TRIBOLOGY STUDIES OF BIO-LUBRICANT ON ALLOY

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DECLARATION

I declare that this project report entitled "Tribology Studies Of Bio-Lubricant On Alloy" is the result of my own work except as cited in the references

Signature	:	....
Name	:	....
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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 (Structure & Materials).

Signature :. ....

Name of Supervisor : ....

Date : ....

DEDICATION

This thesis is highly dedicated to God Almighty, Allah S.W.T. who has been my eternal rock and source of refuge that kept me all through the journey of completing this research. Special dedications to my parents and family members that always love me, my supervisor, my beloved friends, my fellow colleague and all faculty members.

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ABSTRACT

The wear mechanism of 4340 steel alloy and 6061 aluminum alloy lubricated with fixed amount of new cooking oil with banana peel as additive was investigated using pin-on-disk tester. Alloy has excellent mechanical properties which is stronger, harder and high corrosion resistant. Therefore, many alloys used in industries such as the automotive industry. New cooking oil was chosen for the development of bio-lubricant to replace or minimize the usage mineral oil base lubricant. New cooking oil is a vegetable oil extract from palm tree which is non-toxic to human and has high decomposition rate. These factors give advantages to new cooking oil to be produce as an industrial lubricant. The experimental works were performed using a pin-on-disk tribotester, using 4340 steel and 6061 aluminum as the material for both flat ended pin and modified disk. The test were conducted by dripping 5ml of new cooking oil with banana peel as a lubricating oil on the sliding surface at constant speed, which was 800rpm using constant load, which are 78.48N. In this study, the specific wear rate of the pin and friction coefficient was investigated. The weight loss and surface roughness before and after experiment were analyzed. All the results obtained were compared with the percentage of banana peel in cooking oil. The bio-lubrication of 100% NCO, 95% NCO + 5% BP, 80% NCO + 20% BP and 50% NCO + 50% BP was been investigated at load applied with constant parameter. The result presented, the higher percentage volume of bio-lubricant applied, showed decreasing the dynamics viscosity when increasing the temperature. Friction and wear behaviour showed, by increasing the percentage volumes of bio-lubricant applied, triggered decreasing the friction coefficient, wear and weight losses for alloys. Besides that, higher the hardness of alloys increasing the friction coefficient and wear for alloys. It could be concluded that new cooking oil with banana peel has the potential to be developed as a lubricant.

ABSTRAK

Mekanisme haus dan pekali geseran aloi 4340 keluli dan aloi 6060 aluminium yang dilincirkan dengan minyak masak dengan tambahan kulit pisang sebagai bahan tambahan dikaji dengan menggunakan mesin tribo pin-atas-cakera. Aloi mempunyai sifat-sifat mekanikal yang sangat baik seperti lebih kuat, lebih keras dan tahan kakisan yang tinggi. Oleh itu, aloi banyak diguna pakai didalam industri seperti industri automotif. Minyak masak dipilih untuk dibangunkan sebagai minyak pelincir mesra alam untuk menggantikan atau mengurangkan penggunaan minyak pelincir berasaskan sumber mineral. Minyak masak adalah minyak tumbuhan yang berasal dari pokok sawit adalah tidak bertoksik kepada manusia dan mempunyai kadar penguraian yang tinggi. Faktor-faktor ini memberikan kelebihan kepada minyak masak untuk dihasilkan sebagai bahan pelincir industri. Ujikaji telah dilakukan dengan menggunakan mesin tribo pin-atas-cakera dengan menggunakan 4340 keluli dan 6061 aluminium sebagai bahan bagi pin dan cakera beralur. Ujian telah dilakukan oleh menitiskan 5 ml minyak masak dengan kulit pisang di permukaan gelangsar cakera dengan kelajuan tetap 800rpm dengan menggunakan beban yang sama iaitu 78.48 N. ***Dalam** kajian ini, kadar haus tertentu pin dan pekali geseran yang telah dikira. Kehilangan berat pin dan kekasaran permukaan pin sebelum dan selepas ujikaji telah dianalisis. Semua keputusan yang diperolehi dibandingkan dengan peratusan campuran kulit pisang dalam minyak masak. Bio-pelincir 100% NCO, 95% NCO + 5% BP, 80% NCO + 20% BP and 50% NCO + 50% BP telah disiasat pada beban yg dikenakan pada parameter yang tetap.Hasil kajian menunjukkan, jumlah peratusan yang lebih tinggi bio-pelincir digunakan, menunjukkan penurunan kelikatan dinamik apabila peningkatan suhu. Tingkahlaku geseran dan haus menujukkan, dengan meningkatkan kuantiti peratusan bio-pelincir digunakan, mencetuskan mengurangkan pekali geseran, haus dan kerugian berat untuk aloi. Selain itu, lebih tinggi kekerasan aloi meningkatkan pekali geseran dan memakai untuk aloi. Kesimpulannya, minyak masak dengan tambahan kulit pisang mempunyai keupayaan untuk dibangunkan sebagai pelincir.*

