UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY OF THE FRICTION AND WEAR CHARACTERISTIC FORFULLY SYNTHETIC OIL BLENDED WITH MINERAL BASE OIL

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (MaintenanceTechnology) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

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ABSTRAKS

Tujuan kajian ini adalah untuk mengenalpasti ciri-ciri minyak enjin campuran selain mengkaji koefisien geseran, saiz calar dan juga kelikatan sampel dengan nisbah berlainan berasaskan minyak mineral dan sintetik yang berlainan. Sampel itu dicampurkan bersama-sama dan kemudian ujian tribologi dilakukan menggunakan penguji empat bola menurut ASTM Standard D4172 untuk mendapatkan koefisien nilai gesekan. Permukaan permukaan calar dianalisis dengan menggunakan mesin elektron pengimbasan (SEM) dan kelikatan sampel dijalankan pada suhu 40°C dengan menggunakan Heated Viscosity korelasi dengan ASTM D445. Selepas ujikaji dilakukan, data itu dikumpulkan dan dianalysis dengan teliti dan penemuan itu dijangkakan dengan baik. Data dianalisis dan mendapati bahawa permukaan calar, saiz calar dan kelikatan meningkat secara beransur-ansur. Bacaan kelikatan untuk minyak campuran tidak banyak perubahan berbanding dengan minyak tulen. Telah diperhatikan bahawa minyak campuran mempunyai kenaikan ketara dari segi permukaan calar dan saiz calar berbanding minyak mineral.

ABSTRACT

The purpose of this study is to determine the characteristicof blended engine oilof SAE10W50 and SAE20W40.The coefficient of friction, wear scar diameter and the viscosity of the sample with different ratio of mineral based and fully synthetic oil were also investigated. The sample was blended together and then thetribological testing was conducted using a four-ball tester according to ASTM D4172 standard to get the coefficient of friction value. The wear scar surface was analysed by using the scanning electron machine (SEM) and the sample viscosity was conductedat 40°Cby using heated viscometer correlation with ASTM D445.The data analysed and defined that coefficient of friction, wear scar diameter and viscosity increase gradually.The viscosity reading for blended oil is not much changes compared to pure oil. It was observed that blended oil have significant increases in terms of coefficient of friction and wear scar diameter compare to mineral oil

DEDICATION

I dedicated this final year project to my beloved parents and a special thanksfor the support given throughout my studies.

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First of all, I would like to express my thanks and gratitude to Allah SWT for giving me bless to carrying out this final year project. I would like to express many thankful to my supervisor, En. Omar bin Asaroon and my co-supervisor En. Zainal Taufik bin Zainal Arifin who always gave me full guidance and supports in completing my final project.

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LIST OF SYMBOLS

˚C	-	Celsius
˚F	-	Fahrenheit
%	-	Percent
g	-	Gram
wt%	-	Weight percent
F_n	-	Friction force
μ	-	Static/kinematic friction coefficient
N	-	Normal force
vol.%	-	Volume percent

LIST OF ABBREVIATIONS

SEM	Scanning election microscope
SAE	Society of Automotive Engineers
ASTM	American Society for Testing and Materials
API	American Petroleum Institute
ZDDP	Zinc dialkyldithiophosphate
cSt	Centistokes
VI	Viscosity index
COF	Coefficient of friction
WSD	Wear scar diameter
JASO	Japanese Automotive Standards Organization
AISI	American Iron and Steel Institute

CHAPTER 1

INTRODUCTION

1.1 Background

Generally, lubrication is the treat or method by operating a lubricant to minimized friction and wear in a contact between two surfaces. It is depending on the amount of surface separation and another lubrication regime that can be characterized based on type of lubricant. Lubricant is a fluid present to minimized friction between surfaces in common contact that finally decreases the temperature created once the surfaces in motion. Other than that, the purpose of lubricants are transferring forces in hydraulic system, carry wear particles, and keep temperature in constant condition. The reducing friction characteristic is knowing as lubricity.

In addition, lubricants can be applied in various purposes and activities such asusing oils or fat in cooking process in hot pans, ultrasound test and, medical test.According to R. F. Haycook, et al. in 2004, lubricant has been used long time ago. However, researchers claimed that it was being important in middle east a few thousand years B.C. Then, the development of lubrication accelerated due toincreases in industrial and technologies.

