TRIBOLOGICAL PERFORMANCE OF GREASE WITH DIFFERENT TYPES OF ADDITIVES

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A report submitted

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DECLARATION

I Nur Aqila Syamimi Binti Amir Hamzah declares this project report entitled "Tribological Performance of Grease with Different Type of Additives" under the guidance of Dr. Mohd Rody Bin Mohamad Zin, is my original work except references material.

Signature	:	____________________________________
Name	:	Nur Aqila Syamimi Binti Amir Hamzah
Date	:	____________________________________

APPROVAL

I here with declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature	:	____
Supervisors Name	:	Dr. Mohd Rody Bin Mohamad Zin
Date	:	____

DEDICATION

I dedicated my study to my beloved parent who always gives motivation and encouragement to finish my study. Not to be forgotten to all my siblings who always cheer me up and encourage me to work hard in completing this study. Apart from that, to all my peers who always be with me through thick and thin. Finally, I would like to express my sincere gratitude to my supervisor Dr. Rody Bin Mohamad Zin for his time, guidance, and patience to finish the work and those who always help me to the ends.

ABSTRACT

The tribological properties and lubrication mechanisms of oil need extensive performance on a textured surface. Despite this, the lubrication of grease on textures surfaces is considered as new. This report will present an experimental study of grease in frictional behaviors with lubricated sliding contact under mixed conditions. The experiment is conducted by using a 4-ball tester machine with ASTM D2266 with influences surface texture parameters on frictional properties. The results give the friction coefficient is mostly reliant on texture parameters and density. The test is conducted with greases formulation of the different additives. The aim is to suppress the best friction properties in all experimental conditions which can accumulate more grease and trap wear debris. The reduction friction is attributable to the formation of a stable grease lubrication film composed of the oil film and the hydrodynamic pressure effect of the surface texture. This property demand to increase the mating gap and reduces the probability of asperity contact. This result will help in understanding the tribological behavior of grease on a textured surface and predict the lubrication conditions of sliding bearings for superior operation in machinery.

ABSTRAK

Sifat tribologi dan mekanisme pelinciran minyak memerlukan prestasi yang luas pada permukaan bertekstur. Walau bagaimanapun, penggunaan pelinciran minyak pada permukaan tekstur dianggap baru. Laporan ini akan menyajikan kajian eksperimental minyak dalam tingkah laku geseran dengan sentuhan gelongsor yang dilincirkan dalam keadaan bercampur. Eksperimen dijalankan dengan menggunakan mesin penguji 4-bola dengan ASTM D2266 dengan mempengaruhi parameter tekstur permukaan pada sifat geseran. Hasil kajian menunjukkan bahawa pekali geseran kebanyakannya bergantung pada parameter dan ketumpatan tekstur yang menghasilkan pekali geseran. Ujian dilakukan dengan minyak dari pelbagai bahan tambahan dari formulasi. Tujuannya adalah untuk menekan sifat geseran terbaik dalam semua keadaan eksperimen yang dapat menyimpan lebih banyak serpihan gris dan perangkap. Geseran pengurangan disebabkan oleh pembentukan filem pelinciran gris stabil yang terdiri daripada filem minyak dan kesan tekanan hidrodinamik tekstur permukaan. Permintaan harta tanah ini untuk meningkatkan jurang kawin dan mengurangkan kebarangkalian hubungan asperiti. Hasil ini akan membantu memahami perilaku tribologi minyak pada permukaan bertekstur dan meramalkan keadaan pelinciran galas gelongsor untuk operasi yang lebih baik dalam mesin.

ACKNOWLEDGEMENT

All Praise to ALLAH S.W.T the Almighty for the blessing, strength, and endurance in completing the study. I would like to take this opportunity to express gratitude to my supervisor Dr. Mohd Rody Bin Mohamad Zin from the Faculty of Mechanical Engineering Universiti Teknikal Malaysia Melaka (UTeM) been able to supervise, support, and encouragement throughout the final year project. I also want to thank the postgraduate students of the Faculty of Mechanical Engineering laboratory who always support and give good advice on running this project. Besides, I would like to express my appreciation to all technicians of the Faculty of Mechanical Engineering for their knowledge and assist me to use the equipment in the correct way. Finally, I could not have finished this study without full support from my family especially to my parents, siblings, and peer in completing this degree.

