

EXPERIMENTAL INVESTIGATION ON BIO LUBRICANT WITH CUSTARD SEED OIL

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Technology degree in Chemical Engineering

by

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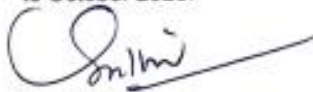
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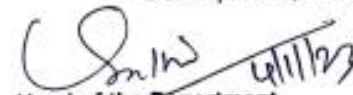
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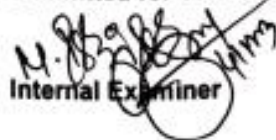

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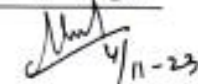

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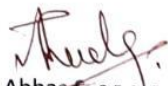
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ABSTRACT

Key features of a bio lubricant mix of 80% SAE 20W40 conventional oil and 20% custard seed oil were the focus of this experimental study. Variables such as kinematic viscosity, fire point, density, and calorific value. were tested. To create the bio lubricant mixture, custard seed oil and standard SAE 20W40 oil were carefully combined. The effectiveness and qualities of the resulting lubricant blend were then evaluated using a battery of tests. A viscometer was used to ascertain the lubricant's kinematic viscosity, a crucial property in determining its ability to flow and create a film. The mixture's viscosity was measured and compared to that of standard lubricants based on the results. Important safety indicators like the flash point and fire point were measured with specialised equipment. These analyses determined the hottest and longest-burning operating temperatures at which the lubricant vaporised.

Utilising a bomb calorimeter, the lubricant's calorific value was determined, which is a measure of its energy density upon combustion. This study shed light on the energy efficiency of the lubricant. We weighed a standard volume of the mixture to determine its density, a key feature that influences lubricant distribution and performance. The density of the mixture was calculated using these data. The bio lubricant blend's viability for different uses was evaluated by comparing test results to those of custard seed oil and SAE 20W40 conventional oil. In sum, the results of this study reveal important information on the functionality and characteristics of a bio lubricant mix, illuminating its potential as an eco-friendly and long-term replacement for conventional lubricants. These results may be used to inform future research and product improvements in the area of bio-based lubricants.

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CHAPTER – 1

1.1 INTRODUCTION

As a result of growing environmental concerns, there is a growing interest in the development of products and processes that are renewable, biodegradable, and friendly to the environment. This interest has been fueled by the search for sustainable development. The growing demands, the diminishing energy reserves from fossil fuels, the cost of production, and the overall damage to the environment fueled the search for renewable sources of energy and other products, which has resulted in significant discoveries. Among these discoveries are significant breakthroughs in areas such as solar energy and wind power. Solar, hydro, and vegetable power have all made major contributions towards fulfilling the requirements for renewable energy on a worldwide scale. The biodegradable fuel and lubricants that are created from vegetable and cereal-based oils typically consist of between 60 and 99% base oil, with the remaining portion consisting of additives in varying proportions depending on the level of performance that is needed. Over the course of the past quarter century, there has been an increase in the utilisation of vegetable oil-based lubricants that are both ecologically friendly and biodegradable. In spite of this, the dependence on edible vegetables and cereals for the production of biodegradable fuel and lubricants has far-reaching implications for sustainable development. The use of fossil fuels and lubricants presents the greatest environmental risk because millions of tonnes of waste are annually discharged into the environment as a consequence of leaks and careless disposal practises. Furthermore, some of this waste is not biodegradable, which means that it contaminates the environment. Both the search for renewable raw materials that may be utilised for the production of lubricants and the creation of products that are biodegradable are the primary challenges that researchers face in the lubricant sector. The utilisation of vegetable and cereal oils, each of which contains three hydroxyl groups and long chains of unsaturated free fatty acids attached at the

hydroxyl group by ester linkages, must strike a balance between the needs for human and animal consumption and the derive for energy generation. These oils contain three hydroxyl groups and long chains of unsaturated free fatty acids. In spite of the fact that vegetable and cereal oils are frequently used in the production of biofuel, these types of oils are not widely used in the production of lubricant base oils. This is largely due to the fact that vegetable and cereal oils have undesirable physical properties, such as a high melting point and inadequate stability after thermal oxidation. The stability of bio-oils in respect to heat, oxidation, and hydrolysis can be improved by modifying their chemical characteristics; however, the impacts of lubricants that have had their chemical properties modified in this way on the environment have not been thoroughly explored and recorded. The carboxyl groups of the fatty acids undergo the most significant alterations, which account for around 90% of the total, whereas oleochemical reactions on the fatty acid chain account for approximately 10% of the total. Several experiments, employing a wide variety of vegetable and cereal oils, have been conducted. The oils derived from vegetables and cereals can be divided into two categories: those that are consumable by humans and other animals, and those that are not. The non-edible (castor seed) seed oil that had a homogeneous catalyst was used in our effort to achieve sustainable development. This allowed us to design a bio-lubricant that strikes a balance between the requirements for human consumption and the requirements for sustainable energy. This research is centred on the development of biodegradable lubricants from renewable sources using the seed of a plant that is not edible (castor seed). The purpose of this research is to alleviate the pressure brought on by the rising demand for consumable oils and to ensure that sustainability is maintained. The overarching goal of this body of study in the field of research is to lessen our reliance on fossil fuels, with the intention of fostering more environmentally responsible and sustainable forms of growth. Castor seed oil may be converted into lubricant, which will not only save foreign currency but also provide work possibilities. The effect of the profits as a multiplier might be duplicated by using a different kind of seed that is not edible.