1.2 Problem Statement

Lubricants are formedfrom the crude oilwhich isabout 1.2 % yearly from petroleumproducts whichisabout 40 million tons of base oil for worldwide application (F Audibert et al. 2006). According to Jan C.J et al. in 2013 state that the increased ofautomotive industries from 980 million vehicle units in 2009 to 1.015 billion in 2010 has proved that lubricants industries continue to develop.

However, crude oil is a non-renewable source that needs to be addressed. This is why we need to store and accumulate unused lubricants in automotive services for best use.For example, motorcycles using engine below 250cc need at least 800ml of a bottle of lubricating oil containing 1 liter to allow the engine to operate. Therefore, we need a mechanism to collect 200 ml of unused lubricant oil to avoid this oil being chemical waste.

If problems such as cracking engines occur, they will cause lubricating oils out of the engine system and the lubricants are below the minimum level to operate. To overcome this problem, lubricating oils need to be added even though different grad to ensure the engine can operate. However, based on practicing oil analysisJ Fitch et al. 2000, state there is a possibility of lubricants to be degraded when different graders are mixed. So, experiments are the best way to study the effects of blended different grade lubricants.

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1.3 Objectives

The objective of this research are:

a) To blend SAE10W50 and SAE20W40 to form a lubricant.
b) To investigate the effect of blended lubricant oil by using four-ball tester, scanning electron microscope (SEM) and viscosity testing.

1.4 Scope of Study

A few scopes are drawn to achieve the objectives:

a) Determine the coefficient of friction by using four-ball testing machine and wear scar diameter of the tested ball bearing by using scanning electron microscope (SEM)
b) Investigate kinematic viscosity of blended lubricant by using heated viscometer.
c) Determine the composition that have lower effect when oilof SAE 20W40 mix with SAE 10W50 as a blended lubricant oil.

CHAPTER 2

LITERATURE REVIEW

2.1 Lubricant

Normally, lubricants are materials used to prevent two surfaces to touch each other directly that will support the components in motion and will decreases friction and wear occur in the contact surface (Zainal et al. 2018). Normally, lubricant can be categorized into three class that usually used in industries that is solid, semi solid and liquid lubricant. It is having specifics function based on their application.

2.1.1 Solid

Solid lubricants are typically composed of a solid, a binder and additives such as corrosion inhibitors or solvents. Solid lubricants, which are used where it is important for the lubricant to stay in place, typically have a temperature range over which they are effective. Above the optimum range they may degrade chemically or physically. This lubricant will reduce the friction between the two surfaces according to Oshita, Komiyama et al. in 2018. Usually, graphite,molybdenum disulfide (MoS_2),hexagonal boron nitride and tungsten disulfide commonly used as solid lubricant.

Solid lubricants are usually used on machines in the food industry due to solid lubricants having low probability of contaminating food. Another solid function of the lubricant is the solid lubricant can work effectively on some surfaces such as ceramics. Finally, solid lubricants are usually used at high temperatures and pressures. It is proven

by Tomala et al. in 2013 when experimental tests showed less friction at high temperatures when using lubricant solvents.

In general, graphite and molybdenum disulfide are often used as solid lubricants as opposed to the benefits and reliability of this material. Graphite is usually created from polycyclic carbon atom which are arranged in hexagonal form. In the industry, commonly used graphite is synthetic and natural. The molecular dimensions and thickness of the coating are important characters for molybdenum disulfide as lubricants based on Gunda et al, in 2016.

2.1.2 Semi Solid

Usually, Grease contains soap extracts from mineral or vegetable oils. In general, the grease has a high viscosity that contains base oils of about 75 to 95% comprising mineral or synthetic oils such as PAO, esters, silicon, glycol. It has additives around 0 to 5% like antioxidants, EP additives, corrosion inhibitors, water repellents and lastly contain fibers about 5 to 20%. The tests conducted by Li et al. in 2010 on the importance of thick fibers that will affect the film's grease thickness.

Low-viscosity greases are usually used for high temperature and load parts and high-speed application. When the grease viscosity is high, it is usually used for high temperature and load sections and is applied to slow speed applications. The grease advantage of comparing other types of lubricants is when it can carry high loads, serves as a seal, avoiding corrosion and serves as a temporary partial lubrication. In general, the use of greases can smooth operations because the contact surface is reduced (Fan et al 2018). However, it has some disadvantages in the context of instability and conductivity, high friction coefficient, no filtering for dust and pollutants.

