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

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Draft Final Report
Projek Sarjana Muda II

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JUNE 2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering (Structure and Materials) with Honours.

by

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2015

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality of the award of the degree of Barchelor of Mechanical Engineering (Structure & Materials)"

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Date: 29th JUNE 2015

DECLARATION

"I hereby declare that the work in this thesis is my own except for summaries and quotations which have been duly acknowledged."

Signature: ....
Author: AZLAN BIN SURAHMAN
Date: 29th JUNE 2015

Dedicated to my parents,

Surahman bin Kimin & Badariah binti Harun

My supporting siblings,

Azahari bin Surahman

and

My entire friends in UTeM

For their encouragement

ACKNOWLEDGEMENT

In the name of Allah, the most Gracious and most Merciful

I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to our final year project supervisor, Dr. Nor Azmmi bin Masripan, whose contribution in stimulating suggestions and encouragement, and also give me a great opportunity to guide me in this final year project.

Finally, I would like to express thanks to the Tribology lab technician, who gave the guide to use all required equipment and the necessary material to complete my final year project. Thank you all very much.

ABSTRACT

These analyses of lubricants are to use various kinds of brand company's fully synthetic lubricants available on the common market. There are three types of brand fully synthetic lubricants which are type A, B and C. To compare the quality of each brand lubricants, analyzing this type of lubricant brands, the method four ball tester machines to obtain the result. From this analysis, Four Ball Tester machine has been used to compare the quality of each lubricant brand. The balls used in four-ball tester was based on carbon-chromium steel ball bearings. The results obtained to present friction and wear characteristics are coefficient of friction (μ), and wear scar diameter (WSD). Each lubricant brand test was conducted for three different loads (150 N, 350 N, and 500 N), one different temperatures (80 ºC), and with constant speed (1000 rpm). The friction analysis also shows how the each lubricant prevents the ball bearing from wear, the less friction produces the highest quality of lubricant. Brand Type C is the best lubricant on friction because result applied load on Coeffiecient of Friction showed less friction compared to other brand. 2% extreme pressure additive selected as the best quantity of additive oil mixed in lubricant brand Type C because a good effect on change in the coefficient of friction result.

ABSTRAK

Analisis minyak pelincir ini adalah untuk menggunakan pelbagai jenis minyak pelincir sintetik sepenuhnya syarikat jenama yang biasa terdapat dipasaran. Terdapat tiga jenis jenama minyak pelincir sintetik sepenuhnya iaitu jenama A, B dan C. Untuk membandingkan kualiti setiap pelincir jenama, kaedah empat mesin penguji bola untuk mendapatkan data digunakan. Daripada analisis ini , mesin Empat Penguji Bola telah digunakan untuk membandingkan kualiti setiap jenama minyak pelincir. Bola yang digunakan dalam penguji empat bola adalah berdasarkan galas bebola keluli karbon - kromium . Keputusan yang diperolehi untuk membentangkan geseran dan memakai ciri-ciri adalah pekali geseran (μ) , dan memakai diameter parut (WSD) . Setiap ujian jenama pelincir telah dijalankan untuk tiga beban yang berbeza (150 N, 350 N, dan 500 N) , suhu dan kelajuan adalah malar (80ºC dan 1000 rpm) . Analisis geseran juga menunjukkan bagaimana setiap minyak pelincir menghalang bola bearing daripada haus, geseran yang kurang menghasilkan kualiti minyak pelincir yang baik. Jenis Jenama C adalah pelincir terbaik geseran kerana beban yang dikenakan ke atas hasil Coeffiecient Geseran menunjukkan geseran kurang berbanding jenama lain. 2 % bahan tambahan tekanan ekstrem dipilih sebagai kuantiti yang terbaik bahan tambahan bercampur-campur dalam pelincir jenama minyak Jenis C kerana kesan yang lebih baik ke atas perubahan dalam pekali geseran.

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μ	=	Coefficient of friction
W	=	Applied load in kg
T	=	Friction torque in kg/mm
r	=	Distance from the center of the contact surfaces on the lower balls to the axis of rotation, which is 3.67mm

CHAPTER 1

INTRODUCTION

Engine oil, engine oil, engine lubricants or any of a variety of well - developed lubricants (oils consist enhanced with additional material, for example, in many cases, extreme pressure additives) used to lubricate the internal combustion engine .

1.1 BACKGROUND

This project focuses on the analysis of the lubricant. The lubricant has many functions and important to the industries, machinery, tools and vehicles. Lubricant is very important in order to minimize the friction for tribological component especially for car engines. From the analysis the lubricant performance can be compared. To observe the performance of the lubricant between temperature and load, Four-Ball Tester machine will give the result based on the friction, diameter, the size of the scar, the variable test of different load and temperature to give different results of coefficient of friction.

