UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE STUDY OF EFFECT OF ENGINE OIL VISCOSITY ON ENGINE PERFORMANCE

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

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirement for the Degree of Bachelor of Engineering Technology Mechanical Engineering (Automotive Technology) (Hons.). The member of the supervisor are as follows:

…….

(En. Ahmad Zainal Taufik Bin Zainal Ariffin)

Supervisor

ABSTRACT

There are some regulations for specific engine on choosing the engine oil. The manufacturers of car company have listed type and viscosity of engine oil that can be used by the user to their engine. The manufacturer have stated that certain viscosity and type of engine oil only suitable for their engine to long lasting life of engine and give high performance to the engine. In this study the characteristics and effects of viscosity to the engine performance to justify the manufacturers claim will be studied. This study focused on the effect of the engine oil to the engine performance. There are 3 types of engine oil that were being tested in this project, which are mineral based oil, semi-synthetic oil, and fully synthetic oil. All these engine oil have their own viscosity to differentiate between each other. The engine being used for this test is 1.3 L Campro engine and the equipment used are Exhaust Gas Analyzer and LAUNCH X431 Scanner Tool. The method chosen for this project is that the engine oil must be run at different rpm, which is at 800 RPM for idle speed and 3000 RPM for top speed. The test will be justified based on the gas emission release from the exhaust and relate it to the engine performance. The data from the scanner tool also being analysed to relate with the engine performance.

ABSTRAK

Terdapat beberapa panduan untuk enjin tertentu dalam memilih minyak enjin. Pengeluar syarikat kereta telah menyenaraikan jenis dan kelikatan minyak enjin yang sesuai digunakan oleh pengguna untuk enjin mereka. Pengilang telah menyatakan bahawa kelikatan tertentu dan jenis minyak enjin hanya sesuai untuk enjin mereka untuk ketahanan enjin dan memberikan prestasi tinggi untuk enjin. Dalam kajian ini, ciri-ciri dan kesan kelikatan dengan prestasi enjin untuk mewajarkan tuntutan pengeluar akan dikaji. Kajian ini memberi tumpuan kepada kesan minyak enjin kepada prestasi enjin. Terdapat 3 jenis minyak enjin yang diuji dalam projek ini, iaitu minyak asas mineral, minyak semi-sintetik dan minyak sintetik sepenuhnya. Semua minyak enjin ini mempunyai kelikatan tersendiri untuk membezakan antara satu sama lain. Enjin yang digunakan untuk ujian ini ialah enjin 1.3 L Campro dan peralatan yang digunakan adalah Exhaust Gas Analyzer dan LAUNCH X 431 Scanner Tool. Kaedah yang dipilih untuk projek ini adalah minyak enjin mesti dijalankan pada rpm yang berbeza, iaitu pada 800 rpm untuk kelajuan terbiar dan 3000 rpm untuk kelajuan tertinggi. Ujian ini dianalisa melalui pelepasan gas dari ekzos dan mengaitkannya dengan prestasi enjin. Data daripada alat pengimbas juga dianalisis untuk mencari perkaitan dengan prestasi enjin.

DEDICATIONS

I dedicated this final year project report to my beloved father and mother, En. Kamalruzaman Bin Atan & Puan Norzanita Binti Syed Sulaiman Sahib, and my lovely family.

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LIST OF SYMBOLS AND ABBREVIATIONS

API	American Petroleum Institute
CCS	Cold Crank Simulator
CO	Carbon Monoxide
CO2	Carbon dioxide
HC	Hydrocarbon
HTHS	High temperature high shear
I.C	Internal Combustion
MAPM	Member of the Association for Project Management
NOx	Nitrous Oxide
O2	Oxygen
OEM	Original equipment manufacturer
PAO	Poly alpha olefins
PIO	Poly internal olefins
SAE	Society of Automotive Engineers
ZDDP	Zinc dialkyl dithio phosphates

