EFFECT OF TBHQ ADDITION IN PALM OIL AS ANTIOXIDIZING AGENT IN ENGINE OIL APPLICATION: DIRECT INTRODUCTION METHOD

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

by

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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 Engineering Technology (Mechanical Engineering Technology Maintenance Technology) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Minyak mineral dan sintetik adalah tidak terbiodegradasi telah medorong kepada isu-isu semasa mengenai perkara yang mesra alam. Kesedaran ekologi hari ini telah meletakkan minyak mineral sebagai pelincir yang paling meluas digunakan sebagai bendalir asas berbanding dengan penggunaan cecair terbiodegradasikan seperti minyak sayuran. Matlamat utama kajian ini khususnya adalah untuk membangunkan minyak pelincir alternatif dengan penambahan agen antioksida ke dalam minyak sayur-sayuran yang iaitu mintak sawit yang berada dipasaran dimana ia dipilih menjadi asas minyak pelincir . Pada masa yang sama, masalah utama minyak sayur-sayuran mempunyai ketidak stabilan termo-oksidatif. Seperti diketahui,sayuran mengandungi asid lemak tak tepu. Asid lemak tak tepu boleh bertindak balas dengan oksigen yang berada di atmosfera. Ini adalah hasil sampingan bagi kes ialah enapcemar dan lakuer dimana ia dihasil didalam sistem suntikan automotif dan juga sistem bahan api. Oleh itu, pengenalan tert-butylhydroquinone (TBHQ) yang dikenali sebagai penambah antioksidan adalah berkesan dalam mencegah degradasi minyak pelincir dimana ia dilarut dalam minyak sawit menggunakan kaedah pencampuran secara langsung. Terdapat tiga kaedah Persatuan Amerika untuk Ujian dan Bahan (ASTM) yang bakal dijalankan dalam ujian sampel dan peringkat pencirian dan ia adalah penting kerana ia dapat mencirikan sifat-sifat minyak baru dan mengujinya untuk aplikasi enjin. Daripada kajian ini, nilai 0.3 pekali geseran telah terhasilkan dalam adunan 3000 - PPM , dimana ia merupakan data paling rendah dalam kajian ini. Tuntasnya, pertambahan 3000-PPM TBHQ adalah adunan terbaik bagi kajian ini.

ABSTRACT

Nowadays eco-friendly issues induce to come along due to the fact the mineral oil and synthetic oil is non-biodegradable. Today's, ecological consciousness has placed up mineral oils as the most broadly used lubricants as a base fluid into consideration to the utilization of biodegradable fluid like vegetable oils. The major goal of this particular study is to develop alternative lubricant oil with the addition of the antioxidizing agent right into the vegetable oil which commercialized palm oil is chosen to be the base oil of the lubricant. All the same, the major problem of vegetable oil has poor thermo-oxidative stability. Vegetable well known that the unsaturated fatty acids identified in common feedstock. These unsaturated fatty acids may react with atmospheric oxygen, forming peroxides and lead in a variety of problematic degradation byproducts, including corrosive, low molecular weight acids and biopolymers. These byproducts are the primary case of sludge and lacquer in automotive injection systems and also fuel system. Thus, introduction of tert-Butylhydroquinone (TBHQ) that known as the effective antioxidant additive in preventing the degradation of lubricating oil dissolved in palm oil using direct blending method. There are three American Society for Testing and Materials (ASTM) methods will be conducted which in a sample testing and characterization stage and it is important because to characterize the properties of the new oil and test it to engine application**.** From this study, 0.3 value of coefficient of friction was produced in 3000-PPM blending, which was lowest data in this study. In conclusion, 3000-PPM addition of TBHQ was best blending in this study.

DEDICATION

I dedicate my dissertation work to my family. A special feeling of gratitude to my loving parents, Abdullah Zam Zam Yaacob and Nor Aini Yusuf whose words of encouragement and push for tenacity ring in my ears plus their endless love and support. Finally yet importantly, I dedicate to the person whose permanence, perseverance and persistence in spite of all obstacles, discouragements, and impossibilities: It is this that in all things distinguishes the strong soul from the weak.

