THE EFFECT OF DIFFERENT TYPE OF ADDITIVES ON FRICTION AND WEAR OF MNR GREASE

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DECLARATION

I declare that this project report entitled "The effect of different type of additives on friction and wear of MNR grease" is the result of my own work except as citedin the references

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APPROVAL

I hereby 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 Master of Mechanical Engineering.

Signature : ....
Supervisor's Name : Mohd Rody Bin Mohamad Zin
Date : 07th October 2022

DEDICATION

In honour of Allah, my Maker and Master, and Muhammad, my great teacher and messenger (May Allah bless and give him), who showed us the meaning of life, I worked hard to learn as much as I could.

They are my wonderful parents, who never cease giving of themselves in innumerable ways.

Ewa, my beloved wife, who shines a bright beacon of hope and support in the midst of my darkest hours,

My beloved kids: Safiyya, Fiona and Ezequiel, whom I can't force myself to stop loving,

My dearest siblings, who never leave my side even when the odds are stacked against us. As a token of my love and generosity to my entire family,

The people who believe in me and always have my back.

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for his time, guidance, and patience throughout the project, as well as the other
people who have helped me along the way.

ABSTRACT

Grease typically has a base of mineral or synthetic oil, a thickener, additives, and fillers. The tribological performance of grease depends on the viscosity of the base oil and the type and concentration of thickening agent used. Grease lubricants are used in many different parts of automobiles, including gears, cams, sealed ball bearings, and others. Having to use more energy to overcome vehicle friction is wasteful. Power consumption can be drastically cut if frictional losses are minimised, making the components more effective. Grease lubrication helps keep surfaces apart, reducing friction and wear for increased durability. Prepared by sonicating the grease supplied by MNR Multitech Sdn Bhd using an ultrasonic homogenizer, the produced greases had a 10% concentration of additive nanoparticles of varying types mixed in. To put it simply, MNR is a grease that has no additives added to it. Molybdenum disulfide (MoS2), lithium complex grease (LCG), and potassium (MNR + K) are some of the other additives that have been introduced (K). Tribological tests were conducted using a 4-Ball Tester in accordance with the American Society for Testing and Materials (ASTM) standards D 2266 for Wear Preventive Characteristics of Lubricating Grease (Four-Ball Method) and 2596 for measurement of Extreme-Pressure Properties of Lubricating Grease (Four-Ball Method). The testing results show that the addition of MoS2 additives to MNR base grease can increase its friction and wear qualities by 52% and 68%, respectively. Extreme pressure testing revealed that MNR + MoS2 grease reduced severe adhesive wear and increased load carrying capability by nearly double that of MNR grease, from 618.03 N to 784.8 N. As a result, the load-carrying capacity and the friction coefficient have both been drastically increased thanks to the additive's use in bearing.

ABSTRAK

Jenis gris konvensional terdiri daripada asas minyak mineral atau sintetik, agen pemekat, aditif dan pengisi. Kelikatan minyak asas, serta jenis dan kepekatan agen pemekat yang digunakan, adalah faktor yang menentukan prestasi tribologi gris. Gear, cam, galas bebola tertutup dan aplikasi automotif lain semuanya menggunakan gris pelincir. Geseran dalam kenderaan membazirkan sejumlah besar kuasa. Sebilangan besar kuasa boleh dijimatkan dengan mengurangkan kehilangan geseran, yang akan meningkatkan kecekapan bahagian. Pelinciran gris membantu dalam pengasingan permukaan yang bersentuhan, mengakibatkan geseran, haus dan jangka hayat yang minimum. Gris yang diformulasikan telah disediakan dengan menyebarkan pelbagai jenis bahan tambahan nanopartikel dengan kepekatan optimum 10% ke dalam gris yang dibekalkan daripada syarikat MNR Multitech Sdn Bhd menggunakan kaedah sonication melalui homogenizer ultrasonik. MNR ialah gris asas tanpa sebarang bahan tambahan. Lain-lain ditambah aditif iaitu MNR + MoS2, molibdenum disulfida (MoS2), MNR + LCG, litium kompleks gris (LCG), dan MNR + K dengan kalium (K). Ujian tribologi telah dilakukan menggunakan Penguji 4-Bola menurut ASTM D 2266 untuk Ciri-ciri Pencegahan Haus bagi Grease Pelincir (Kaedah Empat Bola) dan ASTM 2596 untuk pengukuran Ciri-ciri Tekanan Melampau bagi Grease Pelincir (Kaedah Empat Bola). Berdasarkan keputusan eksperimen, didapati bahan tambah MoS2 berpotensi untuk memperbaiki sifat geseran dan haus gris asas MNR di mana ia mengurangkan geseran sebanyak 52% dan haus sebanyak 68%. Di bawah ujian tekanan yang melampau, gris MNR + MoS2 didapati mengurangkan haus pelekat yang teruk dan meningkatkan keupayaan membawa beban hampir dua kali ganda keupayaan membawa beban gris MNR daripada 618.03 N kepada 784.8 N. Oleh itu, penggunaan bahan tambahan telah meningkatkan dengan ketara keupayaan membawa beban dan pekali geseran yang lebih rendah yang penting untuk aplikasi dalam galas.