1.2 BIO LUBRICANT

Lubricants are crucial in a variety of different industries because of the pivotal role they play in reducing the amount of friction and wear that occurs between moving parts. This, in turn, extends the lifespan of machinery and improves its overall efficiency. Despite the fact that it is typically obtained from sources that are based on petroleum, there is an increasing emphasis around the world on sustainability, environmental responsibility, and reducing our dependence on fossil fuels. Because of this, bio lubricants have been developed, and their use is becoming more widespread.

Bio lubricants, also known as biodegradable lubricants or eco-friendly lubricants, are a category of lubricants that are produced from renewable, biodegradable, and environmentally beneficial sources. Other names for this type of lubricant include "eco-friendly lubricants" and "biodegradable lubricants." They have a smaller impact on the environment and are easier to biodegrade compared to traditional lubricants that are based on petroleum, which is the primary factor driving their greater number of benefits.

The following are some of the key characteristics of bio lubricants:

Renewable Sources: Bio lubricants are often manufactured using renewable resources such as vegetable oils (for example, soybean, rapeseed, and sunflower oil), animal fats, and synthetic esters. This lessens the reliance that we have on dwindling stocks of fossil fuels.

The capacity of bio lubricants to degrade naturally is one of the most important aspects that contribute to the success of these products. They pose less of a threat to the environment over the long term compared to conventional lubricants, which can be persistent pollutants due to the fact that they decompose naturally in the environment.

Low Toxicity: Bio lubricants often have lower levels of toxicity as compared to their counterparts that are based on petroleum, which makes them safer for human health as well as ecosystems.

High Lubricity: A great number of bio lubricants have high lubrication capabilities, which reduces the amount of friction and wear that occurs between the various machine parts and improves the overall performance of the equipment.

Reduced Emissions of Greenhouse Gases: In comparison to the extraction and processing of petroleum, the manufacturing of bio lubricants typically results in a lower overall emission of greenhouse gases.

enhanced Thermal and Oxidative Stability: Under certain conditions, bio lubricants can demonstrate enhanced thermal and oxidative stability, which can result in extended oil change intervals and lower maintenance costs.

Applications: Because bio lubricants are so adaptable, they can be used in a broad variety of settings, including hydraulic systems, industrial settings, maritime settings, and automotive settings. They are utilised frequently in fields that are especially sensitive to the environment, such as agriculture and forestry.

Concerns and Things to Take into Account:

Bio lubricants have numerous advantages, but they also have certain disadvantages, such as the fact that their temperature stability is limited applications and that they may not be compatible with the machinery that is already in use. However, research and development initiatives are currently underway with the objective of overcoming these obstacles and expanding the usage of bio lubricants across a variety of industries.

To summarise, bio lubricants offer a sustainable and environmentally responsible alternative to the conventional petroleum-based lubricants that are currently on the market. Bio lubricants are becoming an essential component of the efforts being made to lessen the negative effects that lubrication operations have on the environment while simultaneously preserving high-performance

standards as the sustainability of both industry and consumers becomes a higher priority.

1.3 VARIOUS KINDS OF BIO-LUBRICANTS

Vegetable-Based Oils: These oils are among the most widely used types of bio lubricants, and they are derived from plants such as soybeans, canola, and sunflowers. They have excellent lubricating qualities and find widespread use in a variety of industries including metalworking, automotive, and hydraulic systems because of this.

Lubricants Derived from Animal Fats Additionally, animal fats as lard or tallow can be utilised in the manufacturing process of bio lubricants. They are especially effective in applications in which conditions of high loads and harsh temperatures are present.

Synthetic Esters Synthetic esters are lubricants that have been developed chemically and can be customised to meet the requirements of a variety of applications. They see widespread application in high-performance contexts, such as the aviation and military industries, respectively.

Polyalkylene Glycols (PAGs): Bio lubricants based on PAGs are renowned for their superior thermal stability and anti-wear qualities. They are put to use in demanding applications such as compressors and industrial gear that operates at high temperatures.

Bio-Based Greases: Greases are a type of semi-solid lubricant, and there are a variety of bio-based alternatives to choose from. They are frequently used in applications that demand a more viscous lubricant, such as bearings, gears, and other similar components.

CHAPTER – 2

2.1 LITERATURE SURVEY

Doddabasawa and Ravi Kumar, (2014), Bio diesel production and physico-chemical property of custard apple seed,

Two essential elements in the process of producing biodiesel are moist and free fatty acids. Greater moisture content and free fatty acids have the tendency to react with the catalyst, resulting in the creation of soap. Incomplete production of soap transesterification. Determination of free fatty acid decides the transesterification process and catalyst to be used. Alkyl method is used when the FFA is less than 3 per cent which is less expensive and faster than the acid catalyst.

Ebtisam k. Heikal, etal (2016), Manufacture of environment friendly bio-lubricant from vegetable oil,

The TMP ester synthesized methyl ester from palm oil and jatropha oil shown good potential as base stock in biodegradable lubricant formation. Bio lubricant from natural oil, especially nonedible oil is promising for special and environmental application.

Ibrahim n. dibal, etal (2017) Production of bio lubricant from custard oil,

The bio diesel produced from custard oil is blended with sodium lauryl sulphate to improve the property of bio lubricant. The sample of A and B were esterified with interval of one hour. The five iterations consist of three turn drastic esterification method and mild esterification method for two times. The process was repeated twice in the determination of percentage FFA values to reduce variation.