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Thank you again to my colleague, for their moral support, the words of encouragement and the tremendous amount of goodwill. My spirits were sustained by their sympathy in the most frustrating moments of this study, and by their sharing of my joy whenever I completed al chapter.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

cSt	-	Centistoke
G	-	Gram
N	-	Newton
TBHQ	-	Tert-Butyhydroquinone
ZDDP	-	Zinc Dialkydithiophosphate
σ	-	Stress
ϵ	-	Strain
τ	-	Torque

CHAPTER 1
INTRODUCTION

1.1 Introduction to Lubrication.

Today's technology is continually enhancing in a quick speed. This actually is pressing devices to operate quickly, keep going longer, as well as work from increased temperature ranges and strengths. The more significant requires in the products right change so that you can more serious situations from the true personal lubricants which usually guard the particular locations within machines. Lubricants should often be enhanced to supply the actual safety required through the devices. In summation, on that point is certainly developing issue globally concerning the effect of lubricants within the environment? Current laws offer limited the exercise of specific lubricants, especially in a number of countries. This particular research had been necessitated through the with regard to improved lubrication overall performance.

For other common example is in the automotive industry, engine oils are involved to perform numerous jobs, including limiting metal to metal contact (thus reducing friction and wear), and cooling the moving pieces. The engine lubricant can be reckoned as a hostile to the environment. Lubricating oils are subject to impairment due to their exposure to oxygen in the air. Although this may happen during their manufacture and storage, the majority occurs during use. The problem is that once the oil has been oxidized it may not attain the required performance standards set by the engine manufacturers. The oil has to perform many physical and

chemical tasks, any of which, if not satisfied, can lead to the failure of the engine. The most authoritative of these tasks by far, is the power to lubricate moving surfaces, and if the oil is severely oxidized, it will fail to act thusly. Lubricating oils contain additive packages to aid their performance and prolong their useful lifespan. The additives only delay the onslaught of serious deterioration of the oil and, once eaten, the oxidation of the oil proceeds at an accelerated rate compared to that of the base oil.

The 21st century will surely discover the developments within equipment and machine technologies. As machines are created to achieve greater output in production, this can go to greater working rates of speed, which will lead to increase in temperature and pressure in a system where the greater demands on the lubricants. (Bhushan, 2000) These types of needs, coupled with the trends of decreased or even totally maintenance-free programs, improved environmental awareness as well as legation, and a higher focus on safety issue, will continue to challenge lubricant technology and related research and exploitation actions.

1.2 Vegetable Oils in Motor Lubrication.

By the late 19th century, engineering advancements headed to the widespread adoption in an assortment of applications like industrial, automotive and portable applications where machines using high-specified power, uncomplicated pattern, lightweight over-all body weight plus low price were definitely demanded. The expansion of the high-temperature and high-pressure gases produced by combustion in an internal combustion engine apply direct force to components of the engine like pistons, turbine blades, or a nozzle thus moving the component over a range, modifying chemical energy directly into mechanical energy. Reliable as well as more secure operations of an automobile at preferred operating conditions needs effective lubrication of the moving components in order to slide well in the system. Inadequate lubrication when focusing to the parts of the engine in metallic -to - metallic contact, friction, heat increasing, premature wear frequently ending in parts turning into friction welded with each other such as pistons in their cylinders.

Lubricants and lubrication have been in use since man invented machines. Natural products like vegetable oils were used in large quantities during the early era of machines due to their ease of availability and absence of other competitive options until the 19th century. The requirement of lubricants stated to be very high subsequently due to the fact of rapid industrialization, adding pressure on the cost and availability of lubricants from vegetable resources.

Mineral oils were started being used as lubricating oils after the successful prospecting and extraction of mineral oils during the second half of the 19th century, which made available large quantities of cheap replacement for lubricants of vegetable origin with desirable properties. Lubricants neither fresh nor used may lead to considerable harm to the natural environment primarily because of too high possible of severe water and soil pollution. Furthermore, the additives generally contained within lubricant may be harmful to flora and fauna. In used lubricant, the oxidation products can be toxic too. Lubricant persistence in the environment mainly depends on the base oil by contrast, if very toxic additives are applied, they may negatively affect the persistence. The depletion of the world's crude oil reserve, increased oil prices and the demand to protect the environment against pollution exerted by lubricating oils and their uncontrolled spillage have brought renewed interest in the development and use of alternative lubricants. Vegetable oils are perceived to be alternatives to mineral oils for lubricant formulations because of certain inherent technical properties and their ability towards biodegradability