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LIST OF ABBEREVATIONS

NCO	New Cooking Oil
COF	Coefficient Of Friction
R&D	Research And Development
ASTM	American Society for Testing and Materials
LVDT	Linear Voltage Differential Transformer

LIST OF SYMBOL

F	=	Friction
μ	=	Coefficient of friction
W	=	Applied load
ρ	=	Density
Δm	=	Difference of mass loss
ΔV	=	Rate of volume loss
L	=	Sliding distance
η	=	viscosity of the lubricant
v	=	sliding speed

CHAPTER 1

INTRODUCTION

1.1 Background

Tribology studies are a very important mechanical field in industries .It is a study of surface interaction in relative motion. It has various practical benefits because the functioning of many mechanical, electromechanical and biological systems depends on the appropriate friction and wear values. Different investigations had been done in the past for the prediction of wear and friction characteristic on the alloy. It is generally acknowledged that wear and friction primarily changes with load, speed (Chowdhury et al., 2011), temperature (Nofal et al., 2011), surface roughness (Terumasa et al., 2000), and environmental effect.

Friction is a force that holds back the movement of a sliding object. The friction can be found everywhere that objects come into contact with each other. The force acts in the opposite direction to the way an object sliding path. Friction is the force which allows us to walk on the ground and prevent the slip. Various parts of the machines are able to rotate due to the friction between pulley and the belt. However, the friction can cause wear on solid surfaces. Friction and wear are related to each other. The excessive friction might be dangerous and can contribute to damage and faulty to system. A lubricant can reduce the friction and wear of the system.

Wear is defined as a process where interaction between two surfaces or bounding faces of solids within the working environment results in dimensional loss of one solid, with or without any actual decoupling and loss of material. Wear of metal occurs by the plastic displacement of surface and near-surface material and by the detachment of particles that form wear debris. This process may occur by contact with other metals, nonmetallic solids, flowing liquids, or solid particles or liquid droplets entrained in flowing gasses (*Davis, J.R., 1998).* Aspects of the working environment which affect wear include loads and features such as unidirectional sliding, reciprocating, rolling, and impact loads, speed, temperature. The wear-rate normally changes through three different stages under normal mechanical and practical procedures which is primary stage, secondary stage and tertiary stage. Primary stage is where surfaces adapt to each other and the wear-rate might vary between high and low. Secondary stage is where a steady rate of ageing is in motion. Most of the components operational life is comprised in this stage. Tertiary stage is where the components are subjected to rapid failure due to a high rate of ageing.

A lubricant is a substance which is in liquid form. It is to reduce friction between surfaces in one or more contact which is reduces the generated heat when the surfaces move. The behaviour of reducing friction is called lubricity. It is used for many other purposes in industrial application such as gear and engine motor. A good lubricant has high viscosity index. Mostly, lubricants contain 90% base oil which is mineral oil. Mineral oil has a lot disadvantages for environment and humans.

Bio-lubricant or lubricant base oil use the vegetable derived materials are preferred. Bio-lubricant which is vegetable oil has highly potential to be commercial in many sectors mostly and try to study deeply about vegetable oil that is high availability in each area. Vegetable oil shows a lot advantages compared with conventional oil. Vegetable oils can have excellent lubricity compared with mineral oil. Vegetable oil is labelled as a renewable fuel as it does not release any extra carbon dioxide and carbon monoxide gas to the atmosphere. Vegetable oils also known as eco-friendly lubricants were selected due to several advantages: high biodegradability, excellent oxidative stability, good low temperature properties and low cost (Syahrullail et al., 2012). The presence of vegetables oil as lubricant is attributed to the decrease of mineral oil application in industries due to its biodegradability (Tiong et al., 2012). Malaysia has a great potential of producing the palm oil tree, which remain untapped and can be used as potential source for vegetable oil based lubricants with an objective of ecological compatibility in addition to engine and industry performance.

