UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE CONCEPTUAL DESIGN AND ANALYSIS OF USED LUBE OIL FILTRATION PROCESS FOR INDUSTRIAL APPLICATION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technologyn(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's in Mechanical Engineering Technology (Maintenance Technology) (Hons.). The member of the supervisory is as follow:

……

(Mr. Azrin Bin Ahmad)

ABSTRAK

Minyak pelincir biasanya digunakan sebagai fungsi untuk mengurangkan geseran , mengurangkan haus, mengurangkan suhu, mengelak daripada pencemaran dan juga mengurangkan kakisan dalam komponen enjin terutama di dalam perindustrian. Objektif projek ini adalah untuk merekacipta bentuk produk yang boleh menapis minyak pelincir yang sudah digunakan untuk aplikasi industri dan juga menganalisis minyak pelincir yang bersih selepas proses penapisan berlaku. Pada akhir projek ini, analisis minyak akan dilakukan menggunakan Berputar Cakera Optik Electrode Pelepasan spektrometri (RDE-AES) dan meter kelikatan untuk mengenal pasti kandungan dan saiz zarah kelikatan minyak pelincir digunakan selepas melalui proses pembersihan. Perisian komputer yang digunakan dalam projek ini adalah “SolidWorks”. Perisian ini digunakan untuk menghasilkan reka bentuk produk minyak pelincir bagi proses penapisan minyak sebelum proses fabrikasi berlaku. Masalah utama minyak pelincir yang digunakan adalah kerana ia mengandungi tahap yang lebih tinggi abu, sisa karbon , logam , air, dan bahan-bahan kotor yang lain , yang dihasilkan semasa pelinciran di dalam enjin . Justeru itu, dengan merekacipta bentuk penapis minyak pelincir, enjin boleh menggunakan semula minyak yang dituras tanpa sebarang pencemaran dan serpihan logam seterusnya mengurangkan kos pengendalian serta melanjutkan kitaran hidup semua komponen sistem di dalam enjin dan minyak itu sendiri.

ABSTRACT

Lube oil is normally used to reduce friction, reduce wear, reduce temperature, seal out contamination and also reduce the corrosion in engine component especially for industrial application. The objective for this project is to design a product that can filter the used lube oil for industrial application and also analyze the clean used lube oil after the filtration process take place. Oil analysis will be done using Rotating Disc Electrode Atomic Emission Spectrometry (RDE-AES) and viscometer to identify the size particle content and the viscosity of use lube oil after the filtration process takes place. SolidWorks is used to develop the desire product design for used lube oil filtration process before the fabrication process takes place. The main problem for used lube oil is it contains higher levels of ash, carbon residue, metals, water, and other dirty materials, which are produced during the course of lubrication inside the engine. So, by designing the lube oil filter, the engine can reuse the oil that filtrate without any contamination and wear metal which can also reduce the running costs by extending the life cycle of all system components inside the engine and oil itself.

DEDICATION

I will love to express my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I am really thankful for their sacrifice, patience, and understanding that were inevitable to make this work possible. Their sacrifice had inspired me from the day I learned how to read and write until what I have become now. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams. Lastly, I would like to thanks any person which contributes to my final year project directly or indirectly. I would be grateful for their comments and suggestions, which was crucial for the successful completion of this final year project.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

RDE-AES	-	Rotating Disc Electrodes Atomic Emission Spectrometry
CAD	-	Computer-Aided Design
HOQ	-	House Of Quality
QFD	-	Quality Function Development
Ag	-	Silver
Al	-	Aluminium
B	-	Boron
Ba	-	Barium
Ca	-	Calcium
Cd	-	Cadmiun
Cr	-	Cromium
Cu	-	Copper
Fe	-	Iron
K	-	Potassium
Li	-	Lithium
Mg	-	Magnesium
Mn	-	Manganese
Mo	-	Molybdenum
Na	-	Sodium
Ni	-	Nickel
P	-	Phosphorus
Pb	-	Lead
Sb	-	Antimony
Si	-	Silicon
Sn	-	Tin
Ti	-	Titanium
V	-	Vanadium
Zn	-	Zinc

H	-	Hydrogen
C	-	Carbon
PPM	-	Part Per Million
cSt	-	Centistokes

CHAPTER 1
INTRODUCTION

1.1 Background

Lubrication is the one that used to develop smoothness in the movement of one surface over another. Therefore, lubricants are generally liquids or semi-liquids, but it could be solids or gases or any combination of solids, liquids, and gases.

