



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**PRELIMINARY STUDY OF THE CAPABILITY USING LUBE  
OIL BASE ON LOCAL VIRGIN COCONUT OIL FOR  
TRANSMISSION APPLICATIONS**

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

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## **DECLARATION**

I hereby, declared this report entitled “Preliminary Study of the Capability of the Using Lube Oil Based on Local Virgin Coconut Oil for Transmission Application” is the results of my own research except as cited in references.

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## **APPROVAL**

This report is submitted to the Faculty of Engineering Technology of 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:

.....

(Project Supervisor)

## ABSTRAK

Dalam usaha mengurangkan penggunaan minyak pelincir berasaskan petroleum pada industri dan aplikasi pengangkutan, penggunaan minyak sayuran merupakan satu alternatif dan penyelesaian yang terbaik. Satu kajian awal mengenai keupayaan minyak kelapa dara tempatan sebagai pelincir bagi aplikasi penghantaran akan dijalankan. Tambahan pula, tujuan kajian ini adalah untuk menentukan keupayaan pencampuran minyak kelapa dara dengan minyak penghantaran. Penguji empat bola dan viscometer pemanas telah digunakan untuk mendapatkan data. Kedua-dua ujian telah dijalankan mengikut American Society for Testing and Materials (ASTM) standard iaitu ASTM D4172. Sampel minyak pelincir dianalisis dan dicirikan mengikut kelikatan kinematik, pekali geseran dan diameter kesan geseran berdasarkan pelbagai sampel campuran minyak kelapa dara dengan minyak penghantaran. Scanning Electron Microscopy (SEM) telah digunakan untuk mendapatkan gambar permukaan bola gelas yang bersentuh selepas digunakan dalam penguji empat bola. Keputusan menunjukkan peratusan yang sesuai bagi komposisi campuran kelapa dara dengan minyak transmisi automatic adalah pada 40% campuran minyak kelapa dara. Kelikatan kinematik pada 10% isipadu campuran minyak menunjukkan nilai yang hampir dengan nilai minyak penghantaran yang tulen, manakala pekali geseran yang rendah dan diameter kesan geseran yang kecil dihasilkan daripada 40% minyak campuran itu. Kesimpulannya, campuran minyak kelapa dara dengan minyak transmisi automatic menunjukkan prestasi yang lebih baik berbanding dengan minyak asas yang tulen.

## **ABSTRACT**

In order to reduce the use of petroleum based oil lubrication oil in industry and transportation application as lubricating oil, the use of vegetable oil as an alternative for lubricant substitution is the best solution. A preliminary study of the capability of using lube oil based on local virgin coconut oil for transmission application will be conducted. Furthermore, the purpose of this study is to determine the capability of mixing virgin coconut oil with transmission oil. A four ball tester and heated viscometer were used to collect the data. Both tests were conducted according to American Society for Testing and Materials (ASTM) standard that was ASTM D4172. The lubricant oil samples was analysed and characterized according to kinematic viscosity, coefficient of friction and wear performance by various blending of virgin coconut oil with transmission oil. Scanning Electron Microscopy (SEM) was used to magnify at the surface contact of the ball bearing used in the four ball tester. The result of the research was obtained and shows the kinematic viscosity at 10% volume of the blends oil shows the closed value to the pure transmission oil, while the low coefficient of friction and small wear scar diameter shows at 40% of the blends oil. In conclusion, the blends virgin coconut oil with automatic transmission oil shows better performance compared to the pure base oil.

## **DEDICATION**

A special gratitude to my parents for your fully support with my study. I am honoured to have you as my parents. Thank you for giving me a chance to prove and improve myself through all my life. Anything good that has come to my life has been because of your example, guidance and love.

