleh pelincir berasaskan minyak galian, para pengkaji telah mula mempromosikan minyak tumbuhan sebagai pelincir untuk digunakan dalam sesetengah industri. Minyak tumbuhan mempunyai potensi untuk menggantikan minyak galian sebagai minyak pelincir atas ciri mesra alam seperti boleh biorosot and tidak toksik. Dalam kajian ini, minyak sawit olein dan minyak sawit stearin yang telah ditapis, diluntur dan dinyahbaukan (RBD) digunakan sebagai minyak kajian. Objektif kajian ini adalah untuk menentukan nilai pemalar geseran dan ciri haus minyak sawit olein RBD dan minyak sawit stearin RBD dengan menggunakan mesin penguji tribo empat bola. Eksperimen telah dijalankan dengan pelbagai bebanan, halaju gelangsar dan suhu minyak pelincir selama satu jam mengikut piawaian ASTM. Keputusan eksperimen telah dibandingkan dengan minyak galian parafin tanpa bahan tambahan dan tertumpu kepada nilai pemalar geseran yang diperolehi dan permerhatian terhadap imej parut haus pada permukaan gelangsar. Hasil kajian ini menunjukkan bahawa nilai pemalar geseran untuk minyak sawit olein RBD adalah lebih rendah berbanding minyak sawit stearin RBD. Walau bagaimanapum, kedua-dua minyak sawit olein RBD dan minyak sawit stearin RBD memberikan nilai pemalr geseran yang lebih rendah berbanding minyak galian parafin. Rumusan daripada kajian ini, minyak sawit olein RBD dan minyak sawit stearin RBD berpotensi untuk digunakan sebagain minyak pelincir dalam sistem mekanikal kerana dapat mengurangkan geseran.

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LIST OF SYMBOLS

μ	-	Coefficient of Friction
F	-	Force
W	-	Body weight
L	-	Length
VI	-	Viscosity Index
Ra	-	Arithmetical Mean of the Absolute Values of the Profile Deviation from the Mean Line
Ʋ	-	Kinematic viscosity
U	-	Kinematic viscosity of oil measure at temperature of 40 ℃

LIST OF ABBREVIATIONS

FTP	-	Flash temperature parameter
RBD	-	Refined, Bleached and Deodourized
PO	-	Palm olein
PS	-	Palm stearin
P2	-	Paraffinic mineral oil
SEM	-	Scanning electron microscope

CHAPTER 1

INTRODUCTION

1.1 Introduction

Vegetable oils have been widely used as lubricant and become very common to be used almost in all area. They are mostly used in industry such as food processing, cable car, agricultural machinery, mining machinery, railway and etc.

Palm oil is one of the edible oils that has been widely developed to be used as lubricant in the industrial sectors. Oil palm is also known as *Elaeis guinensis* and was derived from the mesocarp of its fruit. The oil palm tree is easily recognizable, as it looks like a coconut tree. In fact, the coconut tree is a close relative to the oil palm tree. Oil palm is a domestic plant to Africans for centuries. Besides that, palm oil is one of the few highly-saturated vegetable fats. It is in the form of semi-solid at room temperature which contains several saturated and unsaturated fats. Human started to use oil palms can be tracked back as far as 5000 years ago. The palm oil is widely used as cooking oil at that time even until now. However, palm oil met demand to be traded as an industrial lubricant for machinery during the Britain industrial revolution.

1.2 Background of Study

Lubricant is a substance that is introduced into two moving surfaces with the aim to reduce friction. The property that reduces the friction in mechanical system is called the lubricity of fluid. Besides that, lubricants also play their role in transporting foreign particles and distributing the heat. Generally, there are few types of lubricants:-

a) Base oil group
b) Biolubricant
c) Synthetic oils
d) Solid lubricants

Besides that, these lubricants can be classified into two general categories of applications namely, engine lubricant and non-engine lubricants. Table 1.1 shows the applications of the engine and non-engine lubricants that are used by the industries.

Table 1.1: Applications of the engine lubricants and non-engine lubricants

Engine Lubricants	Non-Engine Lubricants
Gasoline engine oil	Transmission fluid
Diesel engine oil	Power steering fluids
Automotive diesel oil	Shock absorber fluids
Stationery diesel oil	Gear oils
Railroad diesel oil	Hydraulic fluids
Marine diesel oil	Tractor oils
Natural gas engine oil	Industrial metalworking fluids
Aviation engine oil	Greases

Malaysia is one of the world largest palm oil production countries. There is a record of 17.7 million tonnes of palm oil production in Malaysia in the year of 2008 on the 4500000 hectares of land. Majority of the palm oil is shipped to all around the world for various production purposes such as soap, cooking oil and margarine.