The four ball test is the one of the methods of lubricant analysis by load and measures the friction reducing ability and anti-wear property. From the test result, this test method can distinguish not only the property of different type of lubricant brands.

1.2 PROBLEM STATEMENT

Nowadays synthetic lubricant product purchases are hot sold in the market . There are many companies competing synthetic oil brand and looking to further improve performance synthetic lubricant for increased sales and satisfaction of buyers. Users who have bought this brand of synthetic lubricants have stated there are many advantages of using synthetic lubricants, as can maintain the performance of the engine, can improve the speed of the car can extend the life of the engine. The purpose of this analysis is to identify the best brand fully synthetic lubricant oil in the market for UTeM Formula Varsity Car.

1.3 OBJECTIVE

The objectives of this project are as follows:

To compare the quality and performance of different brands of engine lubricants on friction and to study the effect of additive on Coefficient of Friction.

1.4 SCOPE

The scope that focus in this project are:

To analyse three different lubricant type by using a Four-Ball-Tester machine with test parameter such as load, temperature, time and speed. The analyzing will continue with adding additives by repeating the previous test parameter.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

The literature reviews in this section just a summary of the other sources such as books, journals, and internets that related to this project. In this chapter the summary is included about the friction analysis of common engine lubricant in the market for UTeM Formula Varcity car,

2.1 FRICTION ANALYSIS IN TRIBOLOGY

According to Gohar and Rahnejat, (2008); Tribology is defined as " the science and technology of interacting surfaces in motion " . Therefore, it is important for us to understand the interaction surface when they come together to understand the processes occurring Tribology in the system. Physical, chemical and mechanical properties not only cause effects on the behavior of surface materials Tribology but also the near surface material.

According to Arnell and Davies, (1991); Known as friction resistance to movement, friction can be categorized into five types; The dry friction , fluid friction , lubricated friction, skin friction and internal friction. Frictional forces are divided into two types; static friction force necessary to start sliding, and kinetic frictional forces required to maintain sliding. The coefficient of friction is known as a common constant of proportionality two materials may be the same or different, sliding against each other under a set of surface and environmental conditions.

A prerequisite to get the basic knowledge in the field of friction and wear is the use of sensitive measuring method to obtain accurate and reliable data. To investigate the wear process using a scanning electron microscope and increasing radioactive tracer technique (B. Ivkovic and M. Lazic, 1975). To use satisfy many materials containing available, the determination of the coefficient of friction is as important as knowledge of the properties of wear materials under high operating pressure.

Friction can be categorized into five types; The dry friction, fluid friction, lubricated friction, skin friction and internal friction. Frictional forces are divided into two types; static friction force necessary to start sliding, and kinetic frictional forces required to maintain sliding. The coefficient of friction is known as a common constant of proportionality two materials may be the same or different, sliding against each other under a set of surface and environmental conditions (Arnell and Davies, 1991) .

The first laboratory test device for determining the quality of the lubricant known as the four ball tester proposed by Boerlage in 1993. The concept of friction in these engines is three stationary balls pressed against the spinning ball. The quality and characteristics of lubricants that have been established by the size of the scar wear or seizure load and the friction is obtained. The main elements of the four ball machine are a vertical drive shaft that holds the ball moving on the bottom with conical device. In addition, three stationary balls determined by the cone ring and lock nuts are pressed by the moving ball. The holder is mounted on a stationary ball bearing axis so as to rotate and displace in the vertical direction independently. In addition, the lever device used to apply the load on the stationary ball. The frictional force on the stationary ball is set by rotating ball is sent over the lever to gauge. Haus is seen by the size of the wear scar on the ball stationary. 12.7mm diameter ball bearing are usually used. This special process to ensure high dimensional accuracy and uniform hardness and surface quality. Lubricants tested are immersed into the still holding the ball cup with total desire. In addition, the speed of the ball rotates depending on the type of machine and experimental conditions (Ivan, 1980).

Figure 2.1: Four ball tester machine.

The relationship between the surface and the effect of lubricants and additives have received the most attention. Determination of behavior tribochemical lubricants has explained the mechanism of the effectiveness of the additive and synergistic effects and damage them (B.Dimitrov, 1975) . Critical temperature control all effects in the contact zone of friction (A. Dyson and 1975), time pressure and speed conditions (JC Bell, A. Dyson and JW Hadley, 1975) are considered to be factors affecting.

