STUDY ON COEFFICIENT OF FRICTION OF PURE BIO-LUBRICANTS BASED ON BANANA PEEL

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DECLARATION

"I hereby declare that the work in this in my own except for summaries and quotations which have been duly acknowledged"

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APPROVAL

"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 : 27/6/2016

DEDICATION

Dedicated to my Beloved Father and Mother,

MOHAMAD ROZI BIN KAMIS & NOORMAH BINTI SAIDON

My respectful Lecturer,

And

My entire friends in UTeM

For their encouragement

ABSTRACT

The investigation of lubricated friction is an extended study. This investigation is about to study coefficient of friction (COF) based on pure bio-lubricant with banana peel (BP) as additive. The aim of this study is to analyze the effect of temperature and load on coefficient friction of bio-lubricant. There are have four type of bio-lubricant which is classified with 100% new palm oil, 95% new palm oil + 5% banana peel, 80% new palm oil + 20% banana peel and last sample is 50% new palm oil + 50% banana peel. This investigation conducted by using Four Ball Tester (TR-30L) and each bio-lubricant was conducted by using three different temperatures (27°C, 80°C and 100°C) and three different loads (60N, 250N, and 500N). The coefficient of friction shows how the lubricant prevents contact each ball bearing due the less friction produces the highest quality of bio-lubricant. As a result, new palm oil + 20% banana peel as additive in palm oil showed the good lubricant at load 60N on temperature 80°C which is 0.00597 prove the lowest coefficient of friction compare with others bio-lubricant result in term of improving the performance on bio-lubricant.

ABSTRAK

Penyelidikan geseran dilincirkan adalah kajian berlanjutan. Kajian ini adalah untuk mengkaji pekali geseran (µ) terhadap bio-pelincir dengan kulit buah pisang sebagai bahan tambahan. Tujuan kajian ini adalah untuk menganalisis kesan suhu dan beban pada pekali geseran. Kajian ini terdapat empat jenis bio-pelincir iaitu 100% minyak sawit, 95% + 5% kuling pisang, 80% minyak sawit + 20% kuling pisang dan 50% minyak sawit + 50% kuling pisang. Kajian ini dilakukan dengan menggunakan mesin Fourball Tester (TR-30L) dan setiap bio-pelincir dikendalikan dengan tiga suhu berbeza dan tiga beban berbeza. Pekali geseran menunjukkan bagaimana minyak pelincir menghalang hubungan setiap bebola galas kerana kurang geseran menghasilkan kualiti yang tinggi pada bio-pelincir. Kesimpulannya , 20% kulit pisang sebagai bahan tambahan dalam minyak sawit pada beban 60N dan suhu 80°C menunjukkan hasil yang paling rendah iaitu pada bacaan pekali geseran 0.00597 dan ini memnunjukkan peningkatkan prestasi pada Bio-pelincir.

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LIST OF ABBEREVATIONS

BP	Banana Peel
COF	Coefficient of Friction
MSW	Municipal Solid Wastes
RBD	Refined, Bleached & Deodorised
PO	Palm Oil
PMO	Paraffinic Mineral Oil
VI	Viscosity Index

LIST OF SYMBOL

μ	=	Coefficient of friction
W	=	Applied load in kg
T	=	Friction Torque in kg/mm
r	=	distance from the center of the contact surface on the lower ball to the axis of rotation, which is 3.67mm.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In the past decades, along with the rise of the middle class and fast economic growth in China. Different varieties of fruits produced in China and other countries are increasingly consumed. Due to the high consumption and industrial processing of the edible parts of fruit, fruit wastes such as citrus fruit skins, pineapple residues, sugarcane bagasse and other fruit residues are generated in large quantities in big cities. Fruit waste has become one of the main sources of municipal solid wastes (MSW), which have been an increasingly tough environmental issue. One of them is banana peel. Banana wastes are generated in large amounts every year. Due to the large availability and composition rich in compounds that could be used in other processes, there is a great interest on the reuse of banana, both from economical and environmental points of view. (Ibtisam, 2015). The economic aspect is based on the fact that such wastes may be used as low-cost raw materials for the production of other value-added compounds. The environmental concern is to minimize the pollution arise from the waste discharge.