Smoothness in the movement is improved by reducing friction. However, there can be circumstances in which, it is more vital to remain in steady friction than to get the lowest possible friction. In addition to reduced or controlled friction, lubricants are usually anticipated to reduce wear and often to keep away from overheating and corrosion.

The main objective for lubricant is for reducing friction, but there are a lot of other advantages of using this process. Lubricating films can also help to avoid corrosion by protecting the surface from water and other corrosive substances. Besides that, lubricant also plays an important role in controlling contamination within systems. The lubricant works as a medium in which it delivers contaminants to be removed away from systems.

The most important factors for the efficient operation of an internal combustion engine is by maintaining proper lubrication. Oil is used as a lubricant to lower down the power needed to reduce friction and wear between rubbing and bearing surfaces. The lubrication system of an engine is intended to prevent the increase of wear, overheating and seizure of rubbing surfaces. All these help to decrease the spending of indicated power on overcoming mechanical losses in the

engine and also to remove a machine's wear product (Ogbeide, 2010). To prevent corrosion and increase machine efficiency, the mechanical parts that continually move against each other need to be lubricated. Lube oil is the most common lubricant use today due to its wide range of application. Different types of lube oils are created for as many purposes. Lube oils generally contain 90 percent base oil and 10 percent additives. These are categorized depending on it viscosity and end use.

Furthermore, oil use in automotive and machinery of industrial application produce by-product which is known as used lube oils. Lubricating oils must be changed frequently due to contamination from dirt, water, salts, metals, the incomplete products of combustion, antifreeze, or other materials. During the use of lubricant oil inside the engine which are in operation, the used lube oil is usually consists of more values ash, carbon residue, metals, water, and other dirty materials. So, the primary element that affects the service life of oil system components is oil cleanliness (Abercrombie & Weinberg, 2002).

As motor oil is used in automobile engines, it picks up iron, steel, copper, lead, zinc, barium, cadmium, sulfur, water, dirt, and ash as additional components from engine wear. For the reasons that, used lube oil disposal can be more harmful to the environment than crude oil pollution. In addition, it may cause both short-term and long-term effects if they are allowed to enter the environment through our waterways or soil.

Once the new lubricant is replaced, used oil becomes a major management challenge. Without access to suitable recycling selections, used lube oil tends to be disposed in a ways that can harm the environment especially the river. If not disposed properly, the waste used lube oil that consists of various substances can enter the food chain through a natural cycle which is via water (Durrani, et al., 2010).

Without lubricating oil, the engine would radically shorten or rapidly stop working. Thus, it is called the 'life blood' of an engine. Lube filters eliminate impurities and the wear-causing contaminants from the engine's oil, rather like kidneys purify the blood. Moreover, lube oil not only allows the internal component of an engine to move by keeping the various parts separate from each other, it also carries out a number of other very important tasks which is removing heat, and cleaning internal surfaces.

So, by designing the lube oil filter, the engine can reuse the oil that has been filtrate, without any contamination and also reduce running costs by extending the lifecycle of all system components and oil itself.

1.2 Problem Statement

Decreasing of oil reserve and the increasing of demand contribute to increase in petroleum price each year. Because of the increasing of raw material price, thus, we need to find the solution to produce the recycle used lube oil to cut down running costs of the engine.

Used lube oil (engine oil) or transmission oil contains metallic particulates that can damage the component in the engine as a consequence of the breakdown of oil-wetted surfaces due to ineffective lubrication, mechanical working, abrasion erosion and corrosion. The concentration in the oil increases as the metallic particles from deteriorating component surfaces are hard and higher in the wear rate (Hamawand, et al., 2013).

