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ASSESSMENT EFFECT OF COMMERCIAL OIL ADDITIVES (COA) ON ENGINE LUBRICANT FOR FOUR-STROKE MOTORCYCLE ENGINE

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

By

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TAJUK: **Assessment Effect of Commercial Oil Additives (COA) on Engine Lubricant for Four-Stroke Motorcycle Engine**

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I hereby, declared this report entitled assessment effect of commercial oil additives (COA) on engine lubricant for four-stroke motorcycle engine 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 (Automotive) with Honours. The member of the supervisory is as follow:

…………………………………….

(DR. NONA MERRY MERPATI MITAN)

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ABSTRAK

Dalam kajian ini, minyak aditif komersial dengan minyak pelincir enjin diadun bersama-sama untuk menganalisis kandungan air, bahan tambah antihaus, pengukuran kimia minyak, jumlas asas nombor, kelikatan, bahan cemar, *wear debris,* analysis pelepasan gas terhadap empat lejang enjin motosikal. Mekanik mengangarkan idea ini meningkatkan lagi prestasi berbanding sebelum dicampur dengan COA. Terdapat dua jenis pelincir enjin dan minyak aditif komersial dicampur berdasarkan standard yang diberikan oleh COA itu sendiri. Enjin motosikal empat lejang yang mempunyai 110 sentimeter isipadu silinder adalah tempat pengujian. Minyak aditif tersebut dicampur dengan minyak pelincir enjin, mempunyai jumlah nisbah sebanyak 1 : 0.06 dan diuji pada tiga jarak yang berbeza iaitu 0, 200, dan 300 kilometer. Selain itu, pelincir enjin mempunyai dua jenis dan satu jenis minyak aditif. Oleh itu, minyak aditif komersial mumpunyai perezaan yang sangat nyata terhadap pelincir enjin jenis bahan semula jadi berbanding pelincir enjin separuh-sintetik. Minyak aditif komersial meningkatkan lagi kelikatan dan mengurangkan kandungan air berbanding dengan pelincir enjin separuh-sintetik. Ini boleh di konklusikan bahawa, minyak aditif komersial boleh digunakan sebagai aksesori minyak aditif untuk pelincir enjin kualiti rendah. COA tidak boleh dicampur lebih daripada nisbah yang dicadangkan, ini kerana ia meningkatkan kelikatan pada minyak pelincir dan boleh merosakkan enjin itu sendiri.

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ABSTRACT

In this study, a Commercial Oil Additives (COA) with engine lubricant are blended together in order to analyze the water content, anti-wear additive, oil chemistry measurement, total base number, kinematic viscosity, contamination, wear debris and gas emission release of four-stroke motorcycle engine. Mechanics assume this idea have more improvement than before addition of COA. A standard engine lubricant and a COA blended based on standard given by the COA. Motorcycle with four-stroke engine which has 110 cubic centimeters (cc) of cylinder volume was the test candidate. COA blended with engine lubricant, has volume ratio of 1: 0.06 and tested on three different mileages which is 0, 200, 300 kilometers. Furthermore, samples have two types of engine lubricant and one types of COA. The COA has a significant effect on Mineral Engine Lubricant (MEL) compared to Semi-Synthetic Engine Lubricant (SSEL). MEL increased the kinematic viscosity and reduce the water content compared to SSEL. It can be concluded that, COA can be used as an external oil additive for cheap, low quality motorcycle engine lubricant sold on the market. The COA in other hand cannot be blended higher than the recommended ratio due to increases the viscosity of the engine lubricant and can cause fatal in engine itself.

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DEDICATION

To my beloved **Parents** for supporting me until now.

Cause it's you who somehow is always the first to take care of me at my worst.

You are appreciated.