Bio-lubricants known as bio-based lubricants or bio-lubes, are made from a variety of vegetable oils, such as coconut oils, sunflower, soybean, palm oil (PO) and other fruit. The best application for bio-lubricants is in machinery that loses oil directly into the environment during use. (Tina, 2011). This application suitable for two-stroke engines, chainsaw bars, chains, railroad flanges, cables, and marine lubricants.

Frictional coefficient is define as a ratio of frictional force to vertical force and can be representative of lubricating condition. Frictional force is solid, however, not a characteristic of material itself because it is changed with different factor containing mechanical condition, properties of lubricant and materials of opposite surface. (Tanaka et.al 2012). Therefore, friction coefficient is to measure the specific friction under the specific circumferential condition that stimulates the actual condition. Compare with other fruit's skin, banana peel (BP) can be as bio-lubricant because has the lowest frictional coefficient which is 0.07 compare with other fruit's skin. (Mabuchi et.al 2012).

1.2 PROBLEM STATEMENT

Most current lubricants contain petroleum base stocks, which are toxic to environment and difficult to dispose of after use. Environmental concern continues to increase of pollution from excessive lubricant use and disposal, especially total loss lubricants. Over 60% of the lubricants used in the United States are lost to the environment (S.Z. Erhan et al, 2006). Nowadays, instead of throwing or discarding it into the dustbin, the waste skin or seed can be recycled into other precious material such as biodiesel and bio-lubricant. In addition, it is biodegradable and environmentally friendly that transforming from waste into wealth. Thus, bio-lubricant also contains the lowest friction compared with another chemical lubricant.

1.3 OBJECTIVES

1. To produce the bio-lubricant based on banana peel.
2. To determine the kinematic viscosity of bio-lubricant.
3. To investigate the effect of temperature and load on friction coefficient of bio-lubricant.

1.4 SCOPE

1. Prepare of bio-lubricant cooking oil and banana peel by using ultra sonic homogenizer.
2. Measure the kinematic viscosity of lubricant by using Brookfield Viscometer.
3. Use four ball tester machines to perform friction test of different temperature and load by using the lubricant.

CHAPTER 2

LITERATURE REVIEW

2.1 Coefficient of Friction

2.1.1 Definition Coefficient of Friction

Friction is the resistance to motion during sliding or rolling that is experienced when one solid body moves tangentially over another with which it is in contact. Frictional force is solid, however, not a characteristic of material itself because it is changed with different factor containing mechanical condition, properties of lubricant and materials of opposite surface.

The coefficient of friction (COF) is a dimensionless scalar value which describes the ratio of the force of friction between two bodies. The COF is one of the parameters describing the amount of resistance to the relative motion of two sliding objects. COF also known as value that shows the relationship between the force of friction between two objects and the normal force between the objects. It is dimensionless and not has any units. Coulomb's law is given $f = \mu F_n$.

