UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FRICTION AND WEAR CHARACTERISTICS OF ATF OIL WITH NANO ADDITIVE ON LOCAL PALM OIL FOR AUTOMOTIVE APPLICATION

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

by

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of UniversitiTeknikal Malaysia Melaka (UTeM) as a partial fulfillment 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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ABSTRAK

Kajian inibertujuanuntukmengkajisifatgeseran dan ciricalardenganmenggunakanminyak ATF yang ditambahdenganZirkoniumOksida (ZrO_2) pada minyakkelapasawitbagiaplikasiautomotif. Objektifdarikajianiniadalahuntukmenetukanpekaligeseran, diameter hauscalarbebola dan kelikatansampeldengannisbahminyak ATF dan ZirkoniumOksida yang berbeza. Semuasampelujikajitelahdicampurkan Bersama denganmenggunakan homogenizer ultrasonic. Setelah itu, ujiantribologikaldijalankandenganmenggunakanpengujiempat bola mengikut ASTM D4172 bagimendapatkanpekaligeseran dan diameter haluscalar. Permukaanhaluscalardianalisisdenganmenggunakanmesinpengimbas electron (SEM) dan kelikatansampelmenggunakan Brookfield Viskometermengikut standard D2983. Hasil dariujian tribological dianalisa dan dijadualkan. Hasil daripadakajiantelahmenunjukkanbahawapekaligeseran (COF) dan diameter haluscalar (WSD) yang terendahadalahdarisampel yang mempunyai 0.6 dan 0.7 vol% ZrO_2 yang ditambah. Graf COF dan WSD juga menunjukkan trend yang menurunbagisetiappenambahan ZrO_2dalamsetiapsampel. Selainitu juga, bacaankelikatan pada suhu 40°C dan 100°C menunjukkanpeningkatansecaraberansur-ansur.

ABSTRACT

The purpose of this study is to study the friction and wear characteristics ATF oil added with Zirconia Oxide (ZrO_2) on local palm oil for automotive application. The objectives are to determine the coefficient of friction, wear scar diameter and the viscosity of the samples with a different ratio of ATF oil, Palm oil,and Zirconia Oxide. The sample was blended together by using the ultrasonic homogenizer. Then, tribological testing was conducted using a four-ball tester according to ASTM Standard D4172 to gain the coefficient of friction value. The wear scar surface was analyzed by using the scanning electron machine (SEM) and the sample viscosity was conduct by using Brookfield Viscometer according to standard ASTM D2983. The result was analyzed and tabulated. The result shows that the lowest COF and WSD is from the 0.6 and 0.7 vol% ZrO_2 added. The COF and WSD graph showed that the trend is gradually decreasing with the addition of ZrO_2 in each sample. Besides that, the viscosity reading at 40°C is not many changes but at 100°C, the viscosity is gradually increased

DEDICATION

A special thanks to my parents for the support with my studies in degree. Also, a big thanks to my supervisor Ts. Azrin Bin Ahmad and co-supervisor Dr. Muhammad Ilman Hakimi Chua Bin Abdullah that always guided me. Finally, thank you Miss Ayuma, Miss Atiqah, Mr.Syahrizan, Mr. Nazir and my friends.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF SYMBOL and ABBREVIATIONS

ASTM	American Society for Testing and Material
Al_2O_3	Alumina Oxide
ATF	Automatic Transmission Fluid
CI	Certainty Intern
cP	Centipoise
COF	Coefficient of Friction
CuO	Copper Oxide
Nm	Nanometer
Kg	Kilogram
hBN	Hexagonal Boron Nitride
SEM	Scanning Electron Microscopy
Rpm	Rotation Per Minute
TiO_2	Titanium Oxide
vol%	Volume Percent
WSD	Wear Scar Diameter
ZrO_2	Zirconia Oxide
4WD	Four Wheel Drive
%	Percent

CHAPTER1

INTRODUCTION

1.1 NANOPARTICLE

Nanoparticles technology has been evolved rapidly. Applications of nanoparticles have entered avariety of fields such as electronics, cosmetics, medicine,and biotechnology. Nanoparticle today is known to be used as modern lubricant additives. The nanoparticle is a component that used in the creation of a nanostructure and much smaller than the average object stated by Newton's laws of motion, yet larger than a molecule that led by quantum mechanics. Usually, the size of the nanoparticle is in between 1 and 100nm (Horikoshi et al, 2013).