1.3 Problem Statement.

Environment treatment as well as guideline has increased the necessity of renewable as well as eco-friendly lubricants for example oil lubricant, lubricating oil or grease. Current environmental recognition has put mineral oils; as the utmost popular lubrication base liquid into account through the usage of eco-friendly liquid such as vegetable oils and other synthetic fluids into the new lubricant formulation. The lubrication has made the vegetable oil be utilized by human since ancient time. In this era, various kinds of vegetable oils tend to be created in a commercial as

currently becoming utilized in numerous application especially in an industry nor fades. Nowadays mineral oil, which is derived from crude petroleum and synthetic oil from petrochemical mainly use as a base oil in lubricant. Recently there have been the serious anxiety about remaining of the world petroleum resource. For more than a century, mineral oils possess completely outclassed lubrications as well as these days, environmentally friendly problem begins to arise since the mineral oil and synthetic oil is not eco-friendly. Because environment issues embrace, numerous states, such as Malaysia, a number of studies have reconsidered vegetable oils to be used as the base stocks for lubricants because of their advantages such as high biodegradability and high viscosity index. The prevailing interest in eco-friendly lubricants have lead in comparisons of the chemical and physical holdings of major base stock prospects such as vegetable oils, synthetic esters, and petroleum oils.

Vegetable oils have a long history and are practiced as a basis shared with regards to lubricate through historic times. It has outstanding attributes such as a high viscosity index, high lubricity, high flash point, low evaporative loss, high bio-degradability as well as a lower grade of toxicity concerning their own work as a base oil for lubrications. (Pawlak, 2003). However, vegetable oils additionally infamous of its small thermal, oxidative, and hydrolytic stabilities and poor low-temperature characteristic. The improvement in mineral oil as well as artificial or synthetically oils in order to overcome the dilemmas make vegetable oils much less substantive. Nevertheless, in this era, peoples are more using mineral oils or synthetically oils instead of using vegetable oils. It is evident that, mineral oils plus some synthetic oils is not eco-friendly whenever subjected to the surroundings. As being known, the unsaturated fatty acids identified in common feedstock, such as corn and palm, are an excuse of this susceptibility. These unsaturated fatty acids may react with atmospheric oxygen, forming peroxides and lead in a variety of problematic degradation byproducts, including corrosive, low molecular weight acids and biopolymers. These byproducts are the main cause of sludge and lacquer in automotive injection systems and fuel system corrosion. (Quigley, 2007).