$$f = \mu F_n \qquad (1)$$

where f = is the frictional force

μ = coefficient of friction

F_n = normal force

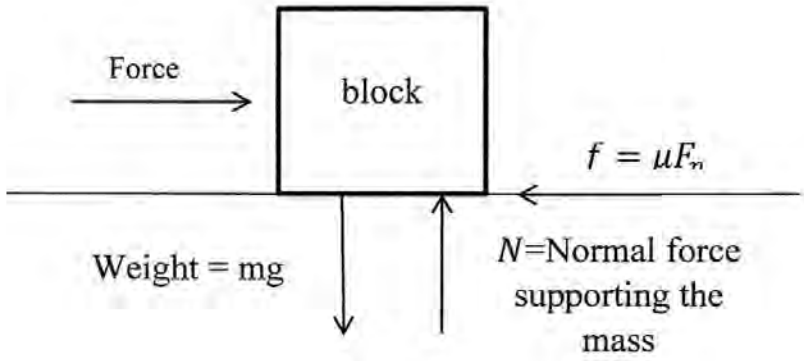


Figure 2.1: Free Body Diagram of Friction

2.1.2 Effect of Load on Coefficient of Friction

The effect of load on the tribological performance of Refined, Bleached & Deodorised (RBD) palm olein is investigated using a four-ball wear tester according to the standard test of ASTM D4172. Tests were conducted with normal loads which is 40kg, 60kg, 80kg, 100kg and 120 kg. Based on figure 2.2 the experimental conditions using RBD palm olein, the incremental increases of the load did not noticeably increase the coefficient of friction. The increase in the coefficient of friction was gradual for 40, 60 and 80 kg loads and began to fluctuate slightly between 0.10 and 0.11 with increases in load beyond 80 kg for the paraffinic mineral oil. (S.Syahrullail, 2013).

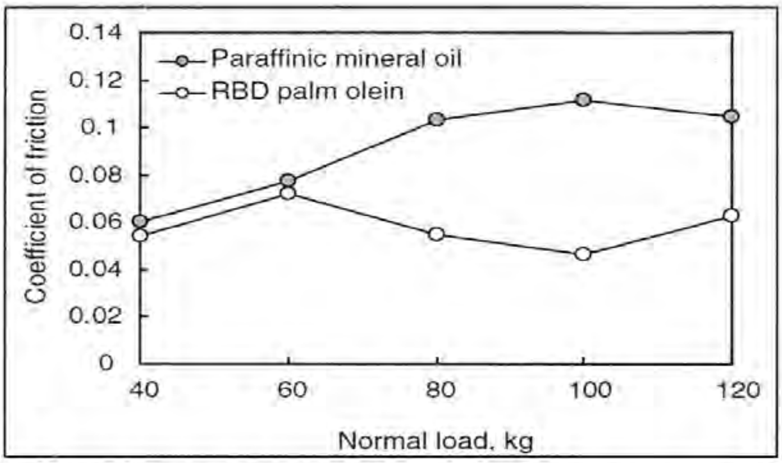


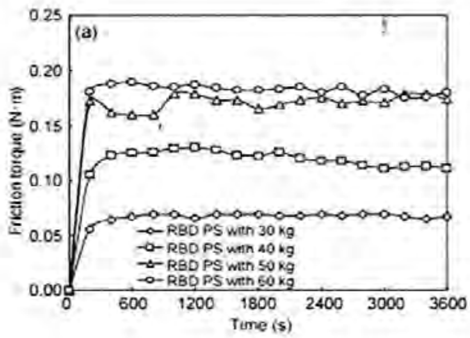
Figure 2.2: COF of PMO and RBD palm olein against normal load
(Source: S.Syahrullail, 2013)

This research presents a statistical evaluation of the experimental data obtained after a tribological study on extravirgin olive oil, in order to point out the lubricating behavior of this vegetal oil. The resulted mathematical models underlined the influence of the sliding speed and the load on the wear scar and the friction coefficient. Tests were done on a four-ball machine. (Liviu Cătălin ŞOLEA, 2013)

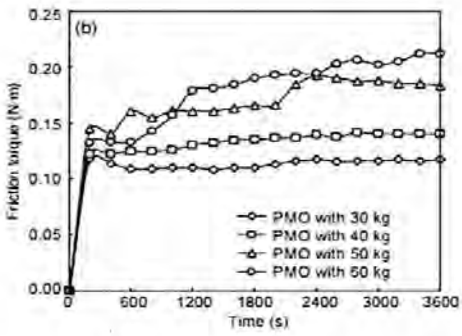
Table 2.1: Experimental result when lubricating the four ball tester with olive oil.
(Liviu Cătălin ŞOLEA 2013)