Omkaresh.B.R, etal, (2015) Biodiesel Production from Custard Apple seed Oil and its Performance Test on CI Engine,

This study examines the transesterification of non-edible seed oils, such as custard apple, karanja, and mauha oil, using methanol and a potassium hydroxide catalyst at 65°C to produce fatty acid methyl ester, or biodiesel. The characteristics of the biodiesels that are generated and their blends for various ratios (B10, B20, B30, B50, and B100) are equivalent to those of the ASTM biodiesel standards. The generated biodiesel, which has the best qualities out of the three, is put to the test to see if it can replace diesel engine fuel. Engine tests for various biodiesel mixes with regular diesel have been carried out at 1500 rpm, with a set compression ratio of 17.5, a fixed injection pressure of 200 psi and variable braking power.

Priyanka Chand, etal (2008), Thermogravimetric Quantification of Biodiesel Produced via Alkali Catalyzed Transesterification of Soybean oil.

The purpose of this work was to show how thermogravimetric analysis (TGA) may be used as a screening technique to monitor the generation of biodiesel through the transesterification of soybean oil with methanol. As benchmarks, several weight ratios of commercially available biodiesel and soybean oil were combined. Furthermore, base-catalyzed soybean oil transesterification with methanol was intermittently interrupted to form mixes with varying ratios of biodiesel to soybean oil. Using TGA, the mixtures generated by the two methods were examined between 25 and 500 °C.

SiddalingappaR.Hotti, etal (2014) Biodiesel Production Process Optimization from Sugar Apple Seed Oil and Its Characterization,

This research describes the characterisation and manufacturing of biodiesel from renewable, non-food sugar apple seed oil. Studies on the transesterification of oil using methanol and sodium hydroxide as a catalyst to produce biodiesel were conducted. For the purpose of producing sugar apple biodiesel (SABD), process variables including catalyst concentration, reaction time, and reaction

temperature were optimised. 95.15% of the biodiesel was produced at ideal process conditions. It was discovered that the fuel qualities of the generated biodiesel were nearly identical to those of diesel fuel and also satisfied ASTM criteria.

Waleed Abuhaimeed, et al (2017), Using Biofuels as Lubrication Oil,

The purpose of this article is to identify the characteristics of several vegetable oil-based biofuel lubricants. The effects of the lubricating oil's temperature and viscosity on changes in its qualities were determined via inquiry. Three vegetable oils—palm, corn, and almond—are evaluated in experiments built around SVM test machines. The findings display the density, absolute viscosity, and kinematic viscosity of the oils.

Lubricants are used to lessen the amount of heat produced by moving parts by decreasing the friction between them. Forces may be transmitted, foreign particles could be moved, and surfaces could be heated or cooled. (Trotsek, 2017) Lubricity is characterized by decreased friction. Lubrication is essential for lowering friction and wear. Common culprits include parts that slide, move, or rotate (Tung & McMillan, 2004). In addition, it can reduce the temperature of the region where the two metals are in close contact. Friction is a major source of wasted energy.

One third of the world's total energy is lost due to friction between sliding and moving elements. The quality and type of lubricating oil are crucial variables in reducing friction. Power, manufacturing, and transportation sectors all spend significant amounts of resources on reducing friction. High costs are incurred when mechanical components, transmission systems, and associated processes need to be replaced (Holmberg & Erdemir, 2007). Industries, machinery, and motor oil all make use of lubricants (Ahmed et al., 2016). A lubricant helps keep moving contact surfaces from wearing down and losing heat. It is used as a transformer insulator.

It functions as a barrier to prevent corrosion and reduce oxidation between two mating surfaces. In addition to protecting against smut, dusty powder, water, and grime, it also works as a sealant. High in The qualities of an excellent lubricant are strong resistance to oxidation, thermal stability, hydraulic stability, and corrosion avoidance. (Singh et al., 2017). Other desirable.

Characteristics include a low freezing point and high boiling point (so it remains liquid over a wide temperature range) and a high viscosity index. Mineral oil based and synthetic lubricants are the two main categories of conventional lubricants. High levels of refining, purification, and processing are used to create mineral oils. Hydrocarbons are distilled out of crude oil during the refining process. In their role as hydrodynamic lubricants, they transport additives for boundary or solid-film lubrication (Singh et al., 2017). Mineral oil is a petroleum byproduct that has seen increasing use as a lubricant in a wide range of contexts and as a component in a variety of beauty and hygiene products in recent years. Its high consumption can be attributed to its widespread use as a lubricant. The use of crude mineral oil as a lubricant is widespread in the transportation sector, particularly in the automobile, train, and aviation industries (Sadriwala et al., 2020). During oil changes, waste mineral oil is frequently released into the environment, contributing to pollution and negatively impacting ecosystems worldwide. Mineral oil contains of chemicals, some of which have been linked to cancer and mutation. The public health problems associated with mineral oil disposal receive minimal attention in many poor countries. It has been linked to higher infant mortality rates (IMR) and child malnutrition (Salimon et al., 2010). Not being fully miscible with diesel and other basic fuels means that any that leak into the combustion chamber will only partially burn, creating pollutants if used in IC engines. As a result, using mineral oils will raise the amount of smoke and UBHCs released by the engines. Since mineral oils cause severe environmental pollution through the contamination of combustion products and damage the cylinder surface by the enhanced rubbing action of metallic compounds added to the lubricant, they are being phased out of use (Syahrullail

et al., 2013). However, vegetable oils can replace mineral oil-based alternatives in some contexts, such as lubrication.