#AlwaysInMyHeart. <3

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LIST OF ABBREVIATIONS, SYMBOLS, AND NOMENCLATURE

%	-	Percentage
°C	-	Degree Celsius
abs/ 0.1 m	-	Absorbance per 0.1 meter
AFR	-	Air-fuel ratio
AGMA	-	American Gear Manufacturers Association
API	-	American Petroleum Institute
ASTM	-	American Society for Testing and Materials
AW	-	Antiwear
BLA	-	COA blended with engine lubricant (1:0.06) volume ratio
cc	-	Cubic Centimetres
CDi	-	Capacitor discharge ignition
cm^3	-	Cubic centimeter
COA	-	Commercial Oil Additive
CoF	-	Coefficient of Friction
cP	-	Centipoise
cSt	-	Centistokes
DV	-	Digital viscosity
e. g	-	Exempli gratia means examples
EL	-	Engine lubricant
HP	-	Hindered phenolic
idx	-	Chemical index
IL	-	Ionic liquid
IR	-	Infrared
ISO	-	Equal, meaning that something is the same in chemistry
ISO	-	International Standards Organizations

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km	-	Kilometer
MEL	-	Mineral Engine Lubricant
MEL+COA	-	Mineral engine lubricant blended with Commercial oil additive
mg KOH/ g	-	The equivalent number of milligrams of potassium hydroxide per gram of oil sample
mm	-	Millimeter
N·m	-	Newton meter
NAS	-	National aerospace standard
NLGI	-	National Lubricating Grease Institute
OCP	-	Olefin copolymer
PMA	-	Polymethacrylate viscosity modifiers
PPD	-	Pour point depressants
ppm	-	Parts per million
rpm	-	Revolutions per minute
SAE	-	Societies are Society of Automotive Engineers
SOHC	-	Single Over Head Cam
SSEL	-	Semi-synthetic engine lubricant
SSEL+COA	-	Semi-synthetic blended with Commercial oil additive
TAN	-	Total acid number
TBN	-	Total base number
VG	-	Viscosity of the grade
VI	-	Viscosity Index
wt	-	Weight
ZDDP	-	Zinc dithiophosphates

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In a fast-growing earth that depends on modern machines, materials that lubricate moving parts are most important. A lubricant is any substance placed between surfaces to decrease wear and friction. Also, lubricants can also act as cleansing agents, coolants, rust preventives, and electrical insulators. Furthermore, the use of lubrication was needed with the innovation of any moving object such as crankshaft in petrol engine. The first carts were made with crude wooden axles and bearings. Eventually, people discovered smearing a lump of animal fat on dry and squeaking parts made the wheel run smoothly and quietly. Besides, no one knew the law of friction and how does it works. Research method for lubricant has been done on many ways, even in analysis or experimental (Sitepu, 2010) Beauchamp Tower was the first in history to study on lubricant, when he analyzed lubricant on wheel car at his laboratory. In his report, Tower has been experimenting four times but the most famous was on year 1883 and 1886. Furthermore, Osborne Reynolds explain the theoretical result of Beauchamp Tower, and reported it in his journal on year 1886. In his journal, it was clear that distribution pressure on lubricated on two surface that split up wear and friction.

People called lubricant between the surfaces to carry the load which mean the pressure generated between the opposing surfaces or in scientific term lubrication in engine is the technique or process to decrease wear of both surfaces almost in contact

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and it relatively move to each other by interposing a substance (Abdullah, 2013). That is why lubricant is crucial to all kind of moving machines. This is because, it is impossible to create a two-smooth surface until there is no lubrication is needed. The lubricants mixtures benefit from other properties of lubricants. They are crucial lubricants that can give best protection to reducing friction and wear generated from sliding between two contact surface when engine in started condition and the engine itself. In this project, two types of lubricants are mixed together in order to maximize wear reduction.