Banana peel can be used as additive in new cooking oil based from palm oil to increase the efficiency the bio-lubricant. The present of banana peel skin has potential to reduce the coefficient of friction (COF). The banana skin shows the COF on floor material (K. Mabuchi et al., 2012). The COF was measured using six degrees of freedom force transducer under a flat panel of linoleum. COF resulted from the test is much lower compared to the value of common materials and similar to the well lubricated surface.

1.2 Problem Statement

Currently, most of the engine and industry used lubricant based on petroleum as lubricating oil. Most of the people in the world are now threatened by the greenhouse effect and pollution phenomenon. Conventional oil contributed in the erosion of ozone layer and affect to the soil and waterways in long term period. This is occurs due to the effect of the toxic, non-degradable properties of mineral oil and increase the carbon intensity in the air. Next, most of the industry are faced the problem with the wear characteristic complications of operating machines and engines that force to shut down the operation that are increase the cost and wasting time. In other case, the petroleum resources are decreasing every day leads to more expensive oil prices will cause an increase in the price of product. This problem can be solving by using alternative lubricant which is bio-lubricant.

1.3 Objective

The objectives of this project are as follows:

1. To determine the dynamics viscosity of the bio-lubricant.
2. To study the tribological characteristics of two different alloys under bio-lubricant on alloys.

1.4 Scope of Project

The scopes of this project are:

1. To prepare a bio-lubricant as new cooking oil with its additive (banana peel) by using an ultrasonic homogenizer apparatus.
2. To perform a frictional test by using pin on disc apparatus.
3. To analyse the friction and wear behaviour of different alloys.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to understand the tribology and related property, the review of literature on tribology, bio lubricant with additive and various alloys as the wear resisting material has been done separately. The first part deals mainly with tribology including wear, wear mechanism, etc. and the other part deals with bio lubricant with add additive and various alloys as wear resisting material and its characteristics.

2.2 Tribology

The term tribology was first used in 1966 in a report of the UK Department of Education and Science. The word tribology is derived from the „Greek" work „tribos" means rubbing. However, the modern definition of tribology is the "science and technology of interacting surfaces in relative motion". It is the study of friction, wear and lubrication, which involve the movement of one solid surface over another (Arnell et.al, 1991). It includes parts of physics, chemistry, solid mechanics, fluid mechanics, heat transfer, materials science, lubricant rheology, reliability and performance. The economic aspects of tribology are significant. By the application of tribological principles a number of countries arrived at figures of savings of 1.0% to 1.4% of the GNPs for proportionally minimal expenditure on Research and Development (R&D).

The (R&D) taking place at the interface controls its friction, wear and lubrication behaviour. During these interactions, forces are transmitted, mechanical energy is converted, physical and chemical nature, including surface topography of the interesting materials is altered. In many technological applications, the surfaces used are mostly either sliding or rolling. So, understanding their tribology is major to successful machine component design. Basic concept of tribology would be useful in choosing and designing various tribological of an automobile machine element like bearings, gears, cams and constant velocity joints.

A solid surface or more exactly a solid-gas or solid-liquid interface, has a complex structure and complex properties depend upon the nature of solids, the method of surface preparation and the interaction between the surface and the environment (Alias, T. Y., & Haque, M. M. 2003). Properties of solid surfaces are crucial to surface interaction because surface properties affect the real area of contact, friction, wear and lubrication. A schematic illustration of cross-section of the surface structure of metals shows in **Figure 2.1**.

