

WEAR ANALYSIS OF COMMON ENGINE LUBRICANT IN THE MARKET  
FOR UTEM FORMULA VARSITY CAR

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## **SUPERVISOR DECLARATION**

“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 and Materials)”

Signature: .....

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Date: 15 June 2015

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This thesis is presented as a part of requirement for the award of the degree of  
Bachelor of Mechanical Engineering (Structure and Materials)

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JUNE 2015

## DECLARATION

I hereby, declared this thesis entitled “Wear Analysis of Common Engine Lubricant in the Market for UTeM Formula Varsity Car” is the results of my own research except as cited in references.

Signature: .....

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## **DEDICATION**

I would like to dedicate this project to my beloved family and my Final Year Project supervisor

## **ACKNOWLEDGEMENT**

I would like to express my deepest appreciation to all those who provided me the possibility to complete this thesis. A special gratitude I give to our final year project supervisor, Dr. Nor Azmmi bin Masripan, whose contribution in stimulating suggestions and encouragement, helped me to coordinate my project especially in writing this thesis.

## ABSTRACT

The purpose of this project is to analyse three different types of common engine lubricant in the market for the UTeM Formula Varsity Car. The analysis will be performed by using a Four-Ball Tester Extreme Pressure (EP) and Wear Preventative (WP) machine which is functions as a way to determine the relative wear-preventing properties of lubricating fluids in rolling and sliding applications. The project will be focused on the wear preventing aspect of the lubricant that would affect the performance of the lubricant. Three common engine lubricant has been chosen for this project which has been denoted in the thesis as types A, B, C. The lubricants will be compared from the results obtained from the Four-Ball Tester machine analysis graphs and the wear scar analysis done by using a CCD Microscope machine. Three of the lubricants are to be tested against wear and based on the performance, the best lubricant is chosen to continue with the experiment with added additives to evaluate whether the performance of the lubricant in terms of wear and friction reduction could be improved. Results from the experiment shows that the coefficient of friction increases in the tests as more load is applied it is also demonstrated that it is directly proportional between the average wear scar diameter and volume loss of the material. Additives will enhance the performance however, the effective concentration for this project is 2% as more will cause degradation in anti-wear performance.

## ABSTRAK

Tujuan projek ini adalah untuk menganalisis tiga jenis pelincir enjin biasa di pasaran untuk UTeM Formula Varsity Kereta. Analisis ini akan dilakukan dengan menggunakan mesin *Four-Ball Tester* Tekanan Ekstrem yang berfungsi sebagai satu cara untuk menentukan *relative wear-preventing properties* dalam aplikasi keguliran dan gelongsor. Projek ini akan memberi tumpuan kepada aspek *wear preventing* dan minyak pelincir yang akan memberi kesan kepada prestasi minyak pelincir. Tiga minyak pelincir enjin telah dipilih untuk projek ini berdasarkan jenama A, B, dan C. Minyak pelincir akan dibandingkan dengan keputusan yang diperolehi daripada *Four-Ball Tester* graf analisis mesin dan analisis *wear scar* dilakukan dengan menggunakan mesin CCD Mikroskop. Ketiga-tiga minyak pelincir akan dibandingkan prestasi ketahanan *wear* dan minyak pelincir yang terpilih akan dikaji dengan menambah *additives* untuk melihat sama ada prestasi minyak pelincir tersebut masih boleh ditingkatkan. Keputusan daripada eksperimen menunjukkan bahawa *coefficient of friction* meningkat disebabkan oleh peningkatan beban. Keputusan juga menunjukkan bahawa *average wear scar* dan *volume loss* bahan adalah berkadar terus. Ia juga menunjukkan bahawa penambahan *additive* akan menyebabkan peningkatan prestasi akan tetapi ianya hanya dalam jumlah 2% kerana selebihnya akan menyebabkan kekurangan dari segi *anti-wear properties*.



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best engine oil lubricant with added extreme pressure  
additive of 2%, 6% and 10%.

## LIST OF ABBREVIATIONS

Extreme Pressure	-	EP
Anti-Wear	-	AW
Society of Automotive Engineers	-	SAE
Universiti Teknikal Malaysia Melaka	-	UTeM
Universiti Putra Malaysia	-	UPM
University of Nottingham Malaysia	-	NU
Politeknik Kota Bharu	-	PKB
Politeknik Shah Alam	-	PSA

## LIST OF APPENDICES

- A Coefficient of Friction (COF)
- B Wear Scar Diameter
- C Wear Scar Volume
- D SAE Viscosity Table and Chart
- E Wear Scar Diameter Images



# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Engine lubricant is any of ubiquitous well-developed lubricants (including oil enhanced with additives, for instance, much of the time, extreme pressure additives) that are utilized for lubrication of internal combustion engines. The principle function of these lubricants is to lessen wear on moving parts; they likewise clean, restrain corrosion, enhance sealing, and cool the engine via diverting heat from moving parts.