1.1 Problem statement

Adding the lubricant with a kind of oil treatment often occur at mechanical workshop for automotive. Mechanics assume this idea have more improvement than before addition of COA. Lubricants for engines and machines contain a large variety of additives, including those to minimize and friction for reducing energy use and increasing the lifetime of the machines (Heuberger, 2007). As a short survey to some workshop in Malacca, many COA's often can be seen in workshop even suggested by some mechanics. One of the issues emerges from these findings that is really COA are efficient to the motorcycle's engine. Thus, there is no scientifically proven the COA are much more effective than a stand-alone engine oil product. Therefore, a research was conducted to determine what is the role of the COA to the engine lubricant.

Lubricating is not an easy problem, yet vital, in the automotive world and industry. In this fast-growing modern industry, lubricant was not only derived from vegetable oils or animal fats, but thanks to the development of lubricant in chemical science and technology, the intensified achievement manufacture of lubricating oils which meet requirements for a variety of automotive engines as well as industrial machines (Ir. Maimuzar & Oong Hanwar, 2005). Thus, engine and lubricating oil were a perfect match, support each other to achieve the purpose for the sake of engine durability. In terms of using lubricating oils are often owners of cars mix them with additives or often referred oil treatment which is Commercial oil additives (COA).

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COA consists of several kinds of brand and heavily trafficked market mainly on car workshop.

To avoid the use of lubricating oil does not cause any loss or wastage for users, then the selection of the formulation lubricating oil must be matched with the machine as well as the working conditions. The existence of many lubricating oil formulations and additives is currently marketed, sometimes making users upset and confused. It became more complex when it came to the basic problem. The additives are marketed many linking benefits oil treatments.

In conclusions, there are several questions that comes in mind. A several proposed problems as follows: “Is commercial additives has more improvement in terms of metal content determination, kinematic viscosity and coefficient of friction as requirement from professional societies?”. Other than that, in market there were standalone lubricant that has its same function already. This is why this research has to be conducted.

1.2 Objectives

The several purposes of the studies about assessment effect of commercial oil additives (COA) on engine lubricant for four-stroke engine motorcycle below:

1. To study the effect of mileage to the engine lubricant.
2. To analyze the water content, antiwear additive, oil chemistry and total base number before and after blended with COA.
3. To compare the effect on blended COA on viscosity, wear debris, contamination, flashpoint.
4. To study the gas emission releases for MEL and SSEL.

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1.3 Scope

The COA will be blended to the engine oil and test it on the four-stroke motorcycle engine which has 110 cubic centimeters (cc) of total cylinder volume. Then it will be analyzed to find its metal content determination, kinematic viscosity and coefficient of friction. From there, the COA will be concluded if it can really improve performance before it was blended with regular engine oil. The mixed oil will run on 3 different mileages (0 km, 200 km, and 300 km). At the end of mileage (300 km/l), the mixed oil will be analyzed. The regular engine oil (before blended with COA) also analyzed to be compared later. Furthermore, there are three different types of engine oil that will be blended with the COA. Project estimated time finish around 4 month depending on how often the motorcycle running.

1.4 Limitations

Although this experiment was about COA, but there are several aspects that are limited in this project. Firstly, for testing the COA blended with engine lubricant that has volume ratio 1: 0.06 liter (BLA) was limited because only one types of engine were used which is four-stroke 110 cc engines. The result may be different when the BLA is used other types of engine for example two-stroke engine, diesel engine, and external combustion engine. Also, it may have different result when used in bigger types of motorcycle engine used or superbike. Thus, discussion and result will be focused on small engine.

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CHAPTER 2

LITERATURE REVIEW

2.0 Lubricant

Lubricating any two surface focuses on minimize the separation of contact surfaces on moving equipment. For decades, both oil and grease have been the lubricants challenged with this mission. Key elements are reducing the wear, the friction coefficient and the energy losses encountered in machinery through its working life.

2.1 History of lubricant

According to O'Brien (1983) the use of lubricants was recorded dates back to almost to the birth of civilization, with early historical developments being concerned with animal fat and vegetable oil origin in machinery or transportation. Ancient inscriptions dating back to long time ago. shows early examples of systematic lubrication with animal fats being applied to reduce squeaking parts on chariot wheel axels. From these very early roots, many methods to reduce friction were dependent on vegetable and animal-based oils.