Test number	Test parameter		Output test parameters	
	Speed [m/s]	Load [N]	The average diameter of the worn tack [mm]	The friction coeefficient
1	0.307	140	0.4567	0.1042
2	0.307	200	0.4965	0.1077
3	0.307	260	0.5324	0.1003
4	0.461	140	0.4352	0.0952
5	0.461	200	0.5418	0.1113
6	0.461	260	0.5738	0.0919

Other research of friction tests is on RBD palm stearin and additive-free paraffinic mineral oil (PMO) were carried out using a four-ball tribotester. In Figure 2.3, both test lubricants show a similar pattern of friction torque increment when the normal load increases. For all RBD PS experimental conditions (Fig. 2.3a), the friction torque was rising rapidly at the beginning of the experiments. At the end of the experiment, friction torque achieved a steady-state condition. For the PMO (Fig 2.3b), only low normal loads of 30 and 40 kg, showed a steady-state condition until the end of the experiment. The steady-state condition of the friction torque shows that the lubricant layer between ball-bearings was stable and no severe breakdown of lubricant film occurred.



(a)



(b)

Figure 2.3 : friction torque distribution vs time for various normal load condition for RBD (a) and PMO (b)

(Source: Chiong Ing TIONG 2012)

This results show that the fatty acid chains in the vegetable oil permitted monolayer film formation with a slippery surface, which prevented direct metal-to-metal contact. Even though the friction increased with the increase of normal loads in this experiment, RBD PS showed lower friction resistance ability than PMO. (Chiong Ing TIONG, 2012)

2.1.3 Effect of Temperature on Coefficient of Friction

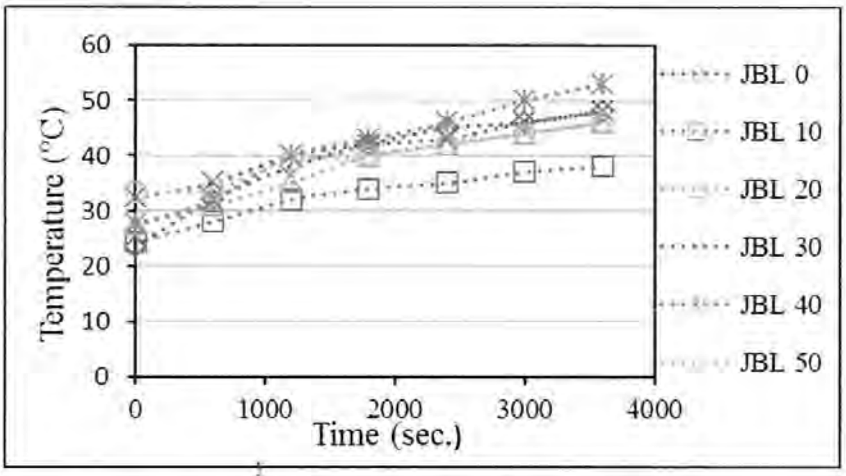


Figure 2.4 : The Lubricant Temperature as a function of sliding time for various Jatropha oil bio-lubricants

The experiment was conducted using aluminum pins and cast iron disc which were lubricated with those of bio-lubricants. The lubricants were characterized by viscosity and elemental analysis using Viscometer and Multi oil analysers (MOA) respectively.

Figure 2.4 shows the relationship of an average oil temperature varies with the percentage of Jatropha oil bio-lubricants sliding time. Increased temperature at run time of one hour to the smallest JBL 10 while the highest changes understood took JBL 40 for each 11.77 ° C and 25.49 ° C. The temperature increased another sample was 12.8°C, 18.65°C and 13.66°C for 20%, 30% and 50% Jatropha oil plus bio-lubricants respectively. Result Fig. 2.4