UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECTIVENESS OF CORN OIL AND ZINC DIALKYLDITHIOPHOSPHATE (ZDDP) AS ANTIOXIDANT IN FOUR STROKE MOTORCYCLE ENGINE

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

by

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ABSTRAK

Kesedaran kepada penjagaan alam sekitar pada ketika ini telah meletakkan minyak mineral sebagai pelincir yang paling banyak digunakan dan perlu digantikan menggunakan cecair mesra alam seperti minyak sayuran atau cecair sintetik lain ke dalam pembentukan minyak pelincir. Tetapi pengoksidaan minyak pelincir merupakan halangan untuk membangunkan pelinciran baru minyak sayur-sayuran dalam industri pelinciran automotif hari ini. Tujuan utama kajian ini adalah untuk mewujudkan pelincir alternatif dengan tambahan agen antioksida ke dalam minyak jagung. Minyak jagung yang dikomersialkan dipilih sebagai minyak asas minyak pelincir dengan penambahan zink Dialkyldithiophosphates (ZDDP). Sampel kemudiannya disediakan dalam 2 kategori yang berbeza iatu 0 wt% berat dan 2 wt% berat tumpuan untuk memerhatikan tingkah laku ke arah ujian dengan merujuk kepada standard kaedah prosedur ASTM dan akan dijalankan adalah ujian yang mudah dan peringkat pencirian. Sampel bersedia kemudiannya di uji pada motosikal enjin 4 lejang dan keputusan itu kemudiannya perlu dibandingkan dan menganalisis hasil yang terbaik daripada ciri pelincir diperolehi. Dalam kajian ini, beberapa faktor perlu fokus seperti kelikatan kinematik minyak pelincir yang baru dibangunkan, takat kilat, dan kepekatan zink dan fosforus minyak. Dari ujian pelincir baru, ia adalah jelas bahawa pada 2% berat ZDDP diperkenalkan ke dalam minyak jagung, kelikatan kinematik telah dikurangkan kepada tahap yang optimum pada 133.2cSt. Pada masa yang sama takat kilat meningkat untuk 180̊ C dan hasilnya dari RDE-AES menunjukkan bahawa pencairan ZDDP ke dalam minyak jagung berjaya. Berbanding dengan hasil daripada SAE20w-40 minyak mineral dan minyak jagung dengan tambahan 2% berat boleh mempunyai yang lebih baik daripada prestasi yang sama dengan SAE 20W-40 minyak mineral dalam kajian ini.

ABSTRACT

Recent environment awareness has put mineral oil as the most widely used lubricant base fluid into consideration by the use of biodegradable fluid like vegetable oils or other synthetic fluids into new grease formation. But the oxidation of lubricant oil is an obstacles to develop a new lubrication of vegetables oil in automotive lubrication industries now days. The main purpose of this study is to create alternative lubricant with the addition of the antioxidizing agent into the corn oils. The commercialized corn oil is chosen to be the base oil of the lubricant with addition of Zinc Dialkyldithiophosphates (ZDDP). The samples was then prepared in 2 different that are 0 wt% and 2 wt% concentration to observe its behavior towards the testing by referring to the standard ASTM procedure methods and will be conducted which is simple testing and characterization stage. The prepared samples was then characterized in 4 stroke motorcycles engine and the result was then need to be compared and analyze the best result of lubricant characteristic obtained. In this study, few factors need to be focused such as the kinematic viscosity of the newly developed lubricant, its flash point, and the concentration of zinc and phosphorus of oil. From the testing of new lubricant, it is evident that at 2 wt% of ZDDP introduced into corn oil, the kinematic viscosity was reduced to an optimum level at 133.2cSt. At the same time the flash point are increased to 180̊ C and the result from RDE-AES showed that the dilution of ZDDP into corn oil is successful. Comparing to the result from SAE20w-40 of mineral oil and corn oil with additive of 2 wt% could had better of similar performance with SAE 20w-40 mineral oil in this study.

