UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON EXTREME PRESSURE (EP) PROPERTIES OF SN0W20 GRADE ENGINE OIL WITH DIFFERENT TYPE OF NANOPARTICLES

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

by

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This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Pada masa kini, nanopartikel memainkan peranan penting dalam mengurangkan haus enjin dengan menggunakan pelincir tambahan. HBN (Hexagonal Boron Nitrat) dan ZrO_2 (Zirconia Oxide) telah digunakan sebagai bahan tambahan dalam kajian ini. Tujuan kajian ini adalah menumpukan kepada penyiasatan mekanisme kehausan dan geseran pada galas bebola yang diuji dengan menghasil sampel yang terdiri daripada minyak enjin SN0W20 dirawat / penyaring dengan komposisi nanopartikel mengikut tekanan yang melampau. Mengurangkan prestasi enjin disebabkan oleh kehadiran sisa kotoran di bahagian enjin seperti aci engkol, rod penyambung dan galas membawa kepada membazirkan banyak tenaga. Oleh kerana sisa ini, banyak kajian telah dilakukan untuk mengatasi masalah ini dengan meningkatkan pelincir. Ujian dijalankan pada tekanan ekstrem untuk galas bola yang dilincirkan oleh sampel dan ujian mengikut Kaedah Ujian Kaedah Kaedah Standard ASTM D2783 untuk Pengukuran Tekanan Bendalir Fluida (Four Ball Method) untuk pelincir. Keputusan mekanisme haus telah dibandingkan berdasarkan jenis nanopartikel aditif yang digunakan dalam sampel yang berlaku dalam bebola gulung diselidiki. Di samping itu, mekanisme haus pada galas bebola telah disiasat menggunakan mikroskop atau mikroskop elektron imbasan (SEM). Keputusan menunjukkan bahawa dengan penambahan nitrat boron heksagon, oksida aluminium oksida oksida dan nanopartikel oksida zirkonia pada SN0W20 dapat meningkatkan kapasiti beban minyak pelincir. Oleh itu, minyak- nano dapat memberikan prestasi yang lebih baik terutama ketika berada di bawah tekanan yang melampau.

ABSTRACT

Nowadays, nanoparticles play an important role in reducing engine wear by using additional lubricants. HBN (Hexagonal Boron Nitrate) and ZrO_2 (Zirconia Oxide) have been used as an additive in this study. The aims of this study are focuses on the investigation of wear and friction mechanisms on ball bearings tested by develop samples consist of treated / filter SN0W20 engine oil with composition of nanoparticle according to extreme pressure. Decreasing engine performance due to the presence of garments in engine parts such as crankshaft, connecting rod and bearing lead to waste a lot of energy. Due to this waste, a lot of study was conducted to overcome this issue by improving lubricant. The tests are carried out at extreme pressure for ball bearings lubricated by samples and tests according to the ASTM D2783 Standard Method Test Method for Measurement of Fluid Pressure (Four Ball Method) for lubricants. The wear mechanism result was compared based on the type of additive nanoparticles used in samples that occur in the ball bearings investigated. Additionally, the wear mechanisms on the ball bearings was investigated using a microscope or scanning electron microscope (SEM). The results show that with the addition of hexagonal boron nitrate, aluminum oxide oxide and zirconia oxide nanoparticles at SN0W20 could increased the capacity of lubricating oil loads. Therefore, nano-oil can provide better performance especially when under extreme pressure.

DEDICATION

To my beloved parents, Mr Abdul Aziz Bin Mohd Yusof and
Mrs Salmah Binti Mokhtar and siblings

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LIST OF ABBREVIATIONS,

API	American Petroleum Institute
ASTM	American Society for Testing and Material
AW	Anti Wear
COF	Coefficient of Friction
P	Extreme Pressure
IL	Ionic Liquid
ISL	Initial Seizure Load
ISO	International Standardization Organization
OA	Oleic Acid
PAO	Polyalphaolefins
SEM	Scanning Electron Microscope
WP	Wear Preventive
WSD	Wear Scar Diameter
RPM	Rotation Per Minute

CHAPTER 1

INTRODUCTION

1.0 Introduction

Tribology is a engineering and science that related to all the motion between a two surface. Tribology is a word derived from a Geek word tribos which is mean by ‘rubbing’. It is covers all about the emerging science of friction, wear and lubrication involved in a moving contact of surface. In today scope of tribology, it involves in all mechanical, chemical and also material technology. According to Bart (2013), facilitate the relative motion of solid bodies, lubricating substance was used as substance to reduce friction and wear between interacting surfaces. The purposes of lubricant to minimize a friction and wear to sustain energy, set up faster and improve precise motion, boost productivity and the most important thing is it can reduce a maintenance problem.

According to Khonsari et al. (2017) which is again stresses the importance of frictional coefficients, which are free from clear contact areas. Friction and wear reduction mechanism with soft coating and coating of molecular lubricating surface were clarify by many of physicist. According to Patil (2014) more complicated machines have a more stringent lubrication requirement that is meaningful by machine components and coupled mechanisms relying on high quality lubricants to enable high temperatures and extreme pressure (EP). Extreme pressure and antiwear (AW) added substances are commonly embraced to enhance the tribological performance of a lubricant in decreasing friction and surface harm under serious conditions.

According to N. Talib (2016) the use of bio-based oils for planned lubrication has been practiced in many functions such as engine oil, hydraulic fluid, two stroke oil, grease and metallic work. It is noted that only 0.1 p.c was used from vegetable oils. Vegetable oils are divided into two which are fit to be eaten and non-edible types. Examples of vegetable cooking oils are rapeseed, sunflower, soybean and palm oil have been used in various machining processes. In addition, due to multiplied demand for the meals industry, safe to eat vegetable oils such as jatropha, castor and neem oil have been used as bio-based lubricants.