Nanoparticles exhibit significantly different properties and have huge advantages compared to recent organic molecules (Abdullah et al, 2013). Among others inorganic nanoparticle used before, metal oxide nanoparticle has benefited the industry, an example; have minimal cost, high stability, and the simplicity of molecule controlling making them a great commercial application in lubricating oils.

Nowadays there are many researchers are using the nanotechnology additives or nanoparticles as the catalyst for their research. Before this, the other types of nanoparticles used for the research are polymers, metals, organic and inorganic materials. The increasing demand of advanced lubricants recently is due to the scope of operational usage, for example, high loads, speed of movement between erosion sets,

more extensive temperature run (Mohan et al. 2014). Generally, the previous and recent researchers agree on the capability of nanoparticle in improving the tribological composition of lubricant (Shahabuddin et al.2013).

1.1.1 Palm Oil as alternative Lubricant

A lubricant is an essential element for gear, engine, and mechanism with a specific aim of lessening the wear and friction between two contact surfaces. Palm oil can be used in various applications such as cooking process and lubricating. As we know, Malaysia is the largest producer of palm oil due to good climate and good management planning in enhancing better research and development. In facts, the palm oil from Malaysia performance has a good viscosity, volatility requirement, and high respond to the additive exceeding the other oil performance. According to (Reddy et. al., 2014) the palm oil is categorized as environmentally friendly due to the biodegradable process output resulting harmless product.

On top of that, recent studies show that palm oil is relevant to be used as an engine lubricant. Since 1988, the Palm Oil Research Institute of Malaysia has taken a brave step in converting the palm oil products into the lubricant, (Imran et al. 2013). (Srivastava et al.2013) stated that, the palm oil has an inherent quality compared to petroleum oil because palm oil is derived from a renewable source and along the process, it can avoid the mainstream pollution, unlike the petroleum refining and extraction. In addition, palm oil is much better than the mineral oils because the composition is good, non-toxicity, high viscosity index and biodegradability

1.1.2 Automatic Transmission Fluid

Automatic transmission fluid (ATF) utilized in transmission systems of cars and trucks, automatic gearboxes and hydraulic-power-assisted steering systems is a special lubricant. This fluid also has been used in some manual transmissions. The fluid working is intended for all transmission part like torque converter. Day by day, the engine transmission design has become more advanced, therefore a study on a new transmission fluid in order to increase the transmission reliability is needed.

1.1.3 Zirconia oxide (ZrO_2) as Nano-technology additives

Nanotechnology additives used today as a catalyst in decreasing engine wear and enhancing fuel efficiency of the automotive application (Ilman et al. 2014). The previous study has been used others nanoparticle additives such as Hexagonal Boron Nitride (hBN), Titanium Oxide (TiO_2), Zinc Oxide (ZnO_2), Copper Oxide (CuO) and more. A hard-white amorphous powder or Zirconia oxide (ZrO_2) are used as pigments, refractories and ceramics.

Besides having a high crack resistance propagation, zirconia also has a purity between 98% and 99.8% that make it stronger. According to (Li et Al., 2017) Zirconia is the best tribological behavior because the wear practices in friction anti-wearare good and may show the difference in composition. The utilization of Zirconia with anotherlubricant might be great; hopeful towards reducing the wear and erosion in the application.

1.2 PROBLEM STATEMENT

The increasing of oil consumption globally by 890,000 barrels per day (Mohan et al. 2014) until the year 2012 has made the energy consumption growth slowing down and the increase the number of vehicles have made the problems become worst, (M. Abdullah et al. 2017). Natural awareness prompts an encouragement towards biodegradable and non-harmful lubricants. These can be achieved by utilizing an appropriate bio-degradable base liquid and low toxicity which requires added substances that are ecologically friendly (Martins et al. 2006).