After the milling of oil palm, various palm oil products are produced using the refining processes. Fractionation is the first stage of the refinery process of palm oil which involves crystallization and separation processes to obtain the solid (stearin), and liquid (olein) fractions. Then the palm oil is put through the melting and degumming process in order to remove impurities.

After that, the oil is filtered and bleached. Next, entering the physical refining removes the smells and coloration, to produce "refined bleached deodorized palm oil" and free sheer fatty acids, which are used in the manufacture of soaps, washing powder and other products. Refined, deodorized and bleached is the basic oil product sold in the world's commodity markets, although many companies fractionate it further to produce palm olein for cooking oil, or to be processed into other products. Due to the increasing demand of lubricant in the industrial sector, palm oils have been developed to replace the petroleum and worked as machinery lubrication in the industrial sector.

1.3 Problem Statement

The earth is warming up and there is now overwhelming scientific consensus that is happening, and human induced. Researches have shown that air pollutants from fossil fuel used make clouds reflect more of the sun’s rays back into space. Petroleum is a kind of natural liquid oil a normal type of oil composed of rock minerals, making it different from other kinds of oils that come from plants and animals. It consists of a complex mixture of molecule of molecules called hydrocarbons.

The contaminants derived from petroleum constitute one of the most prevalent sources of environmental degradation in the industrialized world. These hydrocarbon molecules are highly toxic to many organisms including humans. Besides that, petroleum products also contain trace amount of sulfur and nitrogen compounds, which are dangerous by themselves and can react with the environment to produce secondary poisonous chemicals.

These issues have rose the concern of society and government to find other substitute of petroleum in order to minimize the environmental issue and the risk of human health. Plants oil or vegetable oil is one of the alternatives to replace petroleum in the industrial sector. Vegetable oil is well known as a renewable products and environmental friendly. Vegetable oil with high degradability have been considered to substitute the demand of petroleum in the industrial sector all around the world. Furthermore, it is non-toxic which is closely concerned to the human health in processing and deposing it.

1.4 Objectives of Research

Due to the limited resources for mineral-based oil from day to day and the damages to the environment, many researchers are trying to develop a new lubricant that can be used to replace mineral-based oil in the industries. The objectives of this research are as follows:-

a) To determine the friction value and wear characteristics of RBD palm olein and palm stearin using Fourball Tribotester.
b) To investigate the hemispherical surface contact profiles lubricated with RBD palm olein and palm stearin in term of friction.
c) To investigate the friction result of hemispherical surface contact profiles under different experimental condition lubricated with RBD palm olein and palm stearin.

1.5 Scope and Limitation of Research

Malaysia is one of the world largest oil palm producers. Hence, the main purpose of this research is to investigate the ability of palm oil as lubricant in industries. Following are the scope and limitation of this research.

a) RBD palm stearin is used as lubricant in this research.
b) Additive free paraffinic mineral oil with viscosity of 33Mpa.s is used as test lubricant in this research.
c) Normal load (30kg to 60kg) is applied on to the system.
d) Speed of spindle (800rpm to 1400rpm) is used in this experiment.
e) Operating lubricant temperature (55 ℃ to 85 ℃) is used in this experiment.

1.6 Significant of Research

Half usage of the lubricants ends up in the environment. Mineral-based oils (petroleum) which are the leading type of the based oil used in the industries are environmentally hazardous and poor degradability when released. Besides that, the increasing price of the mineral-based oil and the declining rate of production from older domestic oil fields, governments and individuals created strong incentives to provide biodegradable lubricants. They are pressed in finding new resources, which can be used to substitute the petroleum-based oil that gives similar or better lubricity performance when compared to petroleum-based oil.

Bio-lubricant brings the meaning of biodegradable and renewable based stocks. They can be products from fatty acids from fats and oils, reacted with synthetics alcohols to produce esters. Not only that, natural vegetable oils can be treated through several processes to produce modified products which are renewable and biodegradable. The reduction of wear and friction losses is largely a function of the improved lubricant.

Therefore, advanced lubricants are now being formulated to reduce the wear and friction. The development of modern lubricants and their proper usage are of great importance for the national economy, individual and environment. Lubricants, optimally adjusted to a given task, can save much money in the case of an industrialized nation, reduce wear, reduce maintenance requirements and reduce the problem of air pollution.

Palm olein and palm stearin are used in this research, which both are considered as vegetable oil. Palm olein is the liquid fraction of palm oil while palm stearin is the semi-solid state in room temperature after going through the fraction process. As Malaysia is one of the world largest oil palm production countries, the development of palm oil as lubricant in industry can reduce the pollution and hazard to the environment and also to human being. Currently palm oil with additives has been studied to substitute the mineral-based oil as biodiesel in combustion engine. Thus the development of palm oil as lubricant in mechanical system can also be achieved in order to give better living environment to the creatures.

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