### 1.2 Background of the Project

There are many types of engine lubricant available on the market. Each of the engine oil that are sold on the market comes with different chemical and physical properties. For this project, three types of engine oil are selected to be tested for its wear performance in order to recommend the UTeM Formula Varsity Team to utilise the best oil for their car. The aforementioned lubricants will be chosen as the same base specification which is fully-synthesized and with the various lubricant specification such as 10w-40 which represents its ability to remain the viscosity at low and high temperatures.

### **1.3 Problem Statement**

Engine lubricant plays an important role in an engine system. It provides the lubrication needed during the operation of an engine to reduce friction, wear and temperature of the engine. There are a lot of engine oils with different blend of additives in the market that can provide the protection needed by an engine. These engine oils will be tested and analyzed in terms of wear to determine the best one that can be used for the UTeM Formula Varsity Car.

### **1.4 Objective**

To find the best engine lubricant for UTeM Formula Varsity Car;

- a) Perform friction and wear experiment on different types of engine lubricants that are available in the market.
- b) To analyze friction and wear on different types of engine lubricants.
- c) To study the effect of Extreme Pressure/Anti Wear additive on friction and wear.

### **1.5 Scope of Project**

To analyze three engine lubricants in terms of performance to Wear Prevention (WP) by using a Four-Ball Tester machine and to analyse wear characteristics by using an inverted microscope.

## **1.6 Organization of the Project**

### Chapter 1: Introduction

Introduction about the project. The chapter covers introduction, background of project, problem statement and the scope of project.

### Chapter 2: Literature Reviews

Explanation and discussions about the studies and previous research that are relevant to the project.

### Chapter 3: Methodology

The methodology used to execute the project by presenting flow charts, gantt chart, the material selection process and procedures.

### Chapter 4: Results and Discussion

The chapter will state the obtained result from the experiment and the results will be analysed and discussed.

### Chapter 5: Conclusion and Recommendation

The chapter will discuss the summary of the project and the conclusion that has been gained from the project.

## **CHAPTER 2**

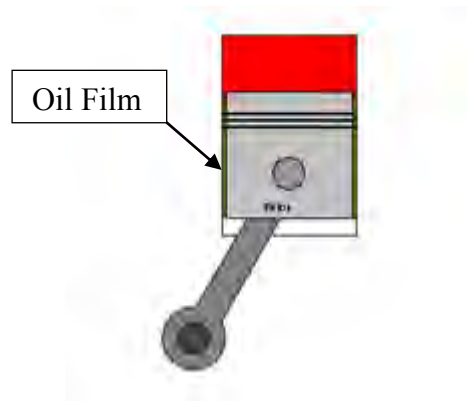
### **Literature Review**

#### **2.1 Introduction**

The project is entitled “Wear analysis of common engine lubricant in the market for UTeM Formula Varsity Car”. This chapter will review related projects, studies, solutions and overview of different approaches based on previous works in order to compare between my project and theirs.

#### **2.2 Lubricant**

Lubricant is widely known as a fluid or a substance that exists in a lot of applications for example; engine oil. The purpose of a lubricant in an engine is to reduce the friction when two surfaces meet with each other. When friction is reduced due to a lubricant, it leads to lower wear rate, energy loss and heat generation. This means that a lubricated part could function for a longer time than it would without any lubrication involved ultimately increasing its lifespan.



**Figure 2.1:** Automotive Engine Piston with Lubrication (Oil Film)

The tribological properties of various lubricating oils are usually studied by using the four-ball tester machine. This studies are with their purposes such as for bearing lubrication, cutting oils and gearbox with specified especially with lubrication and usually with additives in comparing the performance of the lubricants. In my project, the lubricant will be of a fluid type of lubricant which is fully synthesized and a determined value of viscosity (A. D. Dongare, 2014).