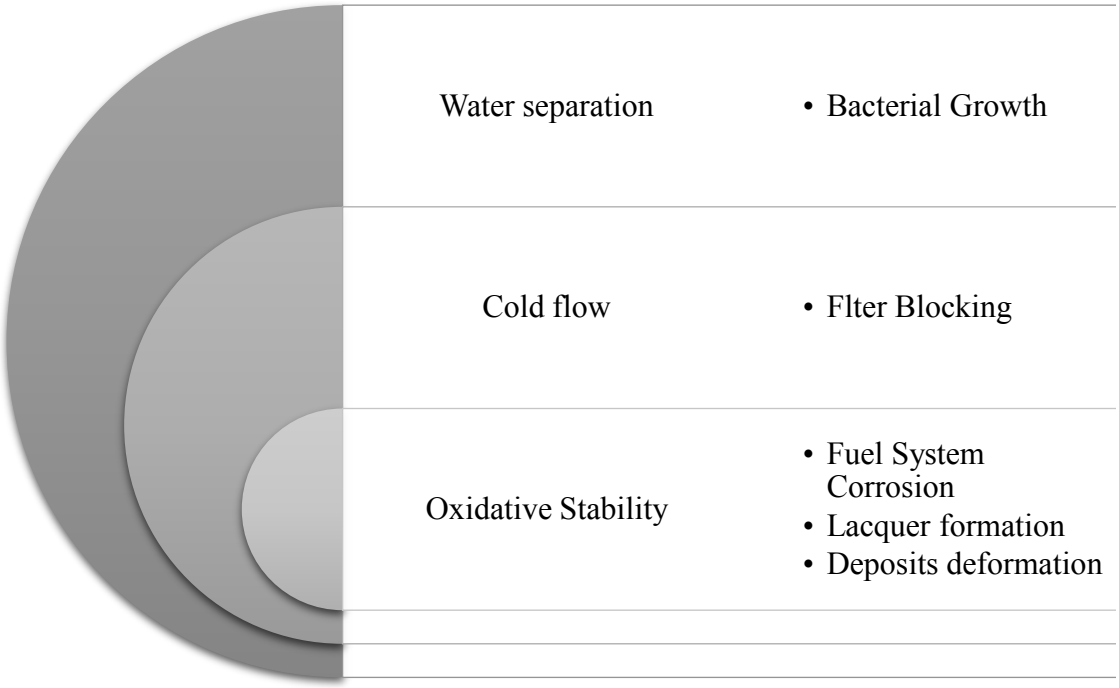

Figure 1.1: Vegetable oils performance concerns. (Quigley, 2007)

In the work executed by Dun, the typical phenolic anti-oxidants were analyzed for their particular performance in enhancing the oxidative stability of biodiesel acquired from soybean oil. Dunn supervised the oxidative stability by means of pressurized differential scanning calorimeter (P-DSC). For both static and dynamic conditions, enhancements in oxidative stability are discovered by the application of anti-oxidants, which included butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), tertiary butyl hydroquinone (TBHQ), propyl gallate (PrG) and a-tocopherol. The research of Dunn further more demonstrated that the relative efficiency of the various anti-oxidants differed for static and dynamic conditions, even though all exhibited superior performance when compared with a-tocopherol. (Dunn, 2005)

Ruger et al.seemed to be looking into the capability of numerous anti-oxidants and chelators (including TBHQ, BHT, and hydroquinone and ascorbyl palmitate) to hold up viscosity increase in soybean oil introduced about through auto-oxidation. Concentrations of 0.01 and 1.28% had been utilized, and the results again

verified the effectiveness of the provided anti-oxidants, by using TBHQ currently being the most efficient at the two temperature ranges. (Ruger, et al., 2002)

The Ferulago ungulate plant indigenous to the west of Iran also has verified antioxidant attributes. Experimental studies recorded suggest that this plants essential oil and extract begins to display preservative properties of vegetable oils at a minimum concentration of 0.02%. In point of fact, it also shows more effectiveness that TBHQ at concentrations of 0.5%. (Masumeh & Kamran, 2006).

On report published by Banu and Prasad, the effectiveness of TBHQ as an antioxidant in groundnut oil had been examined by ultrasonic studies. The final results demonstrated an enhancement in the thermal degradation and oxidation stability of the formula in comparison with the base oil, while ultrasonic research aided to assure the stability of the edible oil. Therefore, it is proposed that peanut oil with TBHQ could be used for frying without having any adverse effect and ultrasonic attributes can be used in the review of the stability of frying oil. (Banu & Prasad, 2013)

Sarin et al. applied the Oils Stability Index (OSI) technique to analysis the destabilizing impact of catalytic quantities of transition metals on palm methyl ester (PME). The sum of the antioxidants BHT, TBHQ, tert-butylated phenol derivative (TBP), and octylated butylated diphenyl amine (OBPA), improved the Oxidation Stability (OS) of metal-contaminated PME with TBHQ the most efficient. (Sarin, et al., 2010)

Mittelbach and Schober have further researched the effect of antioxidants on the oxidation stability of biodiesel and showed the influence of different synthetic and natural antioxidants on the oxidation stability using the specific test method. The induction periods of methyl esters from rapeseed oil, used frying oil and tallow were discovered to improve significantly with Pyrolysis (PY), prostaglandin (PG), and TBHQ, whereas BHT was not really effective. (Mittelbach & Schober, 2003)

Liang et al. have explained the influence of natural and synthetic antioxidants on the oxidative stability of palm diesel. Crude palm oil methyl ester made up of not less than 600 ppm of vitamin E was found to display oxidative stability of more than 6 hands, thus, adapt to the precondition of the European standard for biodiesel. While distilled palm oil methyl ester need to be treated with antioxidants in order to adapt to the standards. Synthetic antioxidants, namely BHT and TBHQ are identified to be more efficient than natural antioxidant, a-T in conditions of their performance to enhance the RIP of DPOME. (Liang, et al., 2006)

The majority of vegetables are triglyceride structural molecules along with long fatty acid chains. The fatty acid chains, which usually are non-polar, are constantly almost straight chains containing 8 to 22 carbon atoms. Unsaturation of fatty acid chains is vulnerable to the oxidation and deteriorates the overall performance of vegetable oils when exposed to an extreme condition which mean the vegetable oil posses poor thermal oxidation stability.