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LIST OF ABBREVIATION

EP	-	Extreme Pressure
R & D	-	Research and Development
WSD	-	Wear-Scar Diameter
MoS2	-	Molybdenum
SEM	-	Scanning Electron Microscopy
LCG	-	Lithium Complex Grease
EHL	-	Elasto Hydrodynamic Lubrication
K	-	Potassium
SH	-	Thiol group
ZDDP	-	Zinc dialkyldithiophosphate
PTFE	-	Polytetrafluoroethylene
MoS2	-	Molybdenum di sulfide

LIST OF SYSMBOLS

λ	-	Film thickness ratio
h	-	The film thickness
σ	-	Root mean square (rms)
Ra	-	Average surface roughness
μm	-	Micrometer
T	-	Frictional torque (kg-mm)
μ	-	Coefficient of friction
W	-	Applied load (N)
V	-	Wear volume in, mm^3
H	-	Height of wear scar in, mm
R	-	Radius of the ball in, mm
A	-	Radius of the wear scar, mm.
k	-	Specific wear rate, mm^3/s
t	-	Sliding time, s
r	-	Distance from the center of the contact surface on the lower balls to the axis of rotation.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Tribology is known as the science and engineering of interacting surfaces in relative motion and the principles of friction, lubrication, and wear. Lubrication is a constituent of tribology in reducing frictional resistance of surface having relative motion under load. Due to the crease of friction, it has been established that surfaces of the bodies are never perfectly smooth.

The lubricating oils are selected considering the various operations conditions like rising of temperature, normal working temperature, working load, and extreme pressure conditions. The industrial revolution using special-purpose oils and greases to lubricate machine components being operated in the environments. There are various types of lubricants which include oil-based, solid, and semi-solid lubricants. Greases are one of the lubricants that commonly used with respect to the chemical mixture and digitization operates under elevated temperatures, higher loads, and long-life service.

The grease is divided into three board categories which are performance additives, inhibitors & stabilizers, and detergents. The performance additives are dispersed in thickeners which make the grease semi-solid that serve as traps for pockets oil constantly released when interacting surface demands. There are several common types of thickener used which are simple soaps, complex soaps, and non-soap thickeners. Lithium-based simple soaps or Li-complex soaps are commonly used while the Sulphur based additives used to enhance wear performance of greases. The Sulphur contains EP additives react with the metal surface to form a conciliatory tribofilm that protects the underlying metal dorm further wear.

The experiment using the parameter of wear scar diameter and friction coefficient. The principal function of lubricants is to control friction, and wear temperature. The standardized method determines the wear of contact and the pressure that leads to lubrication failure. Therefore, the pressure (EP) and anti-wear (AW) additives are used to improve friction and wear behaviors.

The standard schedule presents the conditions and the procedure of the test and the equipment. In the research, it is compared related to the use of the four-ball machine, using American (ASTM D 2266). Metallic dialkyl dithiocarbamates of zinc, lead, and molybdenum are most used as the additive to provide anti-wear protection and inhibit the oxidation of lubricants. The effect of an additive depends on its chemical nature and concentration in the formulation. The aim of the experiment is to determine the influence of wear and weld of greases with different additives by using the four-ball tester as shown in Fig 1.1. The material of the test balls is 100Cr6 steel with a hardness of 24-62 HRC.