The need for the new type of bio-lubricant is a great idea to ensure the world we live today sustainable. Therefore, new lubrication for automotive engine oil additives would make a huge impact on environmental protection and energy conservation, (M. Abdullah et al. 2017). A new type of lubricant additive with nanoparticles is assumed to have an impact in reducing the wear and friction between the two contacting surfaces, (Laad et al. 2016).

On the other hand, the automotive applications lately are exposed to the erosion and wear. Therefore, many researchers have come out with the new idea to overcome this matter and revealing the dependency to the nano additive to blend with engine oil. Based on the previous study, the current capability of nanoparticles used as the oil additives for automotive application still not been widely explored, (Ilman et al. 2016).

In addition, past study on nano additives is lack of several characteristics such as size, concentration,and shape that make the nanoparticles failed to lessen the wear and friction to the application related (Ilman et al. 2014). Besides that, the demand for new lubrication with effective and environmentally considerate has increased.

1.3 OBJECTIVES

The objectives of this study are:

1.3.1. To blend a different combination of the ATF oil, Palm oil with Zirconia Oxide (ZrO_2) additives.

1.3.2. To determine the COF, WSD and viscosity of the oil composition.

1.3.3. To investigate the effect of thedifferentcomposition of oil

1.4 SCOPE

In order to accomplish the objectives, a few scopes have been drawn:

1.4.1. Determine the composition of ATF oil mixed with Zirconia Oxide (ZrO_2) to the palm oil and blending the composition by using the ultrasonic homogenizer

1.4.2. Test the composition of ATF oil mixed with Zirconia Oxide (ZrO_2) to the palm oil by using four-ball tester according to ASTM Standard D4172

1.4.3. Determine the effect of the different combination of Zirconia Oxide (ZrO_2) by performing the wear scar test using Scanning Electron Microscopy (SEM)

1.4.4. Test the viscosity of the oil composition by using rotational viscometer according to ASTM D2983

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Generally, this section will discuss the type of lubricant, the standard used for this study, the explanation on nanotechnology, wear mechanism, tribological properties and finally the summary of the previous study on the related field.

2.2 Lubricant

The use of lubricantsmostlikelydated back to the invention of the wheel. Since these early years, lubrication andthe production of lubricating media have grown up to be themostimportant industries withinthe world. However, nearly a quarter of all the energy created it still lost to friction (Sunil et al. 2016).

The lubricant isused in tribological application toseparate thetwo or more contact surfaces. Lubrication is good for minimizing wear in the mechanical system that operates for a longer time. The lubricant can be classified intothree forms, which is solid, semi-solid and liquid forms. The solid lubricantsused in various operating conditions where oils and greases cannot be effective (Julius O. Abere et al. 2014). The developing of lubricants that environmentally friendly is extremely necessary to increase the lifespan of mechanical components(Deshmukh et al. 2006).Good lubricants are the lubrication that contains properties like low toxicity, high viscosity index, high

load carrying capability, low coefficient of friction, sensible anti-wear capability, low emission into the setting and high ignition temperature (Kalhapure et al. 2012).

Nowadays, a lubricant is improved with nanoparticlesadditives to enhance the tribological properties. A mixture both of additives and dispersion agent can give stability to the oil phase. Lubricants with additives have better tribological properties such as high resistance to friction, better anti-wear characteristics, improved load carrying capacity and better heat absorption,(Prabu et al. 2016). The stability of nano lubricant is important to offeran improved performance in their applications. Therefore, the surface-active agent could be a better mechanism to stabilize the nanofluids. This formula is crucial in developing a new lubricant.

2.2.1 Solid Lubricant

In most tribological applications, liquid or grease are used as friction and wear modifiers; but when service conditions become very worst. For example, very high or low temperatures, vacuum, radiation and extreme contact pressure. Solid lubricants might be the only choice for controlling the friction and wear. Generally, the solid material is acting as a film between sliding and or rolling surfaces. Therefore, an adequate solid material is required for the high lubrication requirements of extreme operating conditions, such as very high or very low temperatures over a wide range, e.g. -200 to 850^{o}C, and corrosive atmospheres. Besides that, some materials normally have a layered crystalline structure which ensures low shear strength, thereby minimizing friction. The shear strength between the crystalline layers is weak and sets up a low friction mechanism by slippage of the crystalline layers under low shearing forces (Sunil et al. 2016).