Dimensionless quantity called the coefficient of friction, or coefficient of friction as it is sometimes called, grew out of the work of many philosophers, scientists and engineers; in particular, (da Vinci, 1400s, Amontons, 1699, and

Coulomb, 1785). These thinkers tried to rationalize the skid resistance of solid bodies with a universal law that describes the observations in their time. In preliminary work with machine tools and tribometers macro scale, it has been observed that the proportionality of force against movement relative to the power that holds the body together seems to be a constant in various situations (Amontons, 1699); for example, is remembered for his two laws of friction:

i. The force of friction is directly proportional to the applied load
ii. The force of friction is independent of the apparent area of contact.

The coefficient of friction (COF) can range from almost zero to one, and vary depending on surface conditions such as lubrication, surface roughness or pre-treatment. The initial value of COF anti-friction solid lubricant is usually the low COF and shortly thereafter changed during 'run-in' the early period called. While the thickness of the coating is gradually reduced, the performance of tribological coatings began to decline, and the COF began to grow rapidly. Anti-friction coating is best as it maintains a low COF value for the longest time (K. Kim, 2006).

2.2 ENGINE LUBRICANT

Reciprocating internal combustion engine as shown in Fig. 2.2 is the most important component in the motor vehicle, and also in many land and marine transportation devices, including motorcycles, scooters, vans, trucks, buses, agricultural vehicles, construction vehicles, trains, boats and ships. The popularity of reciprocating internal combustion engines is because of performance, reliability and versatility. However, there are also some major weaknesses. The thermal and mechanical efficiency is relatively low, with more of the fuel energy dissipated as heat and friction loss (SC Tung, ML McMillan, 2004).

Lubrication means the use of lubricant to improve movement of a surface to another. Lubricants are usually liquids or semi-liquids, but may be solids or gases or any combination of solids, liquids, and gases. The smoothness of movement is improved by reducing friction. It is not always a good result to reduce friction because there may be situations in which it is more important to maintain steady friction than to obtain the lowest possible friction. In addition to reducing or controlling friction, lubricants are usually expected to reduce wear and often to prevent overheating and corrosion. Boundary films or protective films in lubricated sliding is very important and has been recognized for decades. Since these films directly affect friction and wear phenomena, several attempts have been made to develop the proper model to describe their formation mechanism and properties. Boundary films appear to be particularly important in preventing or postponing scuffing, the unexpected and catastrophic failure of lubricated surfaces sometime early in the life of components (J. Zhang, W. Liu, and Q. Xue, 1999).

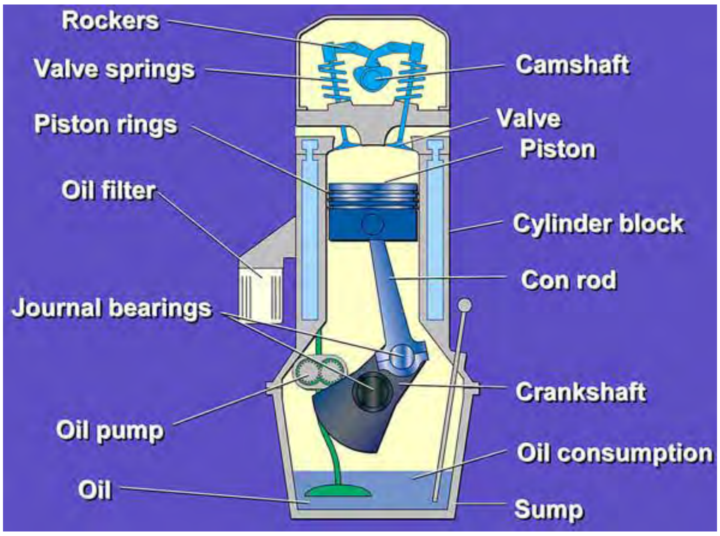

Figure 2.2: Main engine components in an internal combustion engine.

The engine tribologist is required to achieve effective lubrication of all moving engine components. In order to reduce friction and wear, with a minimum adverse impact on the environment. This task is particularly tough given the wide range of operating conditions of speed, load, and temperature in an engine. Improvements in the tribological performance of engines can generate the following benefits:

i. Reduced fuel consumption,
ii. Increased engine power output,
iii. Reduced oil consumption,
iv. A reduction in harmful exhaust emissions,
v. Improved durability, reliability and engine life,
vi. Reduced maintenance requirements and longer service intervals.

According to Jan CJ Bart (2005), lubricants play an important role in industry and transport, which represents the major economic and ecological threats. Lubricant base stock is very diverse, including mineral, synthetic and bio-based oils. Liquids (oil and grease) and solid lubricant has been classified in various ways using various distinguishing identification (base oil type, viscosity grade, application, etc.). There exists a general consensus in relation to the term 'bio' (in the bio-based, biodegradable, biolubricant). Similarly, the use of industrial lubricants for various denominations subjective concepts of environmental lubricants. Outlined the general nature of the lubricant.