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## LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PAO	-	Polyalphaolefin
BN	-	Boron Nitride
ZnO	-	Zinc Oxide
PTFE	-	Polytetrafluoroethylene
MoS <sub>2</sub>	-	Molybdenum Disulphide
HFM	-	Highly Friction Modified
EP	-	Extreme Pressure
ZDDP	-	Zinc Dialkyl Dithiophosphate
Si <sub>3</sub> N <sub>2</sub>	-	Silicon Nitride
CuO	-	Copper Oxide
ZrO <sub>2</sub>	-	Zirconium Dioxide/ Zirconia
TiO <sub>2</sub>	-	Titanium Dioxide
Al <sub>2</sub> O <sub>3</sub>	-	Aluminium Oxide
Cu	-	Copper
CeO <sub>2</sub>	-	Cerium Dioxide
SiO <sub>2</sub>	-	Silicon Dioxide
ASTM	-	American Society for Testing and Materials
RBD	-	Refined, bleached and deodorized
PFAD	-	Palm Fatty Acid Distillate
MCT	-	Medium Chain Triglycerides
rpm	-	revolution per minute
SEM	-	Scanning Electron Microscopy

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction to Lubricant

Lubricant is a substance which is used between two surfaces contact to reduce heat, wear and friction. Lubricant also acts as a cooler on the metal surface, sometimes it prevents the metal surface from corrosion and also cleans the surface from dust and particles contaminants. Lubricant can be classified into three types which are solid, semi-solid and liquid. Various kind of lubrication oil is utilized these days including mineral oil, synthetics oil, refine oil and vegetable oil. The usages of vegetable oil as based oil obtained many advantages such as biodegradable, low viscosity-temperature characteristic, renewable, low volatility, environmentally friendly and poor stability on oxidation (Golshokouh et al., 2013).

The viscosity of the lubricant is an important factor because it can affect the temperature change in the lubricant. When developing lubricants, higher viscosity index can be an advantage for use over a wide temperature range (Srivastava & Sahai, 2013). Moreover, the viscosity is higher when less the viscosity is changed by temperature (Shahabuddin et, al., 2013).

Vegetable oil is an alternative as lubricant or additives in lubricant to improve the quality of the lubricant. According to Rafiq, et al., (2015) vegetable oil has developed as an alternative to replace based oil and the use of vegetable oil has the advantage to the environmental. Animal fat and vegetable oil are considered as an alternative lubricant for mineral-based oil (Jabal, 2014). This research is focused on the mixing virgin coconut oil with the gear oil in a different amount of sample for the transmission application. Four ball tester and heated viscometer will be used to test the combination of both oils. The result will be obtained for the different amount of concentration for virgin coconut oil mixed together with based-oil. If the mixture of

the both oil is a success, the virgin coconut oil can be used as a substitute in the transmission lubrication.

## **1.2 Problem Statement**

Nowadays, the world is facing the huge problem when using the crude oil as a lubricant in industrial and transportation application. The resources of crude oil began to decrease from day to day due to continuous used up to now. Furthermore, most of the lubricants which are available in the market currently are based on mineral oil derived from petroleum oil. These lubricants are not adaptable to the environment due to its toxicity and non-biodegradability (Shahabuddin, et al., 2013). According to Syahrullail et al. (2014), mineral oil also contributed to the erosion of ozone layer and in a long time period can effect to the soil and waterway.

A lot of research works have been done in order to observe the usage of the lubricant and their availability. The usage of biodegradable oil has been introduced in the market which aims to replace the toxicity, and non-renewable. At the same time, the gear system has a long lifetime. This is an alternative to ensure that the use of crude oil can be reduced and meet future demand.

As a solution, vegetable oil can be used as lubricant oil to replace the use of crude oil. This is because vegetable oil is renewable, biodegradable, low viscosity-temperature characteristic and environmentally friendly. Furthermore, vegetable-based oil products hold a greater potential for stimulating the rural economic improvement since agriculturists would profit by the increasing demand for vegetable oils (Syahrullail, et al., 2013). Moreover, the interest in the use of vegetable oils derived lubricant is increasing precipitously and vegetable oils have the potential as a substitute for petroleum based lubricating oil in the future (Imran, et al., 2013). Vegetable oil, nano oil and polyalphaolefin oil (PAO) is an alternative approach to replace the used of mineral oil and petroleum oil in the future due to the advantages and good characteristics of the vegetable oil.



### **1.3 Objectives of Research**

From the background and the problem statement that have been stated, the objectives of this research are:

- i. To determine the suitable composition of mixing virgin coconut oil with transmission oil.
- ii. To test and characterize the capability of using lube oil mixed with virgin coconut oil.