2.1.3 Liquid

Liquid lubricants are usually made of synthetic, plant or mineral base. In general, the use of mineral oils is more widely used for machines in the industry. Synthetic oils are very useful for use when operating in extreme conditions. Vegetable oils will be the first choice as lubricants if it concerns the environment as other liquid lubricants will affect the environment. Liquid lubricant has a function as heat controller, reducing friction and prevention from corrosion. Additionally, liquid lubricants are also agents for carrying debris and contaminants for engines. However, it will affect the oil properties. For example, a higher level of pollution or unwanted lubricant will reduce the viscosity of the lubricant and make high engine failures (A. Munaim et al 2018).

Liquid lubricants can carry soot from the system, but they can accumulate in the inlet and cause high wear as the lubricating system is less effective. However, the soot in the lubricant can be controlled with anti-wear additives in the lubricant (Motamen Salehi et al., 2017). Lubricants serve as a precautionary measure for corrosion in the engine. Lubricants will emulsify alcohol moleculesand water to prevent corrosion from occurring in the engine (Besser et al., 2014).

Mineral oils extracted from petroleum have limits due to petroleum which are non-renewable sources. Therefore, the world is now focusing on other sources that can be used as lubricants such as palm oil due to the advantages in the context of renewable resources. Biodegradable oils such as biodegradable palm oil can meet the need for future based lubricants (Syahrullail et al. 2011. However, in-depth studies have to be done to improve the ability and performance of vegetable oil to enable it to be used in engines.

2.2Type of Automotive Lubricant

The Society of Automotive Engineers SAE International are founded in U.S. as the ground of the society. It is international professional organization and standards emerging group for engineering professionals in different field. Then,American Petroleum Institute (API) also common aimed to natural gasand oil activity in U.S. function as trade organization. Its purposes are to characterize about companies that involved in the petroleum industry like manufacturing, refinement, supplying, and many other aspects in this industry. Generally, there are two type of oi that used in automotive engine lubrication that is mineral base oil and fully synthetic oil.

2.2.1 Mineral Base Oils

Mineral base oil is formed based from a complex mixture of particle that variable form and dimension. Crude oil is a very complex mix that can be manipulated for a variety of uses. However, it has to be a series of physical filtration because only a few crude oils can be used as lubricants. Then chemical steps should also be taken to improve the oil properties.

At refineries, oils have different viscosity and include biochemical features that work in distinguishing functions between one oil and another. There are several categories produced for base oil minerals such as hydrocarbons and non-hydrocarbons. Hydrocarbon is an organic compound consisting of carbon and hydrogen. However, non-hydrocarbons are organic compounds that combine with other elements to hydrocarbon structures such as sulfur, nitrogen and oxygen molecules. Figure 2.1 shows the common molecule structure or arrangement of mineral base oil.

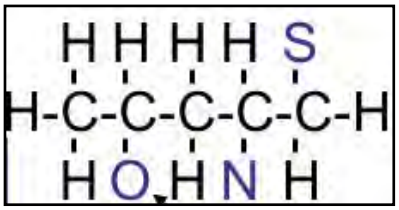

Figure 2.1 Molecular structure for mineral base oil.*(W. Stachowiak et al. 1993)*

2.2.3 Synthetic Oil

Different with mineral oil, synthetic oil that is invented with cautiously controlled treat or modified-approach to encounter an extra exciting condition. It is substance created to encounter the challenging requirement of contemporary engines. Its required extra costly to create but give the excellent performance, good defense from wear and fuel economy since the oil are modify-made. This oil will stay consistence with their characteristic at extremely high and low temperatures.

The pure synthetic now applies in machine oil are polyampholytes (PAOs) and carboxylic acid ester. Most synthetic oils have an additive ratio of 10% or higher in addition to oil. Not only the addictive ratio, the difference in particle structure is the reason why this oil is performing better than mineral base oil. Figure 2.2 shows the molecular structure common to synthetic oils.

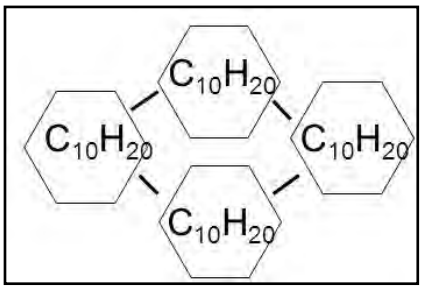

Figure 2.2 Molecular structure for synthetic oil.*(W. Stachowiak et al. 1993)*