Lubricant oil has a number of characteristics which contribute to its long life spent inside the machine. However, after certain years, the lubricant oil will lose it characteristic and become vulnerable. This is because the contaminant or metal waste traps inside the lubricant oil. As the lube oil becomes harder, it will reduce the performance of the machine and need to be replaced immediately.

Misconduct of waste lubricant oil is a serious environmental problem. Almost all types of waste oil can be recycled safely, saving a precious non-renewable source and at the same time lessen the environmental pollution. Unfortunately, most of used oil is handled wrongly such as some of it is emptied into sewers and going directly into water waste, which adversely affecting water treatment plants. Moreover, the waste oils are dumped directly onto the dirt roads, deserts or the ground to kill weeds, where it can lead to surface and ground water contamination. Reused lubricants get more attention than before. Used lube oil that contains of contaminated with impurities in the course of usage and handling which are hazardous and effect to the soil and surrounding environment (Udonne & Onwuma, 2013).

1.3 Objective

Based on the background and problem statement stated above, the objectives of this study are stated below:

1. To design a product that can be used for filtration process of used lube oil for industrial application.
2. To analyze the used lube oil after the filtration process.

1.4 Scope

In order to achieve the objective of the research study, several scopes have been identified:

1. Design filtration product for used lube oil using SolidWork software.
2. Determine properties and characteristics of lube oil that suite for industrial application used.
3. Make oil analysis method using Rotating Disc Electrode Atomic Emission Spectrometry (RDE-AES) after the filtration process takes place.

CHAPTER 2
LITERATURE REVIEW

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2.1 Lubrication

Lubrication is an oil-based element that used to decrease the resistance of friction and making motion easier. The purpose of lubricant in mechanical operations is to lower down the operating temperatures, minimize corrosion of metal surfaces, reduce wear on component and protect against contamination. In engine system, lubricants play an important role to extend the service life of component inside it. Without oil, the component inside the engine will give effect to overheating and seizing very fast. Therefore, the lubricant is needed in the engine to reduce this problem with proper monitor and maintenance. The primary function of lubrication oil condition monitoring and degradation detection is to find out whether the oils have deteriorated to such a point that they no longer fulfill their roles (Zhu, et al., 2013).

2.2 Purpose of Lubrication Oil

Lubricants are elements that introduced between two surfaces in relative movement to minimize rubbing. The principal functions of lubricants are to reduce friction, reduce wear, reduce temperature (coolant), seal out contamination, minimize corrosion and reduce energy.

2.2.1 Reduce Friction And Wear

A lubricant is used to reduce friction by preventing direct contact of two rubbing surfaces by supplying some fluid or semi-fluid substances between them and also replacing solid friction with fluid friction. In addition, there are components which move very closely against each other, causing friction inside the engine that can wastes the useful power by converting energy to heat. These will make the contact between moving surfaces to wear out on that part, which could contribute to lower efficiency and degradation of the machine or equipment. Therefore, lubrication needs to provide a stable film that moves between metal surfaces relative to each other with high relative velocities under high loads and temperatures (Linke-Diesinger & Andreas, 2008). In order to get an increasing power output and engine service life, the friction of rubbing and the bearing surface need to reduce together with the reduction of wear (Gupta, 2013). Figure 2.1 shows an actual magnified surface, this machined surface has been magnified 2600 times.