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DEDICATION

This thesis I dedicate to my parents Mohd Nadzri bin Ab. Wahab and Jaronah binti Yunus. And also my supervisor, En M. Azwar bin Azhari and my friends for supporting me all the way.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

C	-	Degree Celsius
mm	-	millimetre
SAE	-	Society Automotive Engineering
B.C	-	Before Christ
SI	-	System International
wt%	-	Weight percentage
mg	-	milligram
g	-	Gram
KOH	-	Potassium hydroxide
ppm	-	Parts per million
cSt	-	Centistoke

LIST OFABBREVIATIONS

API	–	American Petroleum Institute
ASTM	–	American Society for Testing and Materials
PTFE	–	Polytetrafluorethylene
RDE/AES	–	Rotating disc electrode
SEM	–	Scanning electron microscope
SFM	–	Scanning force microscopy
TAN	–	Total acid number
TBN	–	Total base number
VI	–	Viscosity index
WSD	–	Wear scar diameter
ZDDP	–	Zinc Dialkyldithiophosphate

CHAPTER I

INTRODUCTION

1.1 Introduction of lubricant

The mainly used liquid lubricant in modern usage is to keep up and produces lubricant film and lubricant are generally to reduce wear and frequently to prevent overheating or corrosion between two moving metal surfaces. Since thousands of years ago, liquid lubricant have been used by human in any daily works. Now days, liquid lubricant consist mainly of mineral and synthetic oils with addition of additives where special properties required. The lubricant is known as friction reducing film in supporting sliding load principle (Ludema, 1996). The substance of which the film is composed is lubricant, and to apply is to lubricate. For automotive industry, lubricant generally are to perform various task such as reducing friction and wear limiting contact metal to metal surfaces, and do also as a cooling agent for moving part.

Lubricant are separates into four classes which are liquids, gases, solid, and semi solid or known as greases. The effect of lubricant on surrounding depends on its properties including toxicity biodegradability and the products on. In formulating environment friendly of lubricant, the vegetable oil based and synthetic esters offer the best of. Base stock is lubricating oil begin with base oil. The base stock provides the basic lubricating requirements of an engine. The highly diversified is the lubricant base stock including synthetic, bio-based and mineral lubricant (Bart, 2013). However, base oil will degrade very fast in numerous operating conditions, unless it is supported with additives. Depending on the type of base stock, petroleum, synthetics or others, different additives chemistries are used. Mineral oils is minerals oil stock are developed from petroleum crude oils. The crude oils used for diesel engine lubricants are primarily made up of paraffin, napthene, and aromatic compounds. The higher paraffin content are most commonly used in blended engine oils.

1.2 Vegetables oil in motor lubricant

The vegetable oils with their derivatives used in processed food have been increasing since 1950 for frying or cooking. They are marketed as healthy because the based contain some omega 3fatty acids and monounsaturated fats, due to that they are marketed as healthy product. Vegetable oil have been used at every home as household for cooking and several other usage. Day by day mineral oil price is getting increase due to high requirement usage at every country across the world. The most suitable substitution for mineral oil and also cheap in price only can be seen used vegetables to replace the usage as a lubricant of minerals oil in the future. Vegetable oil can be used as a lubricant in their natural forms. For the industrial and machinery usage must been considered the advantages and disadvantages the vegetables oil capabilities. To develop an extend lifetime for fluid protectives additive or new properties as lubricant performance enhancing, additive can increase the intrinsic properties of based oil (Bart, 2013).

Therefore, vegetables oil is an alternative oil to replace the mineral oil in a future. In a view of the disadvantages of vegetables oil are small thermal, poor temperature characteristic, oxidative and hydrolytic stabilities. But, in other point of view the advantages of vegetables oil are almost the same or even better from the normal mineral oil lubricant characteristics nowadays. The characteristics of vegetables oil are low evaporative loss, high flash points high in lubricity, high in viscosity index, and high-degradability with a lower grade of toxicity to function as a base oil of lubricant. In technical characteristics, vegetables based lubricant are more biodegradable but inferior in many other compared to the lubricant made of petroleum (Erhan, 2006). As an advantages of biodegradable and significantly reduce sulfate and hydrocarbon emissions, the vegetables oil has a potential of huge interest for its environmental characteristic. To improve the lubricating and durability for the vegetables oil, the additives that are chemicals added to the oil in a quantities of few weight percent so that the oil performance can be as good as minerals oil or even better in many aspect of lubricating requirement.

The purpose of lubricant additives is to improve the wear scar, to control the corrosion, improving oxidation resistance, reduce friction characteristics, to reduce excessive decreases of lubricant viscosities at high temperature, to control reaction products, wear particles and debris, and enhancing lubricant characteristics. The addition of additives in vegetable base oil is to

modify the properties of vegetables oil through the stabilizing the oxidation process, the rate of degradation of vegetables oil base can be slowed down (Azhari, et al 2015)