Plants and their seeds are the source of vegetable oils. Polar lipids (phospholipids and galactolipids), monoacylglycerols, diacylglycerols, free fatty acids, and polyisoprenoids make up the rest of the composition. Triacylglycerols account for 91%–96%. Table 1 displays a variety of vegetable oils and their respective uses. Lubrication is a prospective and possible use for vegetable-based oils. In Table 2,

We can see the differences between mineral oils and vegetable oils. Vegetable oil bio-lubricants outperform mineral oil in terms of lubricity, flash point, volatility, and viscosity index. Most mineral oils have a viscosity index between 90 and 100, while vegetable oils that aren't meant for human consumption have an index closer to 220. When operating at high temperatures, the lubricating coating is best preserved by vegetable oil-based lubricants with a high viscosity index. According to Alves et al. (2013), lubricants' volatility and fire-resistance properties are established by their flash and fire points. Energy savings of 16 percent or more are achieved, and operational temperatures are lowered. Bio-based lubricants have low pour and cloud points, excellent heat stability, and a high flash point because to the high concentration of polyunsaturated fatty acids they contain. They are biodegradable, have a high heat content, and low sulphur content. Multi-purpose oils, insulating oils, aviation oils, greases, metal grinding oils, and oils for other applications can all be made from vegetable oils instead of mineral oils (Singh et al., 2015). When compared to traditional lubricants, vegetable oils' biodegradability is the most crucial benefit (Erhan & Asadauskas, 2000a, 2000b a, b; Kumar et al., 2011). If the organisms or their enzymes in renewable raw materials created through aerobic or anaerobic processes can break down the lubricant, then the lubricant is considered biodegradable (Haase et al., 1989). When biodegradation rates of 80% or more are achieved within 28 days, or 60% or more are achieved after 28 days, a lubricant is termed degradable (Reeves et al., 2017). The biodegradability of a lubricant depends on

a number of factors. At the outset, the bio-lubricant disappears and a new compound is formed, which may or may not be totally biodegradable. Infrared spectroscopy is used to examine the C-H bond and quantify this primary bond's disintegration (Perin et al., 2008). Second, the organic molecule figures out how fast it will biodegrade into CO₂ and water (within 28 days) (Battersby & Morgan, 1997).

CHAPTER – 3

3.1 AIM OF THE INVESTIGATION

- To study the key points of SAE 20W40 lubricant oil.
- To prepare the custard seed oil.
- To prepare the bio-lubricant with the composition of 5%, 10%, 15%, 20% blended with SAE 20W40 conventional lubricant.
- Analyze the chemical properties of bio-lubricant with above said blend ratios.
- Compared the obtained test results with conventional bio-lubricant.
- Analyze the GCMS peaks results.

3.2 SCOPE

As issues of sustainability and the environment gain prominence, it is becoming clear that bio lubricants are necessary and crucial. The necessity and significance of bio lubricants can be seen in the following examples:

Petroleum-based materials, like those used to make conventional lubricants, are not biodegradable and can have a negative effect on the natural environment. However, bio lubricants are better for the environment because they are biodegradable and created from sustainable materials.

The usage of environmentally friendly items is mandated by law in a growing number of jurisdictions, both domestic and international. Using bio lubricants is one way for businesses to lessen their environmental effect and show compliance with these rules.

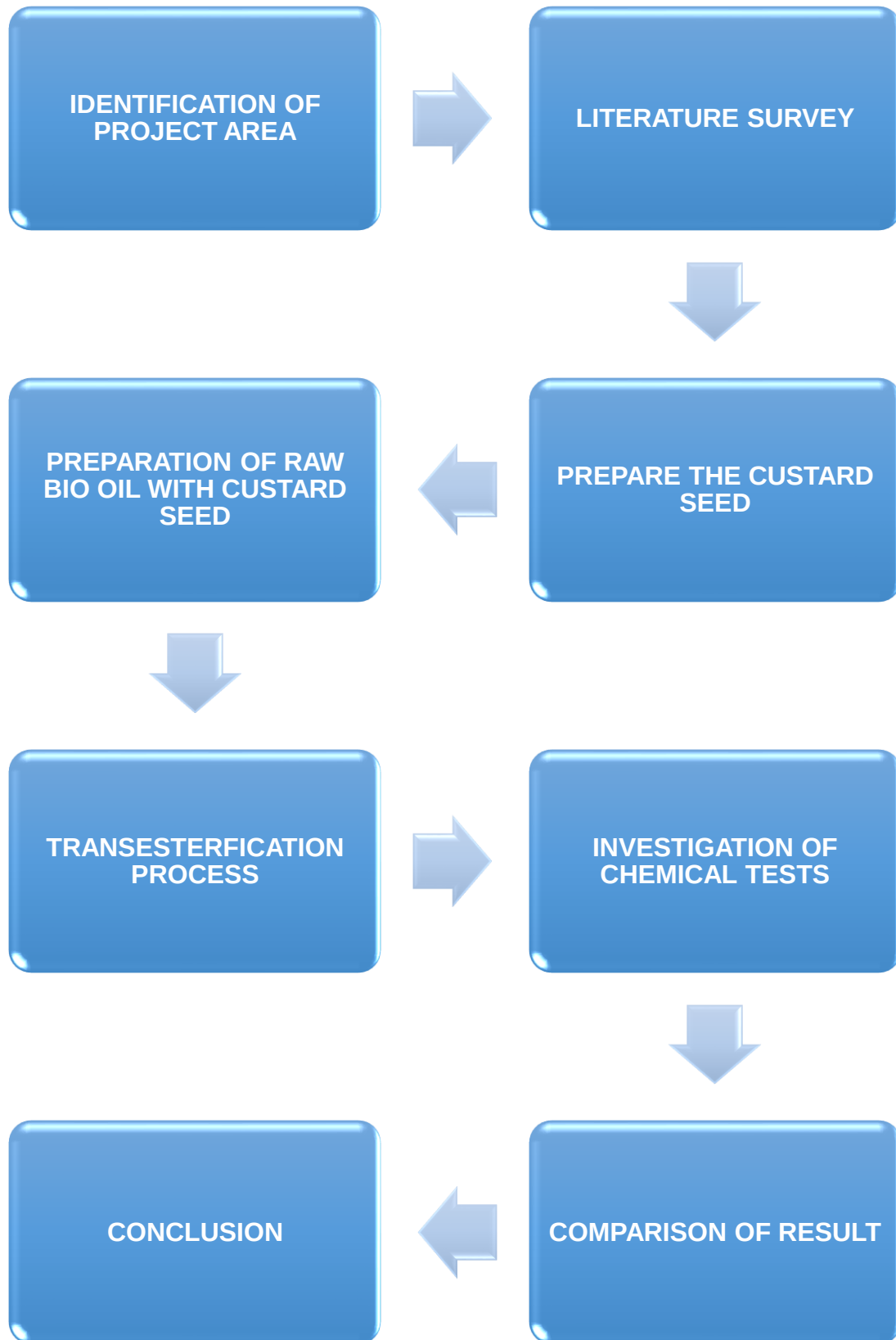
Bio lubricants are safer to use since they are less combustible than conventional lubricants. This is of paramount importance in sectors where the possibility of fire or explosion exists.