### **1.4 Scope of Research**

In order to achieve the objective of the research study, several work scope have been drawn:

- i. Determine the composition of virgin coconut oil that suitable to be mixing with gear lube oil to form a lubricant.
- ii. Test the newly develop lubricant using a four ball tester methods (ASTM D4172) and viscometer.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Lubricant**

Nowadays, the use of machinery and transportations in human daily life is very important. Even in industry, many equipment and machinery used to make process and produce products more easily. According to Imran et al. (2013) reported that most of the mechanical instrument and rotary machines used lubricating oil. So that, lubricant play important roles to make sure all equipment, machines, and transport can function properly. Moreover, the lubricant can reduce friction, wear and give a long lifetime to two contact surface. Lubricants also can act as a coolant to reduce the heat that produced between two moving parts and prevents the surface from corrosion. Using lubricant also can help reduce the noise of the machine or two moving parts that contact each other, besides the operating part can move smoothly.

Based on the lubricant appearance, it can be classified in three physical state which is a solid, semi-solid and liquid state. All the lubricants will be used based on their specific performance in the parts of machinery or transmission application. Lubricants are used to make sure all the parts of machinery and transmission application function effectively. Without lubricants, the operating parts will be a breakdown or a short lifetime. The characteristic of good lubricants is anti-wear, high boiling point, high viscosity index, thermal stability hydraulic stability and corrosion prevention. Moreover, high resistance to oxidation prevents rust and dusts are the purposes of the lubricants used (Nehal et al., 2013).

Solid lubricants made up of graphite and molybdenum disulphide. Examples of semi-solid lubricants are wax, vaseline, and grease. Now, some additive was added to increase the quality of the lubricants. Last decade, liquid lubricants are

usually used crude oils and petroleum oil as lubricating oil. In recent years, researchers did some research and find that vegetable oil can be alternative to replace the decreasing of petroleum oil. Vegetable oil can act as an additive in lubricants oil or can be lubricants based oil (Syahrullail et al., 2013). Furthermore, lubricants from crude oil have bad effects and harmful for the environment (Golshokouh et al., 2013).

### 2.1.1 Solid Lubricants

The solid lubricant also known as dry lubricants are materials in solid state which apply between two surfaces sliding against each other to reduce friction. Examples of solid lubricants are graphite and molybdenum disulphide. Solid lubricants are usually used in the air compressor, gear, ball bearing, transmission joints and brake pads. Other materials can be used as solid lubricants are Boron nitride (BN), zinc oxide (ZnO), polytetrafluoroethylene (PTFE), cerium fluoride, talc, calcium fluoride and tungsten disulphide. Solid lubricants use in dry powder state which form a thin film between the two surface contacts to prevent wear, friction and cool the surface (Osterle and Dmitriev, 2016). Solid lubricants can be used by spraying, dipping or brushing at the moving parts. So that, solid lubricants can separate the two surfaces from contact each other and prevent metal parts from failure.

According to Goncalves et al., (2014), reported that graphite and molybdenum disulphide ( $\text{MoS}_2$ ) can reduce friction and wear at the sliding part and the surface contact. The solid lubricant will be applied when the operating parts are not suitable to use lubricating oil or grease, the temperature or load is too high, the contaminant of the lubricating oil is not acceptable and the parts must be avoided from any combustible lubricants. Graphite and molybdenum disulphide also acts as additive in lubricating oil to improve the quality of the lubricants oil (Osterle and Dmitriev, 2016). Graphite and molybdenum disulphide have a hexagonal structure like in Figure 2.1 which able to prevent contact of the surface.