1.3 Problem Statement

Minerals oil well known as a non- friendly lubricant to the environment and also un-renewable lubricant. Lately, environmental awareness start to concern about environmental issues of pollution when petroleum based lubricant are use in industries (Mahipal et al., 2014). The effects produced by the process of mineral oil and subsequent disposal cause severe environmental hazards, especially in the hydraulic industry, mining, agriculture and petrochemicals. According to Gawrillow, (2003). Since 1650 BC, vegetables oil has been used widely as lubricant. Several based vegetables oil such as soy oil, canola oil, corn oil, karanja oil, and also palm oil were being focused to replace mineral oil in future. However, based on M.A.Azhari (2015), the unitability of oxidation in vegetables oil is one of the obstacles by using this lubricant. The high content of unsaturated fatty acid in vegetables oil may cause the oil will produces the less cooperative in stabilizing the oxidation. But the problem can be overcome by addition with anti-oxidation additive that is ZDDP. The degradation of the lubricant oil can be decrease by the addition of ZDDP into any based vegetables oil as an effective antiwear and anti-oxidation additive according to Azhari et al (2015). Thus, Zinc Dialkyldithiophospates (ZDDP) will be used as an anti-oxidation agent in this study with corn oil to overcome the oxidation problem and to develop the new vegetables oil as a lubricant.

1.4 Objectives

Based on the problem statement, the objective have been drawn:

1) To develop a new lubricant with addition of anti-oxidation agent
2) To test and characterizes the new developed lubricant oil

1.5 Work Scope

In line with the objective stated above, the scopes are:

1) Developing new bio-lubricant using commercialized corn oil and ZDDP as anti-oxidant agent
2) Testing the new developed oil using 4 strokes motorcycles engine
3) Characterized the new developed oil using various laboratory test

CHAPTER II

LITERATURE REVIEW

2.1 Lubricant

From ancient of Egypt, liquid lubricant have been practiced by humans for thousands of years ago. Ancient Egypt shows that the anaglyph in the record that the people in the lubricant used (water) to help bring the statue. A lubricant is a substance introduced to reduce friction between the surfaces in contact with, which ultimately reduces the heat generated when the moving surface. It may also have the function of transmitting force, transporting foreign particles, or heating or cooling surface.

Used lubricant additives at beginning of the 20th century beginning with the use of sulfur in the oil and mineral oil to enhance lubrication under high load. The use of additives which clearly improves the mechanical properties of the surface of the steel-steel friction pair, and nanohardness surface friction and modulus increased by 67 and 90%, respectively (Yu et al., 2007).

The current production of environmentally friendly lubricants only 1% of total production. Worldwide Use of lubricants in 2005 was about 40 million metric tonnesand about 30% of the used lubricating oil ended up in the ecosystem (Bartz, 2013). A lubricant comprising a base oil (> 90%) and additional packages (<10%). The base oil used for the drafting of a hostile natural mineral oil lubricants.

The demand for environmentally friendly lubricant oil is rising because of high concern for environmental protection (Azhari et al., 2015). The properties of some lubricants that include the level of toxicity, biodegradability and products of biodegradation. Pose a threat to the ecology and groundwater reserves are vast. In this context, environmentally adapted lubricants have become more and more important (Alves, 2012). The research have reviewed the application of vegetable oil based as a lubricant to be replaced with the mineral oil based

lubricant. For lubricant oils analysis, their chemical composition and size of particles in wear remains could determine the method of choice.

2.1.1 Liquid Lubricant

Liquid lubricant are classified based on the origin that extracted from vegetables, animals, crude oil, based on their origin, we classify as vegetable oil typically. Examples are castor and rapeseed animal oil is a may be fish oil, olive oil, mineral oil is the most popular and most economic category of this liquid lubricant finally, come the synthetic lubricant. There are many different liquid lubricants that have been used (Hsu, 2013). The classification of the lubricant are silicones, minerals oil, perfluoropolyethers, vegetables oil, and synthetics.

In general, the mineral oil they are extracted we are process from the crude oil. And major constitute is a carbon and hydrogen all is the based, that is why we call as a hydrocarbon best lubricating oils and see that carbon percentage is 83 to 87 percent and hydrogen 11 to 14 percent this is by weight (Hsu, 2013). They are made with a long carbon chain 30 plus generally recommended for a mineral oils in addition to carbon and hydrogen. They often contains sulphur oxygen nitrogen, this carbon chain carbon and hydrogen, when they make bond they can make form in a straight line. They can be in branched form on a cyclic form the property will change the carbon structure is straight chain, behavior will be one kind of the branched carbon chain. Then behavior will change even a cyclic one then behavior will quite change and based on the carbon structure also, they are classified. The silicone fluids lubricant were only moderately successful as lubricant, and not be considered as suitable lubricants for spacecraft (NASA, 1985). They are not used for non-lubricating application however, such as in hydraulic systems, as damper fluids, or thermal conduction materials.