When iron and brass replaced wood as moving parts in machinery, crude lumps of animal fat proved to be improvised lubricants. The second generation of oily and

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fatty substances were taken from animal oils, vegetable oils, or a mixture of these two sources. Some of these lubricants are castor oil, olive oil, rape oil, and peanut oil are still used for certain purposes. After about the 16th century, porpoise oil and whale oil came into wide use.

Today, lubricants have many properties that are synthesized and formulated for application in various operations and mechanical units. Fast growing technologies require intense and varied requirements from lubricants, due to fact that the right formulation of hydrocarbon blends for lubricants being a complex process (Shahnazar, et al., 2015). Lubricants consists of a wide range of base oils and essential additives. Base oil is a lubricant fluid that separate the surfaces of moving parts by creating fluid films (Shahnazar, et al., 2015). Other than that, to minimizing friction, it removes wear and heat particles from the system. Many lubricant properties are created and improved by adding special additive species to the base stock. Lubricants could be derived from two source, biological and non-biological. Therefore, a big collection of hydrocarbon mixtures is available through a combination of the aforementioned groups (O'Brien, 1983).

2.1.1 Classification of lubricant

Based from book section by Parkash (2009), lubricant are designed to do several jobs in engines and other industrial machines by lubricating of moving parts, cooling, cleaning and corrosion control. Lube base stocks produced by refineries and petrochemical manufacturers (synthetic lube base stocks) are used to provide a large number of products such as gasoline and diesel engine oils, agricultural engine oils, marine engine oils, aviation and turbine oils, hydraulic and transmission oils, gear oils, automotive and industrial greases, metal working oils, electrical insulating oils, white mineral oils, and process oils.

Automotive engine oils, gear lubricants, and transmission oils constitute roughly half of the total lube oils produced. Most of these products are prepared by mixing an appropriate percentage of additives with lubricant

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base stocks. For every application, the lubricant base stock and oil additive package has to be carefully selected to meet the compatibility and requirements of the intended application (Parkash, 2009).

2.1.2 Viscosity requirement for lubricant

A standard classification according to viscosity has been created by a group of professional societies and organizations. Hence, it is easy to determine on how to classified lubricant with an appropriate machine. These professional societies are Society of Automotive Engineers, USA (SAE), American Petroleum Institute (API), American Gear Manufacturers Association (AGMA), and National Lubricating Grease Institute (NLGI) (Parkash, 2009).

For an international standard, industrial lubricants before that, different classification systems have been used in the past by different parts of the world. A worldwide viscosity classification system for industrial lubricants has been combined in one. Table 2.0 shows the current International Standards Organizations (ISO) 3448 viscosity classification system and Table 2.1 shows international standards for SAE J 300 Engine Oil Viscosity Specifications. The unit for viscosity where Cp is centipoise. The classification was based on series of viscosity grades, each being approximately 50 percent more viscous than the preceding grade. Viscosity variation within the grade is plus or minus 10 percent of the nominal viscosity of the grade (VG). For lubricating oils other than automotive oils, the ISO VG classification system is generally used. Each ISO viscosity grade number corresponds to the midpoint of the viscosity range expressed in centistokes (cSt) at 40 °C. For example, a lubricant with an ISO grade viscosity of 100 has a viscosity in the range of 90 to 110, with 100 the midpoint of the range.