Bio lubricants have been demonstrated to work better in high temperatures and under heavy loads, expanding its usefulness in a variety of settings.

Since bio lubricants tend to last longer than conventional lubricants, you may find that you save money in the long run by not having to replace them as often. In fields where expensive gear and equipment are used, this is of paramount importance.

In sum, bio lubricants are obviously necessary and crucial. They outperform conventional lubricants in terms of safety, performance, and cost, and they are better for the environment. More and more businesses are switching to bio lubricants, which is great news for the environment and the health of our planet.

3.3 METHODOLOGY



CHAPTER – 4

4.1 MATERIALS AND METHODS; ALGORITHMS USED



Figure 4.1 : Custard Apple

Some fruits go by the moniker "custard apple," as does the tree that bears them, *Annona reticulata*. The fruits can be irregular, spherical, heart-shaped, or oblong in form. Depending on the cultivar, the size varies from 7 centimetres (2.8 in) to 12 centimetres (4.7 in). Depending once again on the type, mature fruit has crimson highlights and a brown or yellowish colour with variable degrees of reticulation. The meat might be hard and taste awful, or it can be luscious and quite scented. Like 'regular' custard, it has a lovely, sweet flavour.

Custard apple may also be the name of some similar fruits produced by related trees: Ramphal Custard-apple.

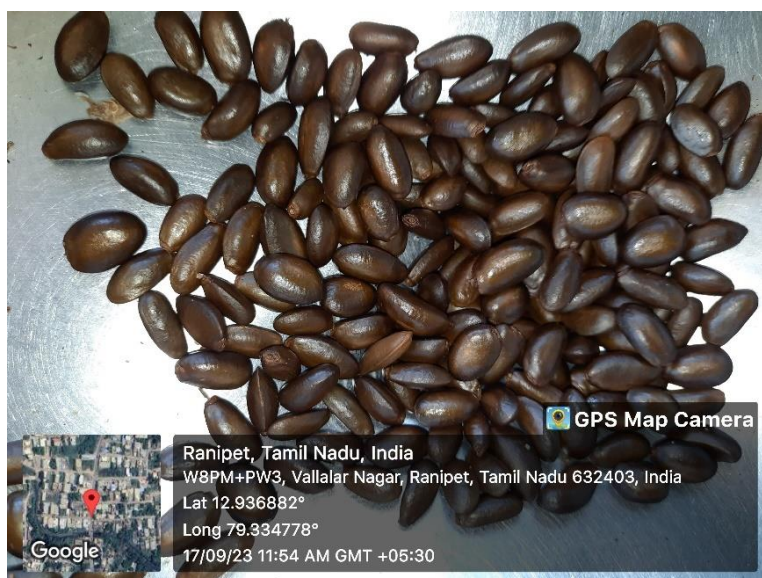


Figure 4.2 : Custard Apple Seeds Dried

This shrub's leaves are combined to create a wonderful remedy that relieves colds and coughs. For those with anaemia, the fruit is quite beneficial on its own. However, it's the seeds of this fruit that catch you off guard. Custard apple seeds are located inside the fruit pulp and have a dark brown hue.

BENEFITS OF CUSTARD APPLE SEEDS

1. Removes Head Lice: Are you annoyed of witnessing lice and nits itch your head? Has everything, including the medicinal shampoos, failed? Examine the custard apple seeds. Simply take a small amount, powder it, and combine it to create a paste, add a little water. Allow the head to rest for 10 minutes after application. Use cold, running water to rinse. If you follow this method two times per week for a month, your head will be totally lice-free and you will see amazing results.