### 2.2.1 Lubricating Properties

From the article entitled “ASTM Performance Tests to Study the Effect of Blend Oil with Based Oil Analysis for Automobile Engines” states that viscosity which is the basic property of a lubricant for a specified grade and class that the viscosity of the oil is mainly influenced by the temperature difference. So, a study of lubricant properties will be discussed in order to address this statement with regard to the implementation of experimental parameter of temperature and other if related (Dr. B. M Sutaria, 2013). This project will be utilising liquid lubricants, which is generally regarded as oil. Liquid lubricants are like any other liquids in terms of properties that they are able to flow and follow the shape of objects that contain

them. There are several other lubricating properties that are used by previous researches in this type of project. The following properties are;

a) Lubricity

Some lubricants are said to have high lubricity, or oiliness. This property comes from the chemical compositions of the oils, which reduce wear and friction even in extreme conditions.

b) Viscosity

Viscosity is a measurement of a fluid's thickness, or resistance to flow. The higher a lubricant's viscosity, the thicker it will be and the more energy it will take to move an object through the oil. One common scale used to describe viscosity in lubricating oils is the numerical grading given by The Society of Automotive Engineers, or SAE.

c) Viscosity Index

The viscosity index, or VI, of a lubricant describes how the oil's viscosity changes as its temperature changes. As temperatures increase, viscosities decrease, and vice versa. For example, a piece of machinery that operates over a wide range of temperatures will require a lubricant with a high VI, meaning that the oil will retain its lubricating characteristics whether it is starting up cold or running at full speed and peak temperature.

d) Additives

Additives are chemical compounds added to grease and oils to change or add certain desirable properties.

The following properties are dependent on the state of the lubricant and these value will affect the result of the experiment of my project and other previous similar projects. By the discussion above, I concluded that the experimental parameter of temperature will be varied in regard to the viscosity of the oil.

### 2.2.2 Synthetic Lubricant

Synthetic lubricants differ from conventional mineral oils due to its base oil which is more refined. Because of this, it offers more protection and higher performance. It also provide a lot of benefits that could keep the engine performing at an optimal rate throughout the years.

There are two fundamental types of lubricants accessible which is conventional mineral oils and synthetic lubricants. Both types are produced using crude oil that originates starting from the earliest stage. The distinction is that synthetic oils are produced using more propelled refining processes and are of a higher purity and quality than conventional mineral oils. This not just expels more impurities from the crude oil, it empowers singular molecules in the oil to be customized to the requests of advanced engines. These altered molecules give more elevated amounts of protection and performance.

The performance of synthetic oils is regularly more vigorous, particularly regarding low temperature pump capacity and high temperature stability and protection against deposits. These qualities can help towards lessened engine wear, fuel economy potential and long engine life.

Synthetic oils have been produced particularly to adapt to extreme conditions found inside of modern engines. They are considerably more free-streaming than customary mineral oils. The greatest benefit is incredibly expanded engine protection. At the point when an engine is initially begun, a mineral oil takes eventually to circulate, permitting friction between un-lubricated parts to bring about wear. Conversely, a synthetic grease begins coursing straight away, securing each moving part inside of the engine.

Synthetic oils can likewise fundamentally enhance fuel economy. Amid the warm-up time of an ordinary truck venture, mineral oils are thicker and move all the more gradually, making the engine thirstier and less efficient. Synthetics, notwithstanding, get the opportunity to work substantially more rapidly, so the engine achieves crest operating productivity that much sooner.

Another favorable position of synthetics is that they're cleaner and environmentally friendlier, serving to slice engine emissions when contrasted with conventional mineral oils. Conventional mineral oils additionally contain more prominent amounts of impurities, for example, sulphur, reactive and unstable hydrocarbons, and other undesirable contaminants that can't be totally evacuated by conventional refining of crude oil.

These are a few examples of advantages of synthetic lubricant over conventional mineral oils.

- a) High Performance of Flow in Low Temperature
- b) High Protection of Wear
- c) Stability of Viscosity
- d) Higher Thermal Stability
- e) Higher Oxidation

### **2.2.3 Viscosity of a Synthetic Engine Lubricant**

Society of Auto Engineers (SAE), in co-operation with engine manufacturers, built up a classification framework for engine oils taking into account viscosity measurements. Oils are appointed numbers taking into account the viscosities showed at specific temperatures.

It has all the more as of late been perceived that oil viscosity at colder temperatures, and at high operating temperatures, is critical in the long life performance of an engine. Consequently, the SAE has built up two different viscosity measurements, one at cold temperatures and one at high temperatures. The most widely recognized temperatures in the high temperature reach are 40°C and 100°C. With the presentation of viscosity estimation at cold temperatures, utilizing a turning viscometer called a cold cranking simulator; temperatures are accounted for