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Table 2.0: Nonautomotive Lubricating Oils ISO Viscosity Grades (Parkash, 2009)

ISO Grades	Midpoint viscosity at 40 ^{0}C cSt	Viscosity at 40 ^{0}C		Viscosity at 37.8 ^{0}C		Approximate viscosity at 98.9 ^{0}C, SUS		Approximate viscosity at 98.9 ^{0}C, SUS		Approximate viscosity at 98.9 ^{0}C, SUS	
		Min. cSt	Max. cSt	Min. SUS	Max. SUS	95 VI Min.	Max.	65 VI Min.	Max.	35 VI Min.	Max.
2	2.2	1.98	2.42	32.8	34.4						
3	3.2	2.88	3.52	36	38.2						
5	4.6	4.14	5.06	40.4	43.5						
7	6.8	6.12	7.48	47.2	52						
10	10	9	11	57.6	65.4	34.6	35.7	34.2	35.3	33.8	34.9
15	15	13.5	16.5	75.8	89.1	37	38.3	36.4	37.8	36	37.3
22	22	19.8	24.2	105	126	39.7	41.4	39.1	40.6	38.5	40
32	32	28.8	35.2	149	182	42.9	45	42	43.8	41.4	42.9
46	46	41.4	50.6	214	262	47.1	49.9	45.4	47.8	44.2	46.2
68	68	61.2	74.8	317	389	53	56.9	50.3	53.4	48.6	51.2
100	100	90	110	469	575	61.4	66.9	56.8	61	54	57.2
150	150	135	165	708	869	74	81.9	66.6	72.7	62.1	67.2

Table 2.1: SAE J 300 Engine oil viscosity specifications (Parkash, 2009)

SAE viscosity grade	Cold cranking max. viscosity		Cold pumping max. viscosity		Viscosity, cSt at 100 °C		Hot/High shear viscosity at 150 °C cP
	cP^+	at, °C	cP	at, °C	Min.	Max.	
0 W	6200	-35	60,000	-40	3.8		
5 W	6600	-30	60,000	-35	3.8		
10 W	7000	-25	60,000	-30	4.1		
15 W	7000	-20	60,000	-25	5.6		
20 W	9500	-15	60,000	-20	5.6		
25 W	13000	-10	60,000	-15	9.3		
20					5.6	9.3	2.6
30					9.3	12.5	2.9
40					12.5	16.3	3.7
50					16.3	21.9	3.7
60					21.9	26.1	3.7

A multigrade engine oil such as SAE 10W/30 has the viscosity characteristics of both SAE 10W and SAE 30 oil. Similarly, the multigrade grade oil SAE 80W/90 has the viscosity characteristics of SAE 80W and SAE 90 gear oils. Today, many trucks and automobiles use what is termed

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"multiviscosity oils." These are in fact multigrade, not multiviscosity, oils. An oil cannot be multiviscosity, but it can be multigrade (Parkash, 2010).

2.1.3 Base Oil

According to Sheida Shahnazar (2016), lubricants are divided in three different group. There are mineral oil, semi-synthetic oil and synthetic oil. It shows all dissimilar assets and suitable for diverse applications. In the industry, the most used lubricant is mineral oil. Mineral oil utilized for machineries, which requires its temperature be moderated and mineral oil are petroleum-based fluids. They are commonly used in engines, turbines, bearings, and gears. Synthetic oils are specially formulated to produce lubricants with greater properties than mineral oils, for example lubricating at high or low temperatures.

Other than that, he also stated that by selecting a suitable base stock for lubricant formulation, different final product properties and performance can be evaluated and forecasted. Being aware of the base fluid features, particularly all possible limitations, is of great necessity for the effective formulation of lubricants. The American Petroleum Institute (API) categorized lubricant base oil quality, as indicated in Table 2.2.

Table 2.2: American Petroleum Institute (API) categories for base oil

Group	Properties
Group I	Saturates are <90%, and sulphur is >0.03%, and VI is >80 and <120
Group II	Saturates are >90%, and sulphur is <0.03%, and VI is >80 and <120
Group III	Saturates are >90%, and sulphur is <0.03%, and VI is >120
Group IV	Polyalphaolefins (PAO)
Group V	All other base stocks not included in Group I, II, III, or IV

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