DEVELOPMENT OF BIO-LUBRICANT FROM WASTE MUSA PARADISIACA ENHANCED BY CRYSTALIZED STRUCTURE OF NANOPARTICLES

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DECLARATION

I declare that this project entitled Develope of Bio-Lubricant From Waste Musa Paradisiaca Enhance by Crystalize Structure of Nanoparticles is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : NURUL NAJEEHAH BINTI MAT SANI

Date : 4 JANUARY 2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours

Signature :

Supervisor Name : Dr. Muhammad Ilman Hakimi Chua Bin Abdullah

Date : 4 JANUARY 2023

DEDICATION

I dedicate this success to my beloved parents and my supervisor Dr. Muhammad Ilman Hakimi Chua bin Abdullah, who offered unconditinal love and support and have always been there for me. Thank you so much for giving me the strength to finish my Final Year Project.

ABSTRACT

Mineral oils, synthetic oils, re-filtered oils, and vegetable oils are just a few of the many lubricants that are offered globally. Most lubricants supplied in bulk are mineral oils made from petroleum oils, which are poisonous, poorly biodegradable, and therefore bad for the environment. Due to the depletion of petroleum resources and environmental concerns, researchers have been more interested in the use of vegetable oil as a lubricant. Vegetable-based lubricants offer superior actual properties, are less corrosive, are unlimited, and are biodegradable as compared to mineral-based oils. As a source for bio-based lubricants, virgin biological oil or processed agricultural wastes are also options. To develop bio-based lubricants, this thesis looked at virgin vegetable oil using nanoparticles as additives to acquire outstanding tribology properties. To locate the most appropriate nanoparticles that can improve wear protection and decrease friction, this research first identified the nanoparticles that satisfy the fundamental requirements in terms of types and concentrations. To enhance the physical and tribological properties of banana oil, zirconium oxide (ZrO_2) and graphene (C) nanoparticles were introduced in place of lubricant additives. The extraction of essential oils and the addition of zirconium oxide (ZrO_2) and graphene (C) nanoparticles lubricated to each of the contact surfaces underwent four-ball wear testing. In contrast to mineral oil, nanoparticles enhanced the lubricant mixtures' physical qualities and gave them good anti-wear and anti-friction properties. Because they meet the basic requirements for bio-based lubricants, banana peel essential oils can replace mineral oil as an advanced sustainable bio-based lubricant for industrial activities concerned with the environment and save money.

ABSTRAK

Minyak mineral, minyak sintetik, minyak yang ditapis semula dan minyak sayuran hanyalah beberapa daripada banyak pelincir yang ditawarkan di seluruh dunia. Kebanyakan pelincir yang dibekalkan secara pukal adalah minyak mineral yang diperbuat daripada minyak petroleum, yang beracun, tidak terbiodegradasi dengan baik, dan oleh itu tidak baik untuk alam sekitar. Disebabkan oleh kehabisan sumber petroleum dan kebimbangan alam sekitar, penyelidik lebih berminat dalam penggunaan minyak sayuran sebagai pelincir. Pelincir berasaskan sayuran menawarkan sifat sebenar yang unggul, kurang mengakis, tidak terhad, dan boleh terbiodegradasi berbanding minyak berasaskan mineral. Sebagai sumber pelincir berasaskan bio, minyak biologi dara atau sisa pertanian yang diproses juga menjadi pilihan. Untuk membangunkan pelincir berasaskan bio, tesis ini melihat minyak sayuran dara menggunakan nanopartikel sebagai bahan tambahan untuk memperoleh sifat tribologi yang cemerlang. Untuk mencari nanozarah yang paling sesuai yang boleh meningkatkan perlindungan haus dan mengurangkan geseran, penyelidikan ini mula-mula mengenal pasti nanozarah yang memenuhi keperluan asas dari segi jenis dan kepekatan. Untuk meningkatkan sifat fizikal dan tribologi minyak pisang, nanopartikel zirkonium oksida (ZrO2) dan graphene (C) telah diperkenalkan sebagai ganti bahan tambahan pelincir. Pengekstrakan minyak pati dan penambahan nanopartikel zirkonium oksida (ZrO2) dan graphene (C) yang dilincirkan pada setiap permukaan sentuhan telah menjalani ujian haus empat bola. Berbeza dengan minyak mineral, nanopartikel meningkatkan kualiti fizikal campuran pelincir dan memberikan sifat anti haus dan anti geseran yang baik. Kerana ia memenuhi keperluan asas untuk pelincir berasaskan bio, minyak pati kulit pisang boleh menggantikan minyak mineral sebagai pelincir berasaskan bio mampan termaju untuk aktiviti perindustrian yang prihatin dengan alam sekitar dan menjimatkan wang.