Fig. 2.3 shows a relationship between the friction coefficient and the oil film thickness ratio or the number of Summerfield. At the top of the figure provides a visual example of lubrication two surfaces move relative to each other and separated by an oil film. In the box on the top left there is a contact surface; in the box at the bottom left of the liquid film separating the surfaces, and in between the two extremes partial or intermittent occur. The curved line under the regimes of lubrication showing the relationship between the friction coefficient and numbers Summerfield (SC Tung, ML McMillan, 2004).

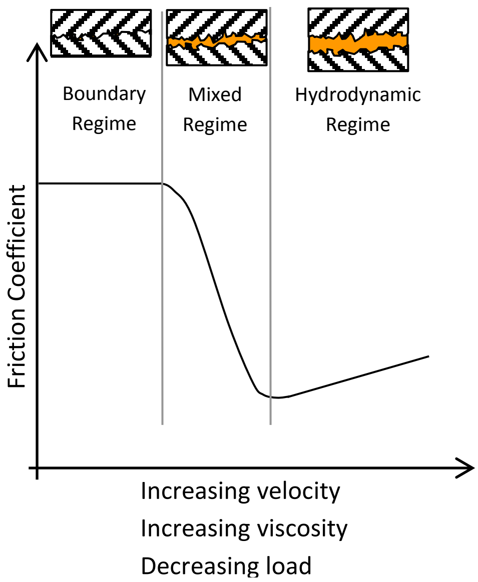

Figure 2.3: Stribeck curve and different lubrication regimes

Synthetic mineral oil production for a typical application described a smooth transition to a fully synthetic lubricating fluid. Lubricating properties of fluorohydrocarbons, liquid esters, liquid polyphenylether, silicone oils and polyalkylglycols determined (H. Loewenthal, RJ Parker and EV Zaretsky, 1974). Synthetic lubricants can be produced using modified chemical petroleum component of overall crude oil, but also can be synthesized from raw materials to another. Synthetic oil is used as a substitute for lubricant refined from petroleum when operating at extreme temperatures, because, in general, it provides excellent characteristics for their mechanical and chemical contained in traditional mineral oils. Advantages of synthetic motor oils include:

i. Better low- and high-temperature viscosity performance at service temperature extreme.
ii. Better chemical and shear stability
iii. Decreased evaporative loss
iv. Resistance to oxidation, thermal breakdown, and oil sludge problems
v. Possibility to extended drain intervals, with the environmental benefit of less used oil waste generated
vi. Improved fuel economy in certain engine configurations
vii. Better lubrication during extreme cold weather starts
viii. Possibly a longer engine life
ix. Increased horsepower and torque due to less initial drag on the engine

Disadvantages of synthetic motor oils:

i. Substantially more expensive (per volume) than mineral oils.
ii. Potential decomposition problems in certain chemical environments (predominantly in industrial use.)

2.3 EXTREME PRESSURE (EP) ADDITIVES

There are situations where there is extreme pressure, in order to operate in this situation, additives used. The lubricant, there are several types of additives are added in a variety of applications. In the application of extreme pressure, additives categorized under Extreme Pressure (EP) are used in lubricants. Oil additives that bring this as an added feature called Extreme Pressure oil. Lubrications extreme pressure made by several different chemical compounds, namely, boron, phosphorus, sulfur, chlorine and others. It also may be possible to form a mixture of compounds of these elements. When the pressure is increased to a level where it is extreme, based on the compound to enable higher temperatures resulting from this pressure. Extreme pressure molecules in chemical compounds react as temperature increases and it produces a small amount of derivatives that act on the surface and form another type of chemical compounds such as iron chloride. This condition causes the protective layer created in the gap on the surface of the object grumbled.

2.4 UTeM FORMULA VARSITY CAR.

UTeM Formula Varsity is an international student racing competition that challenges students to design, manufacture and race their single seat open-wheel formula style racing car in real track condition. This event is inspired by similar student based formula style racing events such as Formula SAE and Formula Student. The aim of the event is to provide a platform for Malaysian students with interest in Motorsport engineering to put into practice their engineering knowledge and skills in developing a working model of a formula style racing car. The event home to foster the tie and collaboration between all Malaysian and international higher education institutions, especially among the students as well as to help create the needed competent human capitals for our country automotive industries.

History of Formula Varsity is a biannual event first introduced in 2006 by Faculty of Mechanical Engineering, UTeM. The first programmer was organized on 14 September 2006 with sole participation from Universiti Tun Hussien Onn. The