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LIST OF ABBEREVATIONS

EP	-	Extreme Pressure
R & D	-	Research and Development
WSD	-	Wear-Scar Diameter
MoS_2	-	Molybdenum disulfide
SEM	-	Scanning Electron Microscopy
EHL	-	Elasto Hydrodynamic Lubrication
PTFE	-	Polytetrafluoroethylene
MoS2	-	Molybdenum di sulfide
ZDDP	-	Zinc dialkyldithiophosphate

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
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

When it comes to high heat, heavy loads, and continuous use, greases are one form of lubricant substance that offers a number of advantages. During the industrial revolution, specialized oils and greases were utilized to lubricate moving parts of machinery. Lubricants can come in a variety of forms, including oil-based, solid, and semi-solid formulations. Performance additives, inhibitors and stabilizers, and detergents are the three types of lubricant basic materials. Thickeners are dispersed throughout the grease to trap oil pockets and keep them from being released during surface interaction; these performance additives make the grease semi-solid. There are several different types of thickeners, including simple soaps, complex soaps, and non-soap thickeners.

With regard to chemical mixture and additization, greases are one of the most commonly used lubricants that operate under elevated temperatures, higher loads and longer service life. The solid lubricant or nanoparticles serves a special function which is anti-wear or extreme pressure (EP) additives and the surfactant prevents agglomeration of the nanoparticles. Sulfur-based additives are commonly used to improve the wear performance of greases, while lithium-based simple soaps or Li-complex soaps are more uncommon. As a result of its EP additives, Sulphur creates an EP-coated layer on the surface of metal to protect it from further wear and tear.

Because of its many advantages, molybdenum disulfide has found widespread use in aerospace and military engineering. As it finds widespread use in many commercial contexts. Grease and other speciality pastes that resemble grease utilize it extensively. Lubricants, such as motor oil and industrial gear oil, also make use of this substance. Molybdenum occurs in both hexagonal and rhombohedral crystal structures. The hexagonal shape dominates, and it's the only kind of disc.

Therefore, this study is inspired from other finding to investigate the seizure wear of steel ball bearing lubricated with grease with Molybdenum disulfide (MoS_2) additives under extreme pressure. The testing procedure adhere to ASTM D 2266 and D 2596 standards for extreme pressure test under boundary lubrication regime. The load of seizure type until weld point will be determine from the test.

1.2 Problem Statement

Load Carrying Capacity under extreme pressure is a critical factor in the application (EP). The diameter of the wear scar is determined by the viscosity of the lubricant. The amount of additives affects viscosity increase. Anti-wear additives have been found to show anti-wear properties in lubricants through experimentation. Different formulation additives are used in the same experimental four-ball testing machines, with the same settings.

Grease performance is enhanced and lubricant consumption capacity is reduced by the addition of additives in this study. Additionally, lubricants that are oil-soluble can be used to reduce power loss. Molybdenum, as an additive to the grease, has been shown to form a low-friction surface film during high-load operation of a machine. The primary goal of this paper is to find and assess the most effective additives for enhancing grease composition.

About 30% of mechanical systems fail due to tribological failures. In order to alleviate this issue as little as possible, it is important to choose a grease formulation that takes wear and friction into account. Additives are commonly used to keep machines clean and avoid damage to the metal surfaces they come into contact with.

Because of this, the friction, heat, and wear behaviour of greases with the best formulation will be reduced. Another benefit of grease is that it extends machine life. As a result of increased reliability and productivity, manufacturing businesses can save time and resources.

1.3 Objective

The objective of this project is.

i. To investigate the effect of different type of additive in MNR grease on friction and wear of ball bearing

ii. To determine the Extreme Pressure (EP) properties of Molybdenum disulfide (MoS_2) as an additive in MNR grease

1.4 Research Scope

Important tasks must be taken into account in order for this study to achieve its goal. Prior to concluding this study, it will be necessary to define some key parameters. In this research, versatile grease was created using MNR grease. MNR grease is supplied by MNR cooperation and is a high-performance grease created from recycled base oil. To add to that, an additive will be used in this study to give the greases an additional special property. MNR is a base grease without any additives. Others were added additives which are MNR + MoS_2, molybdenum disulfide (MoS_2), MNR + LCG, lithium complex grease (LCG), and MNR + K with potassium (K). Tribological test will be conducted by using Ducom 4 ball tester under ASTM D-2266 and D-2596 standards. The quantitative analysis is done using 3D Non-contact Profilometer to obtain the WSD and wear profile surface. The results obtained are used to determine the seizure wear of MNR grease with MoS_2 additives in terms of Wear Scar Diameter against Load.