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LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Material
COF	Coefficient of Friction
ISO	International Standardization Organization
SEM	Scanning Electron Microscope
RPM	Rotation Per Minute
ZrO_2	Zirconium Oxide
WSD	Wear Scar Diameter
SEM	Scanning Electron Microscopy

CHAPTER 1

INTRODUCTION

1.1 Background

Large amounts of waste can have significant environmental and economic effects. On the other hand, most food wastes contain valuable minerals that are utilised in the production of glass, ceramics, and glass ceramics. Furthermore, banana peels are a waste product that could be considered a pile of trash. Despite the potential for compost and cosmetics, this waste contributes to waste management issues. (Hosain et al., 2012). Banana peels are a low-cost, easily accessible, and environmentally friendly biomaterial. This agricultural waste is also unlimited, cost-effective, non-hazardous, and heavy metal-selective, making it simple to burn. (Yusuf et al.,2011). The herbaceous plant Musa sapientum (Musa sapientum) belongs to the Musaceae family. Bananas are both the most popular and the most consumed tropical fruit on the planet. As a result, it has been dubbed the "Healthiest Fruit on the Planet." The banana peel, also known as banana skin, is the outer layer of the fruit. Banana peels are currently unusable for anything else and are collected and disposed as solid waste at a considerable expense. As a result, there is a significant amount of organic waste produced. Waste banana peels can be utilised for a variety of purposes, including water filtration, fertiliser, and the manufacturing of ethanol, cellulose, and laccase. However, leftover banana peel is occasionally utilised as feedstock on small farms for pigs, goats, rabbits, cattle, and other animals. (Oliveira et al., 2013).

Lubricants are created from a variety of oil-based foundations and are used for a variety of purposes. Many investigations have been conducted to identify new alternative oils that may be utilised to replace mineral oils as lubricants. The research reflects advancements and new technologies that will emerge during the next few years. All these efforts were made to protect the ecosystem. Aside from that, mineral oil will be in short supply in the future due to limited availability. Since it is an environmental process, mineral oil manufacturing takes a long time, potentially a thousand years. As a result, if the primary source of energy is no longer available, mankind will have to rely on alternative sources such as vegetable oil, solar energy, and other resources. Lubricants were mostly, if not entirely, produced of vegetable oil and animal fats until the nineteenth century. Mineral oils gradually superseded these lubricants after the discovery of mineral oil and the invention of the internal combustion engine (Ioan et al., 2002). Lubricant oils have long been utilised in automobile and motorbike engines. Lubricant oil might represent our body's blood system. It will cover the entire machine system to guarantee that all the components perform together properly. Without it, the system will be tainted. Friction and surface fatigue, heat generation, operating noise, and vibrations are all reduced by lubricant oil (Serope et al., 2008).

Polymeric particles with a diameter of a few nanometres are known as nanoparticles. Even though microparticles are particles with a size in the micrometre range, there has been an increasing demand for nano-sized semiconductors due to their significant electrical and optical properties, which are extremely useful in fabricating nano scaled optoelectronic and electronic devices with multi-functionality (Tokumoto et al., 2003). Because of a few characteristics, such as their surface to mass ratio and surface reactivity, nanoparticles have sparked a lot of interest. In general, metal nanoparticles are prepared using the highest or base strategies, these methods help obtain nanoparticles with suitable particle size and particle size distribution, but because most of the reaction mixtures used are hazardous, they are not always suitable for further applications, necessitating a second step to modify their surface, which adds cost and importance. Nanoparticles can be made from a variety of components, including proteins, polysaccharides, and synthetic polymers. The material selection depends on the desired size of nanoparticles, water solubility and stability, surface characteristics such as charge and permeability, degree of biodegradability, biocompatibility, and toxicity. (Marzán et al., 2003).