2. Insect Repellent: Do you find your home overrun with ants and other insects? Once more, the custard apple seeds can save your bacon. After adding some powdered seeds to some water, let it sit for a few days. You are now prepared to make your own DIY bug repellent. Disperse the mixture throughout the house, paying particular attention to the areas that are affected. The outcomes will be remarkable and immediate.
3. The same combination may also be used as a weed killer and pesticide in your home garden. For ten to fifteen days, sprinkle a portion of the infected plant on a daily basis to completely eradicate the leaf-eating insects.
4. Pharmaceutical Usage: Because of this fruit's proven abortifacient qualities, pharmaceutical companies employ its seeds extensively. It is employed in the production of drugs intended to cause abortions.
5. Commercial Farm Pesticides: Custard apple and neem seeds are combined to create a powerful, poisonous pesticide that is employed in commercial farming. Thus, the insecticide generated from these seeds is organic and safe for the environment. For human health, using insecticide derived from custard apple seeds is quite advantageous.
6. Production of Biogas: These small marvels are used commercially in countries like as Germany and many other European countries to produce biogas. This fruit's seeds have trapped methyl-ester-rich fatty acids that cause the gas to be produced.
7. Another Unusual Use: Because custard apple seeds are poisonous, several nations employ them as fish bait.

4.1.1 SAE 20W40 Lubricant Oil

The Society of Automotive Engineers (SAE) has designated SAE 20W40 as a standard motor oil grade. Multi-grade or multi-viscosity motor oils are what these fits into the temperature range in which the oil retains its viscosity is indicated by the "20W" portion of its label.

The number "20" indicates the oil's viscosity at 20 degrees Fahrenheit or less. Oil with a lower viscosity number is more suited for cold starts and freezing temperatures.

The "40" indicates the oil's working temperature or higher temperature viscosity. More protective at high temperatures is oil with a higher viscosity rating.



Figure 4.3 : SAE 20W40 Lubricant Oil

The following is a common interpretation of SAE 20W40 motor oil:

Performance in Cold Temperatures: SAE 20W40 motor oil is a versatile choice due to its high cold-start performance. Since engine wear is reduced at engine starter, the "20W" implies that it flows adequately even in cold weather.

Performance at Operating Temperatures: SAE 20W40 Motor Oil has a similar viscosity to SAE 40 Oil at Operating Temperatures. Under typical driving circumstances, engine parts are well-lubricated and protected in this way.

Older petrol and diesel engines, as well as some types of agricultural and industrial machinery, frequently call for SAE 20W40. It's popular in temperate regions since it can withstand a variety of temperatures and protect engines from extremes in operation.

The viscosity index of SAE 20W40 varies from brand to brand and formulation to formulation. Oils with a higher VI maintain their lubricating properties throughout a wider temperature range because their viscosity is less sensitive to variations in temperature.

Checking for the right API (American Petroleum Institute) service grade, like API SN for petrol engines or API CI-4 for diesel engines, is crucial when purchasing motor oil. These grades reveal how well the oil performs and whether or not it is suitable for use in a given vehicle's engine.

Although SAE 20W40 may be appropriate for many engines, it is always best to check the manufacturer's guidelines for your specific model. Engine damage or decreased performance may result from utilising oil that isn't designed for use in that particular machine. Maintaining your engine's health requires regular oil changes using oil of the proper grade and quality.

IMPORTANCE OF SAE 20W40

SAE 20W40 lubricant oil is important for various reasons in the automotive and industrial sectors. Here are some of the key importance and applications of SAE 20W40 lubricant oil:

Engine Protection: SAE 20W40 oil provides vital lubrication to internal engine components, such as pistons, crankshafts, and bearings. This lubrication reduces friction, minimizes wear and tear, and extends the life of the engine.

Temperature Versatility: It has a good balance of viscosity characteristics, making it suitable for use in a wide range of temperatures. The "20W" portion of the designation means it flows well in cold weather, reducing engine wear during startup, while the "40" portion indicates its viscosity at operating temperatures.

Cold-Start Performance: SAE 20W40 is designed to flow readily at low temperatures, which is crucial for effective lubrication during cold starts. It helps protect the engine from wear and damage, especially in regions with cold winters.

High-Temperature Protection: At high operating temperatures, SAE 20W40 provides the necessary film strength and viscosity to protect engine components from heat-related wear and damage. It maintains adequate lubrication even under extreme conditions.

Compatibility: SAE 20W40 is compatible with many types of engines, including older gasoline and diesel engines. It can be used in a variety of vehicles, including cars, trucks, agricultural machinery, and industrial equipment.

Versatility: Due to its versatility, SAE 20W40 is often used in applications where a single oil type is required to work across a range of temperatures and conditions.

Fuel Efficiency: Proper lubrication with SAE 20W40 can help improve engine efficiency by reducing friction. A well-lubricated engine operates more efficiently and may contribute to better fuel economy.

Engine Longevity: Regular use of SAE 20W40 oil can contribute to the longevity and reliability of an engine. It helps prevent premature wear and damage to engine components, reducing the need for costly repairs.

Minimizing Sludge and Deposits: High-quality SAE 20W40 oils often contain additives that help prevent the deposits and sludge buildup in the engine. This keeps the engine clean and maintains its performance.

Industry Standards: SAE 20W40 lubricants meet industry standards and specifications, ensuring that they provide the required level of protection and performance for different applications.