CHAPTER 1
INTRODUCTION

1.0 Background

This study was to define the effect of engine oil viscosity to the engine performance of the engine car. Motor oil, engine oil, or engine lubricant is lubricants that are used for lubrication of internal combustion engines. The main function of these lubricants is to clean, reduce wear on moving parts, prevent corrosion, cool the engine by carrying heat away from moving parts and improve sealing. Engine oils are derived from petroleum-based and non-petroleum-synthesized chemical compounds. Engine oils today are mainly blended by using base oils composed of hydrocarbons, polyalphaolefins (PAO), and polyinternal olefins (PIO). Oil crucial to capable of flowing at low temperatures, so that it gets around the engine in a fraction of a second at start-up and must protect engine components at high temperatures without evaporating or carbonizing and maintain adequate oil pressure. The performance of an engine is measured by fuel consumption, power output, durability, and emissions. Today's engines are computer controlled and regulate the air / fuel delivery, ignition timing, and emissions. There are a few calculation that can show the performance of the engine such as fuel consumption, gas emission, thermal efficiency, torque and horsepower that will be tested in this experimental study.

1.1 Problem Statement

Nowadays, the engine oil company have produced and sell many types and viscosity of engine oil. We can see at the market to many choice of engine oil have been displayed. They claim that this new and fresh formulated engine oil have added additive that can improve your engine life span, engine performance, fuel consumption and many others good effect. This mineral base type, semi synthetic and fully synthetic have added additive such as zinc dialkyldithiophosphate, molybdenum disulfide and phenols to get low fuel consumption, anti-wear effect and retard the degradation of the stock oil by oxidation. But car manufacturer or engine manufacturer has stated that not all types of this engine oil can be used for our car engine. There are specific viscosity and type of base oil we can use for our car engine.

For this project, the study was held to identify why such claim were made by car manufacturers and made analysis on the different viscosity of engine oil to engine performance to prove their claim.

1.2 Objectives

The function of an engine oil is to create and maintain a lubrication film between two moving metal surfaces and this function is very much dependant on the viscosity of the oil itself .Without oil your engine and other moving parts would wear out very quickly. Engine oil viscosity is not within specified viscosity range, a condition known as insufficient lubrication will occur, resulting in increased friction, wear and heat. This wear, heat and friction will cause the engine cannot perform its maximum and reduce its power slightly.

The objective of this study is as follows:

1. To study the characteristic of engine oil

2. To analyse the performance of the engine based on engine oil viscosity.

1.3 Scope

The scopes of this project starts from finding the type of engine oil, find the engine used for the test and find the suitable test that can show the engine performance that can be used in this study. Overall scopes of the project are stated below.

1.3.1 Engine Oil

1. Mineral base (20w-50)
2. Semi-Synthetic (10w-40)
3. Fully-Synthetic (5w-40) engine oil.

1.3.2 Engine

1. 1.3 L Campro four-stroke combustion engine (petrol) .
2. Total displacement: 1,332
3. Bore: 76 mm (3.0 in)
4. Stroke: 73.4 mm (2.9 in)
5. Max output (/rpm) 70 kW (95Ps; 94 hp)/6000
6. Max torque (/rpm) 120N.m (89 lb.ft) /4000

1.3.3 Test Method

1. Gas Emission Test using Exhaust Gas Analyzer
2. LAUNCH X431Scanner Tool

CHAPTER 2

Literature Review

2.0 Introduction

This section will discuss about the theories and previous research of this project in detail. Besides that, it also explains about the method that will be used in this project

2.1 Lubricant

The lubricant uses have been tracked from ancient of Egypt thousands of years ago. The ancient of Egyptians shows that the anaglyph inside recorded that people at the time used lubricant in the form of water to help carry the monument. Lubricant also has the function of transmitting forces, heating or cooling the surfaces and transporting foreign particles. The perfect lubricant would not have no friction, allow no wear and be able to operate at any temperature for any length of time without any change in its properties (Jackson, A. , 1987). Lubricant also acts as a substance introduced to reduce friction between surfaces in mutual contact, which effectively reduces the heat generated when the surfaces move.