1.2 Problem Statement

In most developing countries, waste generation and management has become a problem. Organic garbage accounts for most of the trash created in Malaysia. When compared to other food waste, banana peels reported the largest amount at 27.15 kg per month, according to (Aeslina et al.,2017). The figures of the mass-based composition of food waste generated by the industry were derived from the results of an eight-month food waste collection. According to the overall amount of waste generated by the industry, banana peel waste made up most of the waste (27 percent). Inefficient and incorrect solid waste disposal endangers public health by polluting air and water resources and increasing disease vectors such as rodents and insects, as well as causing public nuisances and interfering with community life and growth according to G. Tchobanoglous et al., (1993). Furthermore, the lack or inability to economically salvage and re-use such materials results in unnecessary waste and natural resource depletion.

The market has grown increasingly price sensitive because of economic and financial crises, making it harder for synthetic lubricant suppliers to educate clients and grow this sector. Oil companies have every motivation to do so because synthetic lubricants have such high profit margins. The industry is currently dominated by multinational oil giants. It's also expected to grow because it's a specialised market, and larger companies with a broader and more diverse reach would buy smaller companies. The Malaysian market for industrial lubricants is expanding. By importing base oil from other nations and manufacturing industrial lubricants in the United States, the sector largely meets the demand expectations of every end-user industry. Due to increased demand from end-user industries, new industrial policies, the introduction of bio-based lubricants, and a rise in the number of players in the market, the market grew at a cumulative rate of around 3% from 2013 to 2018. (By Origin, Malaysian Industrial Lubricants Market Outlook to 2023).

1.3 Objectives

The objectives of this project are stated below:

1. To extract the banana peel as a new lubricant-based stock.
2. To bland the based stock with an optimized composition of selective nanoparticles.
3. To test the tribological behaviour of the developed bio-lubricant.

1.4 Scope of Research

The scope of this research are as follows:

1. Extraction of banana peel as a new lubricant-based stock using crystalized structure of nanoparticles.
2. Formulating based stock with an optimized Zirconium Oxide (ZrO_2) and Graphite composition as selective nanoparticles.
3. Testing tribological behaviour of the developed bio-lubricant according to ASTM D4172-Standard test method for wear preventive characteristics of lubricant fluid.

CHAPTER 2

LITERATURE REVIEW

2.1 Problem of Conventional Oil

There is growing fear that world oil production is nearing its peak, and that the peak will be followed by a sharp fall. On the one hand, the oil industry claims that there are sufficient oil resources to meet global demand for decades, backed up by reports from organisations (CGES, 2006; EIA, 2006; IEA, 2006; EIA, 2007; IEA, 2007), and that adequate financial resources are put in place quickly to explore, develop, and produce oil and gas. On the other hand, due to finite resources, some organisations and individual debaters (Simmons et al.,2009) say that oil output has peaked or will soon peter out. The Hubbert model is the basis for the majority of contemporary peak oil forecasting models. Hubbert correctly predicted that the US would reach peak oil production in 1971 in 1956, and he developed a model for predicting cumulative production and ultimately recoverable resources (URR), which became known as the Hubbert model (Hubbert et al., 1967). The model is simple in concept, but it is built on several assumptions (Maugeri et al., 2004). The oil production follows the "Central Limit Theorem" from statistics, based on data from several integrated oil fields. Since then, several scholars have studied the Hubbert curve in depth and utilised it to anticipate the growth of global oil and gas reserves and production (Doucet et al., 1992). Geologist Jean Laherrère believed that the production growth curve should be a duplicate of the discovery graph across time, excluding the impact of political or other forces. The discovery and production peaks have a clear link (Laherrère et al., 2000). The Hubbert model's success in predicting peak production in the United States simply reflected the peculiar nature of this area, which was the most intensively explored and exploited area in the world at the time, so the production pattern was not rendered by a one-cycle curve but was marked by significant discontinuities. Many factors influenced oil and gas production, including exploration, development technology, economic factors, policies, and regulations, resulting in multiple peaks that can be fitted with a multi-cycle model. In 1999, Al-Jarri and Startzman converted the one-cycle Hubbert model to a multi-cycle model, which they used to anticipate global natural gas supplies in 2000. (Al-Fattal et al.,1999). An analysis by Hirsch et al., (2005) showed that while the shape of the oil production curve can be affected by mitigation efforts, mitigation efforts are also affected by the shape of the Hubbert curve.