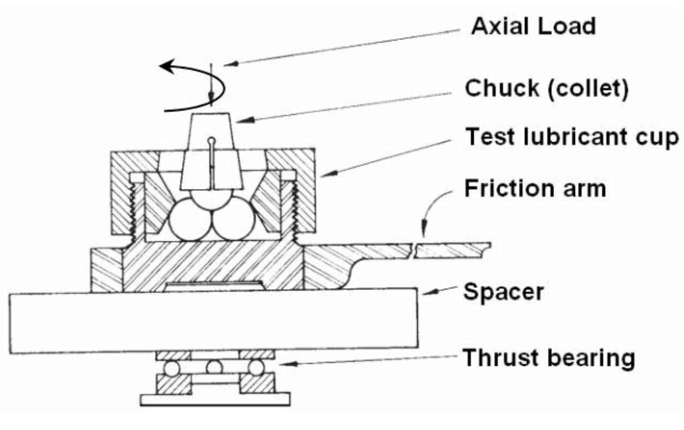

Figure 1.1 Schematic diagram of the 4-ball tester machine

1.2 Problem Statement

The important parameter for the application is Load Carrying Capacity of extreme pressure (EP). The viscosity gives anti-wear benefits to lubricants by the wear scar diameter. The increase of viscosity is varying by the percentage of additives. The study of the anti-wear additive has been found through the experimental condition to show the anti-wear properties of lubricants. In the experimental, the four-ball testing machines are used with the same parameters but different types of formulation additives.

This study, the additives are known to increase the performance of greases as well as to reduce the capacity of lubricant consumption. Moreover, the power loss can be control by reducing friction lubricants containing oil soluble. From the research, it is stated that the molybdenum present as the additive to the grease forms a low-friction surface film during the operation of a machine under high loads. The main objective of this report is to observe and search the best additives selected to improve the performance of greases formulation.

The tribology related failures compose in mechanical systems about 30 percent failure. The problem needs to be minimized by the best selection of grease formulation for wear and friction consideration. In general, additive use for the contamination control which prevents contact surface that leads to damage to the metal machine surface.

Therefore, greases with the best formulation will reduced friction, heat, and wear behavior. Moreover, the great formulation of grease helps to maximize the machinery's life. Eventually, it saves money, time, and energy to the production industry for efficient and reliable operation.

1.3 Objective

The objective of this project is:

i. To investigate the tribological performance of grease with different type of additive.

1.4 Research Scope

To achieve the objective of this study, there are important tasks that need to be considered. There are important scopes need to be identified to complete this research. In this study, the MNR oil is used in formulating multipurpose grease. In this study, by using the MNR oil formulating grease which is a heavy-duty grease from the recycling base oil. Moreover, this formulated grease is providing high performance at low cost, environmentally friendly, and safe. In addition, in this research, the additive will be added to give an extra special property in the greases. Each additive gives a different property for example anti-wear, anti-corrosion, antioxidant and extreme pressure, and solid lubricant. In this research, the analysis would be done using the 4-ball testing machine with standard ASTM D2266.

1.5 General Methodology

In this section will describe the progress of the project to achieve the objective by using the analysis and data gained. The methodology of the project is summarizing in the flowchart in Figure 1.2 below.