For perfluropolyether lubricants are divided in three main classes. Their commercial name are Fomblin, Krytox, and Demnum. The chemistry and the properties of these fluids seem to be ideally suited for space lubrication. They have very low vapor pressure, very low pour points, and higher viscosity indexes than mineral oils, and they are extremely inert. Perfluoropolyethers have been very successful for lubrication applications in the hydrodynamic or ekastohydrodynamic regimes. But under boundary lubrication conditions, they degrade. The degradation of the fluid can result in higher friction, bearing torque noises, excessive wear and eventually bearing failure.

For synthetics lubricant, the vapor pressure of this lubricant fluid are lower than minerals oil. It has been found that removal of the light fractions of the oil can reduce the vapor pressure several orders of magnitude without affecting the room temperature viscosity. These synthetics hydrocarbon can be blended with conventional additives to provide the same protection against wear, oxidation, and corrosion as achieved by mineral oil (Liston, 1992). And that is why say synthetic oils are engineered is an being as they are engineered they will be uniformly shaped molecules that is why will be having much more than mineral oils and they are generally made with a low carbon chain. So, that if they have more heat and stress stability they have much more strength. However, they property will go down with low chain that means, a good for high speed application. If there is more possibility of hydrodynamic action for high temperature separation is not a problem. But, the high temperature is problem based on requirement is in can be selected.

2.1.2 Solid Lubricant

Solid lubricant films are three common types of burnished, bounded, and vacuum deposited (McMurtrey, 1989). Burnish film improved use by scrubbing process that removes the lubricant to the surface to be coated. The resulting film thickness, coverage, and stick very dependent on the supply of substrate and scrubbing procedures, which are generally difficult to control and reproduce. Burnished film has improved durability is low compared to other preparation methods as poor adhesion. Other than that, the rubbing approach is that the transfer of lubricant can be sporadic or uneven, resulting in bruises lubricants or areas that are exposed on the surface of contact (Rowntree, 1989)

Bonded film is a mixture of solid lubricant bonded with binders and solvents. The decision to use a binder in better in better adhesion of the lubricant to the substrate, resulting in longer lifetimes compared with burnished films. Bonded film usually a few micrometers thick, which often do not allow the lowest possible friction of the low friction material, and that the dimensions are too thick for many people to precision components. The bonded film technology is well established and is quite effective and appropriate for many low cycle applications, such as release mechanisms, journals, clamps that cannot tolerate seizure (McMurtrey, 1985).

Vacuum deposition techniques can be used to apply a thin film of dry lubricant to obtain a uniform layer of protection components in system accuracy. For precision mechanism, the film can be applied by sputtering, ion plating, or other ion beam assisted technique for controlling the lubricant coverage (Bowden, 1958). To improve adhesion to components, ion cleaning before deposition can be used as a kind of method. Dopant can be added continuously or periodically to form a multilayer film to modify the microstructure of film and performance (Hilton, 1992)

2.1.3 Semi Solid Lubricant

A semi-solid lubricant obtained by combining the lubricant with a thickening agent called grease. The lubricant is a major component, and it can be either petroleum or synthetic hydrocarbon oil with low to high viscosity (Crone I. et al., 2003). The thickeners consist primarily of special soaps of Li, Na, Ca, Ba, Al, etc. Non-soap thickeners include carbon black, silica gel, polyureas and other synthetic polymers, clays. Grease can support heavier loads at lower speeds. Grease resistance is higher than the lubricant. Therefore it is better to use oil rather than grease. Compared with lubricating oil, grease cannot effectively dissipate heat from the bearing, so the work at a lower temperature.

The characteristics of the grease will be unaffected by water. If the thickener has a high temperature stability, the grease will function at high temperature (Jeremy Wright, 2001). Usually greases are thickened by soaps. And a soap is a metallic element reacted with fat or fatty acids. Metallic elements used to make soap include: calcium, lithium, sodium, aluminum, and barium. Lubricating additives such as PTFE graphite and lead are sometimes used as thickeners. Additives are often added to grease to provide anti-oxidation such as rust, corrosion and improved load carrying ability

Lubricating oil or oil-based fluids that can carry out the actual lubrication oil (mineral) oil, synthetic oil, or vegetable oil (Lundberg J et al., 2003). Thickener gives the grease consistency in character and is sometimes regarded as the "three-dimensional network of fibers" or "sponge" that holds the oil in place (Crone I. et al., 2003). Common thickener soap and non-soap thickener, organic or inorganic. The majority of greases on the market is made up of a mixture of mineral oil with soap thickener. Additives to improve performance and protect the