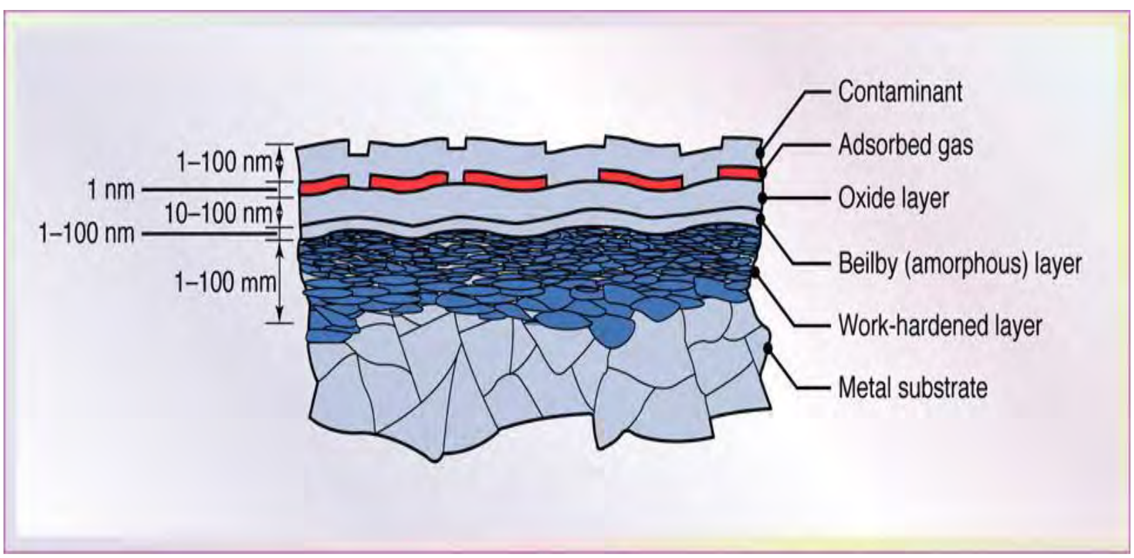

Figure 2.1: Schematic illustration of cross-section of the surface structure of metals.

The thickness of the individual layers depends on both processing conditions and processing environment. Occasionally, there will be a greasy or oily film. The presence of surface films affects friction and wear. The effect of absorbed films, even a fraction of a monolayer, is significant on the surface interaction. Sometimes, the films are worn out in the initial period of running and subsequently have no effect. Another important property that must also be considered is surface tension or surface free energy. This affects the adsorption behaviour of the surfaces of the materials. These films are found both on the metallic and non-metallic surfaces.

2.2.1 Type of Wear and Their Mechanism

2.2.1.1 Wear

It is well-defined as a process of elimination of material from one or both of two solid surfaces in solid contact. Wear is characterized as "the damage to a solid surface, for the most part including the progressive loss of material, due to relative motion between two moving surfaces". Such a process is complicated, involving time-dependent deformation, failure and removal of materials at the counterface. Research in this area is of vital importance from the economic point of view because it is a major problem and its direct cost is estimated to vary between 1% and 4 % of a nation‟s Gross National Product.

2.2.1.2 Types of Wear

Following are the various types of wear processes based on the types of wearing contacts.

(i) Single-phase wear: In which a solid moving relative to a sliding surface causes material to be removed from the surface. The relative motion for wear to happen may be sliding or rolling.

(ii) Multi-phase wear: In which wear, from a solid, liquid or gas acts as a carrier for a second phase that actually produces the wear (Phakatkar, H. G., & Ghorpade, R. R., 2009).

2.2.1.3 Wear Mechanisms

Common types of wear mechanisms are as listed below;

(i) Abrasive wear

(ii) Sliding and adhesive wear

(iii) Fretting Wear

(iv) Corrosion Wear

(v) Impact Wear

(i) Abrasive wear

Abrasive wear occurs when a hard rough surface slides across a softer surface. ASTM (American Society for Testing and Materials) defines it as the loss of material because of hard particles or hard projections that are constrained against and move along a strong surface.

Wear, in turn, is defined as damage to a solid surface that for the most part includes dynamic loss of material and is because of relative movement between that surface and a reaching substance or substances. The rate at which the surfaces abrade depends on the characteristics of each surface, the presence of abrasives between the first and second surfaces, the speed of contact, and other environmental conditions. In short, loss rates are not inherent to a material .The mechanism of abrasive wear shown in **Figure 2.2**.