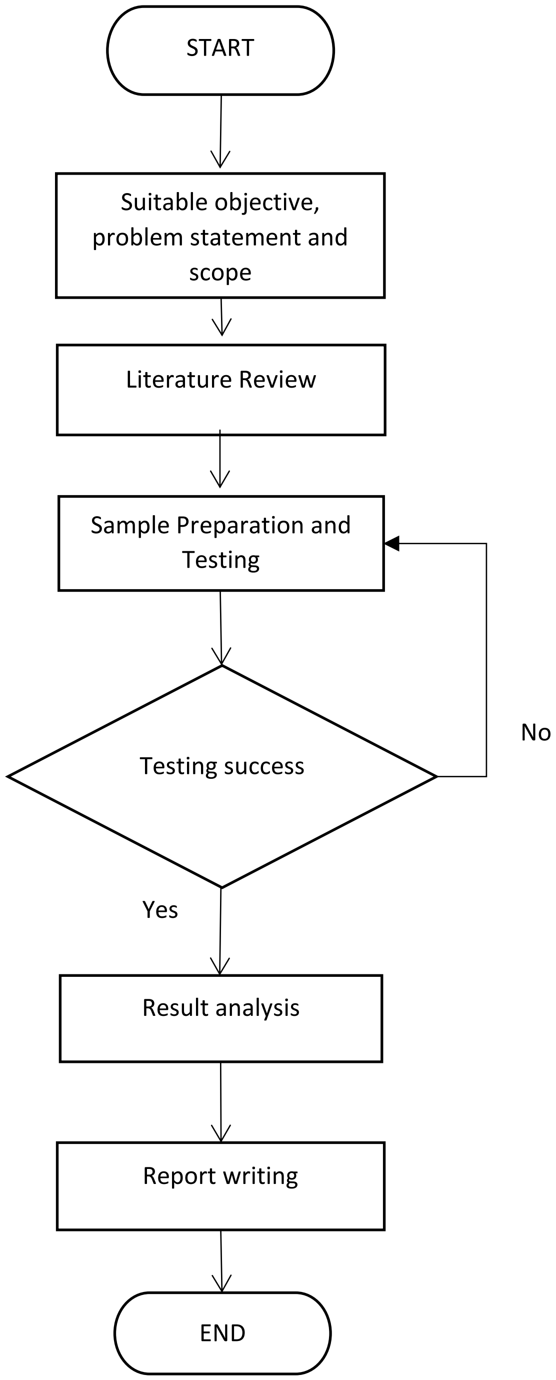

Figure 1.2: Flow chart of the project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the information related to the study is obtained by the previous research and sources from journals, articles, reports, websites, and books. The focus of this chapter is to act as a guideline from previous knowledge and ideas to run the project. The objective achieves by acquiring the tribological studies which more on the lubricant of the component.

This chapter is organized with the following order which in Section 2.2 will describes more on the tribology studies following the 2.3 Lubricant understanding, 2.4 on greases knowledge, and all parameters of the experiment.

2.2 Tribological Study

In 1966 the UK Department of Education and Science articulates the concept of tribology which encloses the integrative science and technology of surfaces interact in relative motion correlated subjects and practices. Tribology is the Science & Technology of surface contact between surfaces moving connected. Tribology is influential to reduce the frictional resistance of surface with the relative motion under a certain load. Moreover, the concept includes the hydrodynamic, hydrostatic and Elasto Hydrodynamic Lubrication (EHL) exploiting as a lubricant (Dongare, Pr. Dofr. A. D., 2014)

2.2.1 Automotive tribology

The most important component in the motor vehicle is the reciprocating internal combustion engine as shown in Fig.2.1. It also can be found in any transportation including the ground and sea which are motorcycles, scooters, mopeds, vans, trucks, buses, agricultural vehicles, construction vehicles, trains, boats, and ships. The deficiency of reciprocating internal combustion is it has a low thermal and mechanical efficiencies which cause the energy fuel dissipated as heat loss and friction. The internal combustion engine also acts as a contributor to atmospheric pollution which causes the greenhouse effect via carbon dioxide, hydrocarbon, and particulate NOx. (S.C. Tung et al., 2004)

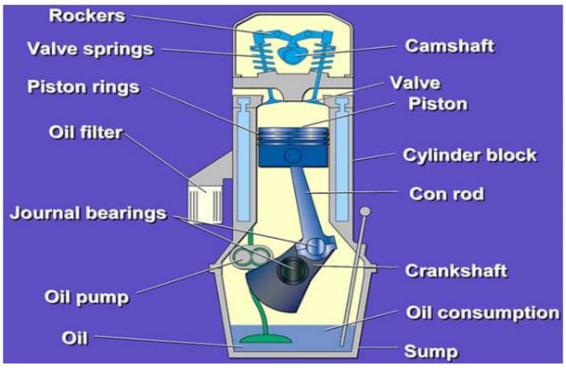

Fig. 2.1: Main components in an internal combustion engine

2.2.2 Importance of engine tribology

Effective lubrication of all movement component can be achieved by the engine tribology. The adverse impact on the environment can be minimized by reducing friction and wear. The task has a wide range of operations which involves the speed, load, and temperature in the engine. There are several methods to improve the tribological performance of the engines which are by reducing fuel consumption, increasing the engine power output, reducing the oil consumption, reduce the harmful exhaust emissions, Improved durability, reliability, reduced maintenance. Fig. 2.2 shown that only 12% of energy in the fuel available for a drive wheel, 15% dissipated as mechanical due to frictional losses.