LITERATURE REVIEW

2.1 Introduction

This chapter presents the study's background information, which was compiled from a variety of sources, including but not limited to journals, papers, reports, websites, and books. This chapter's objective is to act as a road map for carrying out the project in accordance with what has been learned and established thus far. Tribological investigations, which are particularly interested in the component's lubrication, are what will help you reach your objective.

Structured as follows: Tribology investigations are described in further detail in Section 2.2, lubricants are discussed in Section 2.3, grease is discussed in Section 2.4, and finally all experimental parameters are described in Section 2.5.

2.2 Tribological Study

Tribology, as defined by the United Kingdom's Department of Education and Science in 1966, is the study of the complex interactions between moving surfaces and the technologies used to study them. One who specialises in the study and application of tribology is known as a tribologist. Tribology is the study and technology of the science and technology of surface contact between moving, linked surfaces. For a given load, tribology can be used to lessen the surface's frictional resistance to relative motion. In addition, it covers hydrodynamic lubrication, hydrostatic lubrication, and Elasto Hydrodynamic Lubrication (EHL), all of which make use of lubricant (Dongare, Pr. Dofr. A. D., 2014)

2.2.1 Automotive tribology

Motor vehicles are propelled by a reciprocating internal combustion engine, which is the most critical part. Motorcycles, scooters, mopeds, vans, trucks, buses, agricultural vehicles, construction vehicles, trains, boats, and ships are all examples of ground and sea transportation. Replacing an external fuel source with an internal one is inefficient because of the heat and friction lost during the combustion process. The greenhouse effect is exacerbated by emissions of greenhouse gases such as carbon dioxide, hydrocarbons, and nitrogen oxides (NOx). Tung et al. (2004) found that (S.C. Tung et al.)

2.2.2 Importance of engine tribology

The engine tribology can effectively lubricate all moving parts. It is possible to reduce the negative environmental impact by lowering the friction and wear rates. Speed, load, and engine temperature all play a role in the task's operation. There are several ways to enhance the tribological performance of engines, such as decreasing fuel consumption and improving engine power output, decreasing oil consumption, and minimizing dangerous exhaust emissions.

The energy produced by combustion is then routed through the various components of the engine and drivetrain. In addition, the friction loss, which accounts for 48 percent of an engine's energy consumption, is also a major factor. 35 percent of the resistance is attributed to acceleration, while 17 percent is attributed to cruising. About 66% of all friction loss occurs in the engine's valve train, crankshaft, transmission, and gears (34 percent). Rotating bearing, valve train, and auxiliary components all cause frictional losses. McMillan et al. conducted a study in 2004.

2.3 Lubricant

In order to reduce wear, lubrication plays an important role in preventing the components from coming into direct contact with each other. Grease can be found in motors, bearings, pumps, and other automotive components. In addition to high pressure resistance, viscosity, anti-wear and corrosion resistance, the lubricants' reaction affects the performance of the machine. Engines benefit from the reliability and protection that efficient lubrication provides by reducing corrosion and wear. It also reduces wear, corrosion and shocks by lubricating the parts. This complex mixture of base oil and additives makes up motor oil or the lubricant of the engine. There are a number of different anti-wear additives on the market, each with a slightly different goal in mind. To prevent abrasive, adhesive, and corrosive wear, apply a layer of protection to the contact surface (Nazare et al., 2018).

2.4 Greases

The National Lubricating Grease Institute classifies greases based on the percentage of worked infiltration (Nagendramma et al., 2015). Soap and synthetic oils known as thickener are used to make semi-solid lubricants. Since the dawn of the industrial revolution, grease has become a well-known lubricant component. Grease properties such as rheology and microstructure are influenced by the ingredients and manufacturing microstructure. In addition to graphite, PTFE, and talc, MoS2 and EP additive for greases are widely used as a solid lubricant. Load-bearing potential is provided by the lamellar structures of the MoS2 and graphite particles, which are interconnected by weak Van der Waals forces. In order to prevent asperities from contacting, the forces are sheared and deposited on the surfaces that are in contact with each other. In addition, the reaction acts as a barrier to further seizure, wear, and abrasion of the surface (Bagi et al., 2015)

2.5 Additives

Additive is a synthetic chemical substance that improve the parameter of lubricants. It boosts the existing property and suppress the undesirable property in the base fluids. The main function of additive is to improve the performance of grease. There are several types of additive and each of them have a special property in lubricant. The most common additives are:

- Anti-corrosion: -

  It prevents and reduce the process of corrosion.

- Anti-wear: -

  It prevents wear forming a strong surface film which reduce the contact surface to prevent heating due to extreme pressure.

- Antioxidant: -

  It prevents oxidation from occurs which lead to damage and turn to admit the impurities.

- Viscosity index improver: -

  It retains the viscosity of grease which will break down at high temperature due to engine overwhelmed.