It's important to note that while SAE 20W40 oil is versatile and suitable for many applications, it's essential to use the oil recommended by the manufacturer for your specific vehicle or equipment. Different engines and applications may have varying requirements, and using the correct oil is crucial for optimal performance and engine longevity.

CHARACTERISTICS

SAE 20W40 lubricant oil has specific characteristics that make it suitable for various applications. These characteristics are determined by its viscosity, temperature performance, and other properties. Here are the key characteristics of SAE 20W40 lubricant oil:

Viscosity Range: SAE 20W40 is a multi-viscosity or multi-grade oil. The "20W" part indicates its viscosity at low temperatures, where it behaves like a 20-weight oil. The "40" part indicates its viscosity at high temperatures, where it behaves like a 40-weight oil. This dual-viscosity characteristic makes it versatile for use in a wide range of temperatures.

Cold-Start Performance: The "20W" viscosity rating means that SAE 20W40 flows well at lower temperatures. This is important for cold-start performance, ensuring that the oil can quickly reach and lubricate engine components when the engine is started in cold weather.

High-Temperature Protection: At high operating temperatures, SAE 20W40 provides the necessary thickness and film strength to protect engine components from wear and friction. It maintains adequate lubrication even under extreme conditions.

Versatility: SAE 20W40's ability to perform well in both cold and hot conditions makes it versatile for use in various applications, including older gasoline and diesel engines, agricultural machinery, and industrial equipment.

Engine Protection: It provides essential lubrication to internal engine components, reducing friction and minimizing wear and tear. This lubrication is vital for prolonging the life of the engine.

Compatibility: SAE 20W40 is compatible with many types of engines and equipment, making it a widely used choice across different industries.

Fuel Efficiency: Proper lubrication with SAE 20W40 can help improve engine efficiency by reducing friction. A well-lubricated engine operates more efficiently and may contribute to better fuel economy.

Cleanliness: High-quality SAE 20W40 oils often contain additives that help prevent the formation of sludge and buildup in the engine. This keeps the engine clean and maintains its performance.

Industry Standards: SAE 20W40 lubricants meet industry standards and specifications, ensuring that they provide the required level of protection and performance for different applications.

It's important to note that the specific characteristics of SAE 20W40 lubricant oil may vary slightly between different brands and formulations. When selecting an oil for a specific application, it's essential to consider the manufacturer's recommendations and specifications to ensure optimal performance and engine longevity.

DRAWBACKS OF CONVENTIONAL LUBRICANTS

The use of standard lubricants, such as SAE 20W-40 oil, might present challenges and drawbacks depending on the circumstance. Some typical problems with SAE 20W-40 oil include Because of its variable viscosity, SAE 20W-40 oil may not be the best choice for use at extremely high or low

temperatures. In colder temperatures, it can thicken up and become difficult to move and lubricate, whereas in warmer temperatures, it can thin out and be less effective at protecting moving components.

It has been found that SAE 20W-40 oil may not flow as freely at startup in cold conditions, which can lead to engine wear and decreased fuel efficiency.

Shear Stability: The capacity of SAE 20W-40 oil to preserve engine components may decline with time and in high-shear circumstances due to a decrease in the oil's viscosity. Pollution and greenhouse gas emissions are caused by the production and use of conventional lubricants since they are primarily made from fossil fuels. Without proper management, they pose a threat to soil and water quality since they do not biodegrade. Many common lubricants have components and additives that are harmful to people and animals. The human body can react negatively to exposure to certain chemicals.

When compared to synthetic or high-performance oils, SAE 20W-40 oil often requires more regular oil changes, which raises both maintenance costs and environmental effect. **Reduced Lubrication Efficiency in Extreme Temperatures:** SAE 20W-40 may not function as well in extremely cold or extremely hot settings.

Traditional lubricants have poor oxidation stability, which means that engine sludge and deposits can accumulate over time, limiting efficiency and perhaps causing damage.

Because of the increased friction and decreased lubrication efficacy, using SAE 20W-40 oil might decrease fuel efficiency in specific situations. **Problems with Compatibility:** Some engines, especially newer high-performance ones, may not work with SAE 20W-40 oil because they need different, synthetic lubricants.

It's worth noting that SAE 20W-40 oil's potential drawbacks can shift depending on the context of use and the quality of the oil itself. Many times, these problems can be avoided by following the manufacturer's recommendations for lubricant

use. In some situations, these issues can be mitigated, and improved performance and fewer negative effects on the environment can be gained, by switching to synthetic or bio-based lubricants.

One of the most frequent kinds of motor oil used in internal combustion engines is designated by the SAE as 20W-40. In internal combustion engines, some of the most common and important uses and applications of SAE 20W-40 lubricant include the following:

Lubrication of the Engine: SAE 20W-40 oil is most commonly utilized for the purpose of providing lubrication to the moving parts of internal combustion engines. These parts include the bearings, crankshaft, camshaft, and pistons. It does this by forming a protective film that cuts down on friction and wear, which in turn helps the engine to last longer.

Temperature Range: Because SAE 20W-40 is formulated to function successfully in a moderate temperature range, it is an excellent choice for a wide variety of automobiles and pieces of machinery that are used in regions with moderate climates. The "20W" portion of the classification reflects the fluid's low-temperature viscosity (flow) properties, whereas the "40" component of the classification indicates the fluid's high-temperature viscosity.

traditional Engines: This viscosity grade is frequently used in traditional gasoline and diesel engines, particularly older ones, where the original equipment manufacturer (OEM) advises or mandates using that particular grade. However, its application can change depending on the design of the engine and the weather circumstances.