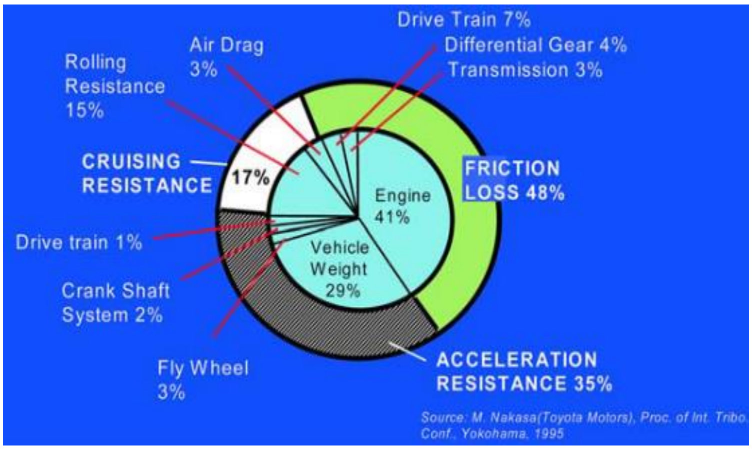

Figure 2.2: Energy consumption developed in an engine

From the combustion the energy is distributed in an engine and a powertrain system. Apart from that, the friction loss shown as the major portion which is 48% of energy consumption developed in an engine. The portion of 35% stands for acceleration resistance and 17% for the cruising resistance. For the Fiq.2.3 shows that engine friction loss of bearings, piston rings, and piston skirt friction. Approximately the total friction loss of the valve train, crankshaft, transmission, and gears are 66% while the remaining (34%). The frictional losses arising from the rotating bearing followed by the valve train and the auxiliaries. (M.L. McMillan et al, 2004)

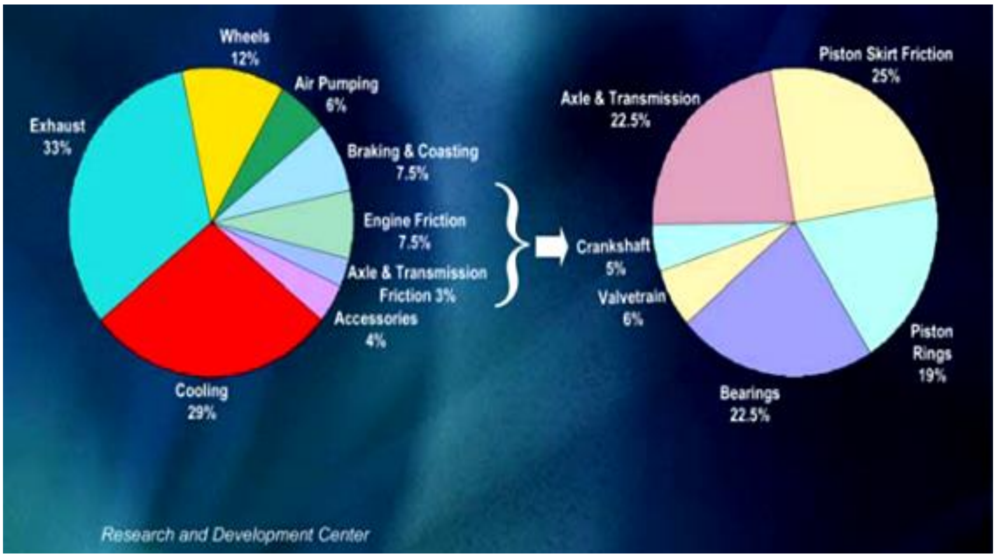

Figure 2.3: Distribution of energy consumption in a light-duty vehicle