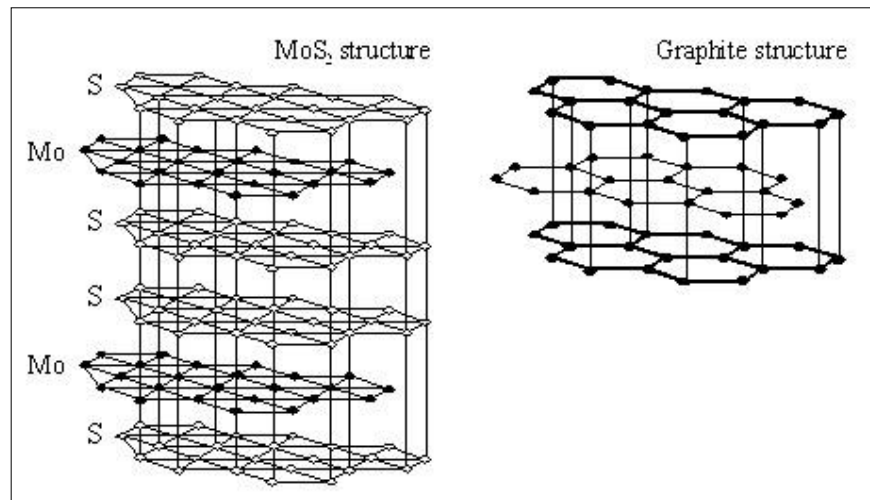


Figure 2.1 Structures of Molybdenum Disulphide and Graphite (Source: <http://www.ktzmy-us.com/>).

### 2.1.2 Semi-solid Lubricants

Grease is an example of the semi-solid lubricant that applies to the operating and rotating parts in industrial and transmission application. Grease made up from animal fats or vegetable fat (Ahmed and Nassar, 2013). In addition, wax and petroleum jellies such as vaseline also the other example of the solid lubricant use in the machinery parts and equipment. The part that can apply grease is bearing which it has high viscosity, prevent from water and dust. Grease can prevent the surface from corroding and the part has a long lifetime. Many types of grease can be used based on the operating and performance such as silicone grease, laboratory grease, clay grease, multi-purpose grease, extreme-pressure grease, and others. Grease also will apply to the gear system to make it functional properly. Using grease, the noise and shock at the moving or rotating parts can be reducing. Some parts are more suitable to apply grease compare to the liquid lubricant due to its function.

### 2.1.3 Liquid Lubricants

Many parts of machinery and transportations application use the liquid as lubricants to prevent from breakdown or failure. Nowadays, liquid lubricants that present at the market made up from mineral oil, petroleum oil, synthetics oil, and vegetable oil. Different types of lubricant have different properties and usage. The liquid lubricant has water content, sulphur content, chlorine content, additives, and others. Some additive was added in liquid lubricant to improve the quality of the lubricants. In lubricant oil, chemical additives such as graphite and molybdenum disulphide are added in order to enhance their performance (Osterle and Dmitriev, 2016). Using liquid lubricants have some advantages such as acts as a coolant to prevent heat form at the surface of the parts, reduce wear and friction occur at the surface contact. In transportation, the liquid lubricant will use at engine system and transmission application while in machinery, the liquid lubricant is applying at the bearing, gear motor, and other parts. Lubricant will prolong the lifetime of the equipment, machine, and transportation.

#### 2.1.3.1 Types of transmission oil

Transmission oil also known as gear oil is usually used in the machinery and vehicles. In the car, different types of transmission oil properties will be used for specified car produce. The properties of transmission oil included anti-war, anti-rust, anti-corrosion, anti-friction and thermal stability (Abusaad et al., 2015). Transmission oil is the one types of the liquid lubricant which is from mineral oil, petroleum oil, synthetics oil and vegetable oil. The purpose of transmission oil is to protect and clean metal surface, extend rotational speed and temperature range, provide the right amount of viscosity, prevent foam and oxidation of fluid. Moreover, the characteristic of gear oil is very important such as biodegradable, renewable, environmentally friendly and non-toxicity.

Currently, in the market selling many types of transmission oil been sold that can be confusing for the consumer to choose the suitable oil for their car or vehicle. There is a different grade of transmission oil with different properties and specification. Synthetic hydrocarbons, mineral oil, ester and naphthenic oils are some kinds of the lubricant oil used as transmission oil. There are several types of new development of transmission oil such as Type F, Dexron, Mercon, HFM Fluid (Highly Friction Modified) and Synthetic Fluid. Type F lubricant used a long time ago but most car manufacturers today use Dexron and Mercon series as transmission fluid. Transmission oil will add with some types of the additive with specific properties to use in different types of vehicles (Martins et al., 2006). In recent years, researchers develop new types of lubricant for transmission application due to improving the quality and the performance of the oil. Vegetable oil is one type of the additive that will add in lubricants oil (Abere et al., 2014).