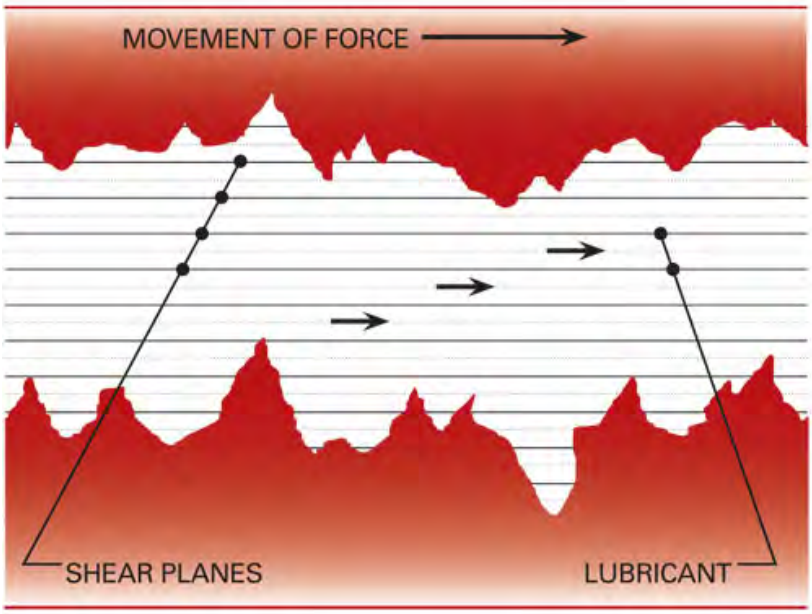

Figure 2.1: Lubrication Separates Moving Parts (Bannister, 2007)

2.2.2 Reduce Temperature

Temperature is the most important element in figuring out the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have good thermal stability at high temperatures, thus preventing formation of harmful carbonaceous and/or ash deposits. The friction creates heat, so for a lubricant to be successful, it demands to keep its lubricity even when in high temperature. If a lubricant lacks thermal stability, then it begins to break down, which leads to increased friction. The changes of temperature depend on viscosity of oil. Besides, heat reduction has provided an extra effect of lubricating oil. By decreasing friction, lubricating oil will eventually decrease the temperature that caused by friction. So, with enough lubricating oil in the engine at moving surface, it can help to extend the lifetime of each component. The frictional heat makes the temperature at contact spots to increase continuously which give effect on lubricant oil film (Nasiri-Khuzani, et al., 2012). When lubricating oils are used in service, they serve to protect rubbing surfaces and promote easier motion of the connected components. In the process, lubricant oil serves as a medium to get rid of high build up of temperature of moving surfaces (Udonne, 2011).

2.2.3 Seal Out Contamination

Lubricating oils can also act as a seal, which keep out contaminants from engine system. But in regular operation conditions, lubricants such as motor oil can be disrupted by heat and contaminants that provide combustion products such as water, acids, carbon, and unburned fuel. The lubricant inside open bearing and between gears can be contaminated with dust and dirt, which wears away the contacting surfaces that mix with the oil or grease to form a rough paste. Contamination degrade the performance of engine lubricants that can affect engine components, thus these extant of degradation depends on the severity of engine conditions and duration of machine usage. (Tippayawong & Sooksarn, 2014).

2.2.4 Minimize Corrosion

When certain metal come together with oxygen, it can form oxidation. In other words, oxidation of metal surfaces is known as rust, which can cause glossy metals to lose their properties. There are reaction between iron and steel contact involve, if both metals are exposed to moisture and oxygen which it can form an oxide. Thus, this will lead to pitting as the oxide does not firmly hold to the surface of the metal and will cause it to wear off. If this condition go continuously it will eventually result in weakness and degradation of the metal, leading it to disintegrate. Other than that, water and other polar compounds will drastically enhance the speed of corrosion processes. There are many conditions that need water to be filled into the engine such as it is present in fuel, in the products of its combustion and is condensed during temperature difference at the stop. Fuel and soot that unburned can mix together with water to form sludge and varnish that will lodges on critical engine parts. Sludge that was buildup might clog oil passages, which decrease the oil flow. While, the proper clearances of the engine will be interfered with the present of vanished buildup that eventually lead to restricts oil flow and causes vital engine parts to attach and cause it to breakdown. The ability of oil to reduce the effects of these corrosive substances will increase the life span of an engine.

2.2.5 Energy Reduction

In order for the component within the engine to move one over another, it required energy. The energy that produces is mainly by any resistance of motion through friction between two surface contacts. Increased friction in a piece of moving equipment consequence causes elevated operating temperature. Friction is due to the contact between metals that move in opposite surfaces relative to each other. The amount of friction increase as there are increases in the amount of contact. As a result, more energy is needed to move the surfaces relative to one another which will lead to higher electrical power costs. These frictions can reduce by using lubricants. Therefore, electricity that is required to drive component inside the engine can be reduces.