In the early 20th century, the lubricant additives began with the use of sulfur in mineral oil and fatty oil to improve lubrication under high loads. The nano hardness and the modulus of the friction surface are increased by 67 and 90%, respectively by using the additive because the additive have improved the surface mechanics properties of steel-steel friction pair (Yu et al., 2007).

Several lubricant attributes which include the level of toxicity, biodegradability and the products of biodegradation. This has posed a constant threat to the ecology and vast ground water reserves. Demand for environmentally friendly lubricants are increasing because of the high concern for environmental protection (Azhari et al., 2015). For lubricant oils analysis, their chemical composition and size of particles in wear remains could determine the method of choice. Based on this fact, environmentally adapted lubricants have become very important (Alves, 2012).

2.2 Mineral oil

Mineral oil or also known as base oils, mineral base oils or lubricant base oils are chemical substances produced from naturally occurring crude petroleum oil (Nehal, 2013). Mineral oil refined recomplex and variable mixtures of straight and branched chain aromatic hydrocarbons, naphthenic and paraffinic have the range of 300-600°c for boiling points (Halder, 1984). Firstly crude oil is distilled atmospheric pressure and then under high vacuum distillates and residual fractions that can be further refined from petroleum crude oil.

To get a proper lubrication often are made with a long carbon chain 30 plus generally recommended for a mineral oil in addition of carbon and hydrocarbon. The lubricant contains sulphur oxygen nitrogen, this carbon chain carbon and hydrogen.

Mineral or petroleum oils are basically lower molecular weight hydrocarbons with about 12 to 50 carbon atoms. As they are cheap, available in abundance and stable under service conditions, hence they are widely used. But the oiliness of mineral oils is less, so the addition of higher molecular weight compounds like oleic acid and stearic acid increases the oiliness of mineral oil (Halder, 1984).

2.3 Synthetic Oil

Synthetic oil is a lubricant consisting of chemical compounds that are artificially made (synthesized). Synthetic lubricants can be manufactured using chemically modified petroleum components rather than whole crude oil, but can also be synthesized from other raw materials. Synthetic oil is used as a substitute for lubricant refined from petroleum when operating in extremes of temperature, because, in general, it provides superior mechanical and chemical properties to those found in traditional mineral oils.

There are three major classes of synthetic base stock; hydrocarbon, organic ester and plyglycols (Jackson, A. ,1987). An example for hydrocarbon are polyalphaolefins, polysobutenes and alkylated aromatics. Low yield process and expensive raw material were the main reason for unpopular uses of hydrocarbon in the past. For organic esters, the usually chemical uses in lubricant industry are dibasic acid esters and polyol ester but the main advantages of esters are low temperature gelation and high temperature deposits due to glycerine portion of the molecule. Polyglycol such as ethylene oxide and propylene oxide previously used as brake fluids but now available as lubricant base stock.

Synthetic lubricants are also used in metal stamping to provide environmental and other benefits when compared to conventional petroleum and animal fat based products. These products are also referred to as non-oil or oil free .Usually, special synthetic lubricants are developed for some purpose demands. For example, conventional mineral-oil based lubricants could not meet extremely low- (Arctic) or high-temperature operations and fire resistance requirements.

Synthetic base oils, a complex mixture of hydrocarbons, are the result of a carefully controlled chemical reaction process that produces a pure chemical of pre-selected composition (Chevron,2013). This reaction process produces an unlimited variety of products. Many synthetic-based lubricants are formulated with additives similar to those in mineral-oil based lubricants. However, some synthetics require newly developed additives. This is true of the fully formulated lubricants for internal combustion engines and heavy-duty gear cases. Various types of synthetic-based oils

used to formulate synthetic lubricants have certain advantages over conventional mineral-oil based products. These advantages are low pour point, volatility and toxicity. It also has a high viscosity index, oxidation stability and flash and fire points.