#### 2.1.3.2 Mineral oil

Mineral oil is based oil group that derives from crude oil with the addition of an additive such as anti-wear additive, rust-corrosion inhibitors, anti-foam additive, detergents, dispersants, kinetic viscosity and viscosity index improvers. Mineral oil and synthetic oil is deriving from crude oil which is used as based oil. Nowadays, the used of mineral oil is in crisis due to the decreasing of crude oil and the cost of the mineral increase day by day. Mineral oil has properties such as anti-oxidation, anti-corrosion, anti-foam and anti-wear that prevent the surface of the equipment (Imran et al., 2013). Furthermore, mineral oil can improve the viscosity of the lubricant oil and act as a coolant to transfer heat from the metal surface (Aluyor et al., 2009).

#### 2.1.3.3 Vegetable oil

Vegetable oil has some good characteristic to make as lubricant oil such as biodegradable, renewable, environmentally friendly, anti-wear, anti-oxidation and non-toxicity. Vegetable oil has the potential to be additive or base lubricant oil for

machinery parts in industrial and transportation application. According to Abere et al., (2014) state that vegetable oil can obtain from containing fruits, nuts or seed by combination method or pressing method. Researchers found that vegetable oil is the one of the alternative oil to replace the decreasing of the crude oil and petroleum oil. Many researchers already had done which blended base mineral oil with a different type of vegetables such as soybean oil, palm oil jatropha oil, coconut oil and more. Different types of vegetable oils have a different application such as shown in Table 2.1.

Table 2.1 Selected Applications for Various Vegetable Oils (Rudnick and Erhan, 2005)

<b>Types of vegetable oil</b>	<b>Application</b>
Canola oil	Hydraulic oils, tractor transmission fluids, metal working fluids, food grade lubes, penetrating oils, chain bar lubes
Castor oil	Gear lubricants, greases
Coconut oil	Gas engine oils
Olive oil	Automotive lubricants
Palm oil	Rolling lubricant-steel industry, grease
Rapeseed oil	Chain saw bar lubricants Air compressor-farm equipment Biodegradable greases Hydraulic fluid, fuel, soap
Safflower oil	Light-coloured paints, diesel fuel, resins, enamels
Linseed oil	Coatings, paints, lacquers, varnishes, stains
Soybean oil	Lubricants, biodiesel fuel, metal casting/working Printing inks, paints, coatings Soaps, shampoos, detergents, pesticides, disinfectants, plasticizers
Jjoba oil	Grease, cosmetic industry, lubricant applications
Crambe oil	Grease, intermediate chemicals, surfactants

Sunflower oil	Grease, diesel fuel substitute
Cuphea oil	Cosmetics and motor oil
Tallow oil	Used in steam cylinder oils, soap, cosmetics, lubricants, plastics

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#### 2.1.3.3.1 Jatropha Oil

Jatropha oil obtains from jatropha seeds by the extracting method as new developing of vegetable oil. Jatropha oil is widely grown in Asian countries such as Malaysia, Indonesia, and Thailand because of the condition of the country suitable for plants Jatropha (Golshokouh et al., 2013). Jatropha oil has characteristics of anti-wear, friction and higher coefficient of friction. According to Imran et al. (2013) reported that 10 % and 20 % of Jatropha oil based bio-lubricant are same quality with pure lubricant SAE 40. The lower wear scar diameter for Jatropha oil blended with pure lubricant is at 10% (Shahabuddin et al., 2013). So that, Jatropha oil has the ability as an alternative oil which to replace the decreasing of mineral and petroleum oil.

#### 2.1.3.3.2 Palm Oil

In Malaysia, plantation of palm oil is the biggest percent compare to latex, paddy fields, and others. Palm oil will be processed to produce cooking oil in different grade and quality. Besides that, palm oil has the ability to use as a lubricant in machinery and automotive application. Palm oil produce from palm seeds or kernel by compressing and extracting methods to produces oil. Vegetable oil such as palm oil has characteristics that can improve the quality of lubricants such as wear and friction (Aberé et al., 2014). Palm oil can act as a hydraulic fluid lubricant, diesel engines, and transmission fluid which reduce the amount of carbon monoxide at atmosphere (Syahrullail et al., 2013).