2.1.1 Synthetic Oil

Synthetic oils are created with the goal of providing consistent and superior performance (2013). Their primary advantage over mineral oils is that they protect engines over a wider temperature range and up to the maximum engine temperature. Mineral oil also has no contaminants and does not degrade quickly, it is also thinner, which helps to enhance fuel efficiency. Synthetic oils are lubricants made up of chemical components that are formally classified as synthetic (synthesized). Kashif et al., (2011) claims that the resulting synthetic crude exhibits low impurity asphaltene fractions that can be used in current petroleum refineries. Chemically modified petroleum components, rather than whole crude oil, can be used to make synthetic lubricants. Synthetic oil has some advantages over mineral oil. It can reduce friction and wear of components while also improving fuel consumption and energy use. Figure 2.1 shows a graphical representation of the difference in molecular sizing between mineral and synthetic base oils. Table 2.1 shows the petroleum production and consumption amounts of some countries.

Table 2.1: The Petroleum production and consumption amounts of some countries (Huseyin Sanli, 2011)

Country (Barrel/Day)	Petroleum Consumption (Barrel/Day)	Petroleum Production
USA	18,690	9,056
EUROPE	13,680	2,383
CHINA	8,200	3,991
INDIA	2,980	879
RUSSIA	2,850	9,932
GERMANY	2,437	157
FRANCE	1,875	71
TURKEY	580	53
GREECE	414	7

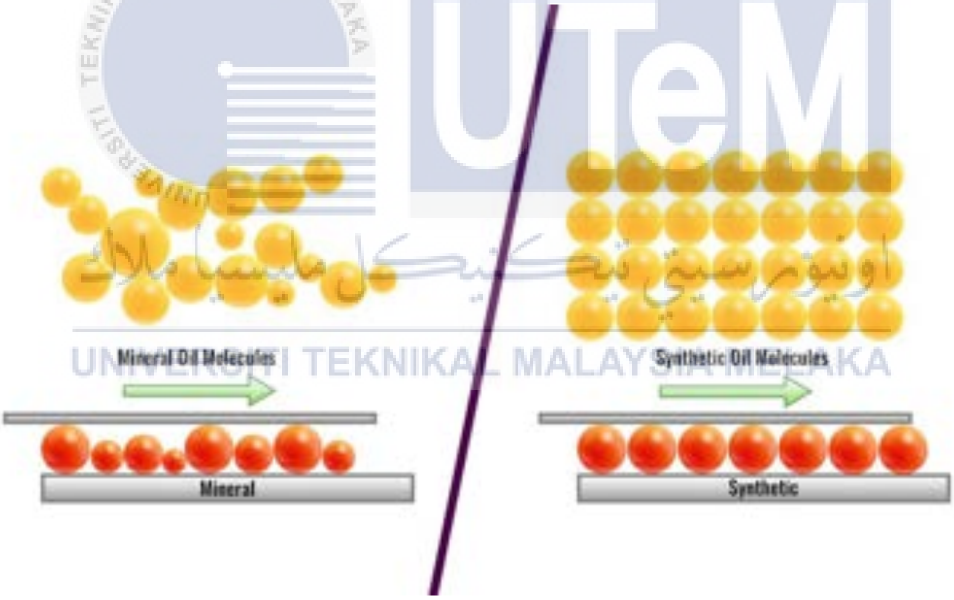

Figure 2.1: Graphical representation of the molecular sizing difference between synthetic and mineral-based oils.