Table 2-1 : Synthetic lubricant: Advantages compare to mineral oils

Synthetic Base Type	Main Advantages	Applications
Alkylbenzenes	Low temperature performance	(Refrigeration) compressor oils mineral oil-like solvency
Polyalphaolefins	Wide temperature performance range, low volatility	Engine oil, gear oils, hydraulic oils
Diesters	Wide temperature performance range, low volatility	Gas turbine oils, air compressor oils, Hydraulic oils
Phosphate Esters	Fire resistance	Fire-resistant hydraulic fluids
Polyalkylene Glycols	Wide temperature performance raneg, hydrolytic stability, frictional properties	Gas compressor oil, gear oils
Polyolesters	Wide temperature performance range, low pour point	Jet engine oils, refrigeration compressor oils (chlorine-free refrigerants)

2.4 Semi-synthetic oil

Semi-synthetic oils are blends of mineral oil with no more than 30% synthetic oil designed to have many of the benefits of synthetic oil without matching the cost of pure synthetic oil. Motul introduced the first semi-synthetic motor oil in 1966. Lubricants that have synthetic base stocks even lower than 30% but with high-performance additive packs consisting of esters can also be considered synthetic lubricants. In general, a ratio of the synthetic base stock is used to define commodity codes among the customs declarations of tax purposes.

Other base stocks help semi-synthetic lubricants like API Group II- and API Group III-type base stocks help to formulate more economic-type semi-synthetic lubricants. API Group I-, II-, II+-, and III-type mineral-base oil stocks are widely used in combination with additive packages, performance packages, and ester and/or API Group IV poly-alpha-olefins in order to formulate a semi-synthetic-based lubricants. API Group III base oils are sometimes considered fully synthetic, but they are still classified as highest-top-level mineral-base stocks. A Synthetic or synthesized material is one that is produced by combining or building individual units into a unified entry. Synthetic base stocks as described above are man-made and tailored to have a controlled molecular structure with predictable properties, unlike mineral base oils, which are complex mixtures of naturally occurring hydrocarbons and paraffin.

2.5 Viscosity

For any oil lubrication system, oil viscosity is considered as the most important parameter. One should always ensure that the viscosity of the oil in use meets OEM recommendations. The main function of a lubrication oil is to create and maintain a lubrication film between two moving metal surfaces and this function is very much dependant on the viscosity of the oil itself.

Often, when the oil viscosity is not within specified viscosity range, a condition known as insufficient lubrication will occur, resulting in increased friction, wear and heat. Viscosity can be defined as the measurement of fluid internal resistance to flow at a specified temperature. Low viscosity engine oil can improve the fuel economy by lessening the friction between the engine components that relatively moves in action. (Sae Il Jeon et al.,2007). Engine oil seal frictional torque has increased in proportional to the shaft rotational speed for all three engine oil grades.

Engine oil seal frictional torque decrease due to the usage of low viscosity engine oil was confirmed. Also, the leak free performance of the engine oil with the seal was satisfying the criteria for the life limit durability test. Thus, low viscosity engine oil usage to improve the fuel economy not only decrease the frictional loss of the engine oil seal, but also have no defect in the performance of the leak free function. The automotive industry today is confronted with the pressing challenge of improving the fuel consumption with the onset of the global squeeze on energy supplies and rising fuel prices. In particular, the engineering activities for improving the fuel economy is accelerated due to the global trend of establishing a far more cutting edge regulation on the fuel emission. Since the fuel economy improvement is directly linked with decreasing the CO2 which is the main factor for the greenhouse effect, it is an essential demanding technology in terms of environment.

The engine oil is necessary to decrease the friction and the wear of the relative dynamic contact movements of the parts within the engine. But, when high viscosity engine oil is being used for the engine, frictional loss due to the high viscosity is inevitable. To decrease these frictional losses, researches over using low viscosity engine oil to improve the fuel economy is in action. On the other hand, problems due to the low viscosity engine oil take place. When using the low viscosity engine oil, load capacity defect and wear increase due to oil film strength decrease takes place among the valve train, crank train and engine bearing which are key parts in terms of tribology. Therefore, it is necessary to use the low viscosity engine oil for fuel economy improvement, but excessive lowering of the viscosity can arouse the adhesion of the various engine parts. It is of utmost importance to consider the engine characteristic for the optimization of the engine oil viscosity (Sae Il Jeon et al,. 2007).