In a recent year, nanoparticle have bring to great interest in tribological field because of their good physical and chemical properties. There are many sources that study about nanoparticle as an additives in lubrication. According to Wu (2016) research the tribology properties of API-SF engine oil lubricants and base oils with CuO, TiO2 and nano-diamond nanoparticles used as an additive. CuO provides a precise friction reduction popular oil and anti-wear property. The addition of CuO nanoparticles in API-SF engine oil & base oil reduced the friction coefficient of 18.4 and 5.8% respectively, and reduced through 16.7 and 78.8% respectively in contrast with popular oil except CuO nanoparticles. This anti-wear mechanism is due to the deposition of CuO nano particles on the surface used, which can minimize the shear stress, thereby enhancing the tribological properties.

1.1 Problem Statement

The lubricant is a working material between two transferring surfaces to limit friction and wear, distribute heat, do away with contaminants, and enhance efficiency. The significance of lubricants and non-stop lubrication systems can now not be fully liked to apprehend the effect of not the usage of excellent lubricants or lubricants altogether. According to Straffelini (2015) wear can cause direct failure, may reduce surface finish and tolerance, or cause surface damage responsible for subsequent component failures. Thus, there is a number of failures occurs in mechanical machine elements due to lack use of lubricant. So for these failures causes reliability and operating cost of plant or machine.

According to Laad (2016) different mechanical systems need a variety of functional lubricants significantly to moderate the total energy disbursed by mechanical systems and also to reduction the friction and wear of contacting surfaces as well as. Theoretically, wear of machine component parts should not occur if their surfaces are separated with the aid of a lubricant film. The lubrication mechanism is that a self-laminating protective film is fashioned on the friction surface and the wear behavior modifications from sliding friction to rolling friction.

Nanofluid has been an active research area for nearly twenty years due to better thermal conductivity compared to base fluid, however nanofluid research for tribological purposes has been slow, with problems encountered in the dispersal and preserving nanoparticles in lubricants (Gara, 2012). Furthermore, the addition of nanoparticle in oil as additives can improve the reduction in friction and wear. Hence, the hexagonal boron nitrate (hBN) and aluminium oxide (Al_2O_3) are to be use as a new nanoparticle additive in oil to ensure all of this problem can be reduced.

1.3 Objective

Based on the problem statement are discussed above, the objectives of this study are listed below:

1. To determine suitable type of nanoparticle to be added in SN0W20 as an additive.
2. To test the develop sample according to the extreme pressure testing
3. To investigate the wear type and mechanism that lead to bearing failure

1.4 Scope of work

In order to achieve the objective, the scopes of the research are:

1. Determine suitable type of nanoparticle to be added in SN0W20 as an additive.
2. Testing the develop sample according to the extreme pressure testing by using ASTM D2783-Standard Test Method for Measurement of Extreme-Pressure properties of Lubricating Fluid (Four-Ball Method).
3. Investigating the wear type and mechanism that lead to bearing failure using Scanning Microscope Electron (SEM).

CHAPTER 2

LITERATURE REVIEW

2.1 Function of Lubricant

Lubricants is a substance delivered to minimize friction between two or extra mutual contact surface, which final purpose to limit the warmness generated when the floor move. It also have the ability of transmitting forces, transporting overseas particle, heating or cooling the surfaces. This proper is known as lubricity. Lubricant with additives have better tribological properties such as increase resistance to friction, better anti wear characteristics, improved load carrying capacity and the ability to absorb heat better (Prabu, 2016). The stability of nanofluids is essential to give a better performance in their application. Thus, the surfactant is a better mechanism to stabilize the nanofluids. This formula is crucial in developing a new lubricant.

According to Gunda (2016) solid lubricant additives have showed better tribological performance in terms of reducing friction and sliding zone temperature without contaminated the environment. In addition, the main use of lubricant to is to reduce friction and lubricant to surface structure is more less friction compare to the surface to surface contact friction without any lubricant being applied. In some lubricants may contain additives known as fused friction modifiers with metal surfaces to reduce surface friction although there is a lack of most lubricants present in hydrodynamic lubrication

Lubricants can also be differentiate between pollutants and wear debris. According Mortier (1992) many lubricating properties are improved or created by the addition of special chemical additive to liquid foundation. Additives of lubricant continue to develop to provide improved properties and performance to a modern lubricant. Today, better lubricants are needed for more complex machine.

2.1.1 Mineral Oil

Mineral oil is widely used in the industry for fluid lubrication and grease lubrication. Mineral oil usually made from oil come by petroleum- based fluids and utilized for machinery. Mineral oil normally utilized in turbines, engine s, gears, and bearings. Furthermore, it is low cost, easy and can be found in many different types of viscosity. The characteristic of viscosity mineral oil hydrocarbons are mainly determined by the molecular weight, molecular length and branching molecules. According to Lugt (2013) mineral oils produce a good fluid film lubrication properties because of the mineral oils stay in liquid shape over an extensive range of temperature and pressure. Mineral oil is hydrolytically stable and indicated better oxidation stability at the temperature under 100 ºC. Besides that, mineral oils also compatible with a variety of additional system and grease thickeners.

The mineral lubricant obtained from crude oil through refine ring process. Usually 10% additives use in mineral lubricants. According to Stachowiak (1993) the first type of mineral oil are paraffinic oils. Mineral oil can be divided into three types which are