As stated earlier in above, the main problem is, vegetable oils have poor thermal oxidative stability. To overcome this problem, the introduction of (TBHQ) as antioxidants into palm oil can act out as a resolution to this problem. At present work concentrates on the parameters affecting the oxidative mechanism of palm oils. The parameters include, temperature, additive dosage, and introduction of additive into base oil and the interaction of these parameters.

1.4 Objectives.

The objectives of this project are:

i. To develop an alternative lubricant oil with the addition of antioxidizing agent.
ii. To test and characterize the newly prepared lubricant oil.

1.5 Scopes.

The scopes of this project are:

i. Prepared an alternative lubricant oil using palm oil with the addition of TBHQ as antioxidizing agent.
ii. Prepared the alternative lubricant oil using the direct introduction method of antioxidizing agent in the product.
iii. Test and characterize the newly developed lubricant oil using different test method.

CHAPTER 2
LITERATURE REVIEW

2.1 Lubricants.

Humankind has applied liquid lubricants for thousands of years. In the beginning, mud is used as raw lubricants to ease daily activities. . Artwork from ancient Egypt shows that the Egyptians pouring lubricant in front of a sled which is being pulled (Williams, 1994). The current history of lubricant additives started within early 20th century, along with the utilization of fatty oils plus sulfur in mineral oils to enhance lubrication within high loads. World War II has established a significant inspiration to the progression of lubricant additives since the military, engine builders, and machine manufacturers required a lot more public coming into court within their equipment (O'Brien, 1983). Afterwards, animal and vegetable oils had been applied to lubricate equipment of war such as catapults and body armor.

Current liquid lubricants are made up largely of minerals and synthetic oils together with the add-on of additives where exactly specific attributes are needed. The main aim of most lubricants would be to reduce friction as well as wear in between two surfaces in relative motion (Harnoy, 2003). Other important components include viscosity, viscosity index, oxidative stability, foam tendency, pour point and corrosion protection (Forbes, 1970). Besides the lubricant attributes pointed out previously, environmentalist worldwide has raised the requirement of lubricants which are friendlier towards the environment (Sander, 2013).

The impact of lubricant upon the environment is dependent on several lubricant attributes, which includes the level of toxicity, biodegradability and the products of biodegradation (Mansfield, 2009). Synthetic oils have already been the major lubricant implemented where the environmental problems tend to be considered (Miller, 2009). The latest research projects have reviewed the prospect of applying a vegetable oil based lubricant.

2.2 Vegetable Oils.

As environmental concerns grow, vegetable oils are developed into lubricants for industrial and transportation applications (Cheenkachorn & Udornthep, 2006). These oils offer significant environmental benefits with respect to resource renewability and biodegradability, as well as providing satisfactory performance in a wide array of applications. Synthetic ester based fluids may also provide these advantages, but their cost can be prohibitively high.

The new stocks are present for generating vegetable oil lubricants. Now, more than 125 million metric tons (MMT) of vegetable oils are generated (Sharma, et al., 2006). Hence, could possibly be more suitable to promote oilseed crops throughout substantial -value purposes for instance lubricants and industrial raw elements. Moreover, formulating vegetable oils in term of specifically high-saturated oils will certainly cause distinctive difficulties. These are simply because of its unique attribute like low temperature plus viscosities, oxidative instability, and hydrolytic instability issues when related to the triglyceride (Cheenkachorn & Udornthep, 2006).

Olive oil had been implemented as lubricant since 1650 BC (Rudnick, 2009). A mixture of oils acquired in palm, rapeseed, castor beans, olive, and the fats from the sperm whale, animal lard, and wool grease have been employed from the late of AD 50 until the early 19th Century. These sorts of organic oils experienced restricted stability. The Industrial Revolution from 18th century to the 19th century has triggered the necessity for affordable, oxidative and thermally stable lubricants.