SAE 20W-40 is a type of motor oil that is frequently used in light to medium-duty vehicles. These kinds of vehicles include cars, trucks, vans, and even certain minor pieces of industrial equipment.

Agricultural and Industrial Equipment: It is also utilized in a wide variety of equipment, including as tractors, construction machinery, and other industrial engines, amongst other sorts of equipment. This viscosity grade is appropriate for the lubricating requirements of these engines because they frequently run at operating temperatures that are constant. It's possible that some fleets of vehicles, such as delivery trucks, buses, and other

commercial vehicles, utilize SAE 20W-40 motor oil because it's compatible with their engines and the conditions under which they operate.

Stationary Engines: SAE 20W-40 may be an option worth considering for lubrication consistency maintenance in applications involving stationary engines, such as power generators and other types of machinery that remain in one place. **Option That Is More Economical:** SAE 20W-40 motor oil is a cost-effective solution for engines that do not require the advanced performance characteristics of synthetic lubricants and is typically more cheap than synthetic oils. It is essential to keep in mind that the selection of motor oil for an internal combustion engine should be in accordance with the recommendations of the engine's manufacturer as well as the conditions under which the engine operates. For best engine performance and longevity, it is vital to examine the owner's handbook and follow the directions provided by the manufacturer. Since many modern engines have specific requirements for the oil viscosity and performance characteristics, this makes it essential to review the manual. Certainly, in regard to the application of lubricant according to SAE 20W-40 standards in internal combustion engines, the following are some extra factors to consider:

High-Mileage Engines: SAE 20W-40 motor oil is occasionally used in high-mileage engines, which tend to have more wear and tear than other types of engines. These older engines may benefit from improved lubrication and protection thanks to the increased viscosity of the oil.

Agricultural Machinery: SAE 20W-40 oil is frequently used in agricultural applications, such as tractors and other types of farm equipment, because it is compatible with older types of machinery and is able to handle the stresses that are associated with farming operations.

Compatibility: The gaskets and seals that are typically found in older engines are generally compatible with SAE 20W-40's viscosity. However, it is essential to

check for compatibility with the particular materials being used and to review the instructions provided by the engine manufacturer.

Change Intervals: Compared to synthetic oils, SAE 20W-40 oil may require more frequent oil changes than synthetic oils. The frequency of these changes is determined by the engine and the operating circumstances. It is essential to do routine maintenance in order to keep the engine in good health. **Use During the Summer** Because of its higher-temperature viscosity characteristics, SAE 20W-40 is ideally suited for use during the summer or in locations that are warmer. It is possible that the fluid will not flow as well when the temperature is lower, which could lead to problems during the startup process.

Minimized Oil Consumption The use of SAE 20W-40 can be beneficial for some older engines that have a propensity to eat oil. This is because the viscosity of SAE 20W-40 can aid reduce oil consumption. **Blends Made to Order** In certain instances, mechanics or engine enthusiasts may make custom oil blends by blending SAE 20W-40 with different oils in order to accommodate special conditions or fulfil the requirements of a particular engine.

Heavy-Duty Applications: Even though SAE 20W-40 is most frequently used in light duty to medium-duty vehicles and equipment, it is also sometimes utilized in heavy duty applications, provided that the engine's design and the operating conditions are compatible with its use. When selecting the right motor oil, it is vital to take into consideration the recommendations of the manufacturer, as well as the environment and operating circumstances, as well as the age and design of the engine. Synthetic oils with the necessary viscosity and performance characteristics may provide improved protection and fuel economy for modern engines. On the other hand, SAE 20W-40 oil may be more reliable and compatible with older engines and machinery, which could be to their advantage.

When used as a bio lubricant, the combination of custard seed oil with the conventional lubricant SAE 20W-40 can have a number of beneficial effects. The following are a few of the potential advantages: **Environmental Friendliness**

Because custard seed oil is derived from a renewable resource, it is considered to be more environmentally friendly than lubricants that are derived from petroleum. It lessens reliance on fossil fuels, which in turn reduces carbon emissions and the overall negative impact on the environment.

Biodegradability: Custard seed oil is biodegradable, which means that it decomposes in a natural way and produces fewer harmful effects on the environment when it is released into the environment or discarded.

Reduced Toxicity Bio lubricants, such as custard seed oil, often have a lower level of toxicity compared to lubricants derived from petroleum, making them safer for both people and wildlife.

Improved Lubrication qualities: When combined with other types of lubricants, custard seed oil can enhance the lubrication qualities of a mixture, hence reducing the amount of friction and wear that occurs in machinery and engines.

Improvements to a Lower Viscosity Index Because custard seed oil can assist increase the viscosity index of the lubricant, it can provide better lubrication in a wider range of temperatures. This is especially helpful in applications in which temperature changes are common.

Enhanced Protection Against Corrosion Because custard seed oil contains a number of naturally occurring additives, the bio-lubricant blend might provide enhanced protection against corrosion.

Potential Cost Savings Although custard seed oil can be more expensive than conventional lubricants, combining it with SAE 20W-40 oil can result in potential cost savings when compared to the use of fully synthetic bio lubricants.

Longer Lifespan of Equipment: Increased lubrication and less wear can result in a longer life span for equipment, which in turn lowers the expenses of both maintenance and replacement.

Compliance with Regulations It's possible that using a bio lubricant mix will make it easier to comply with environmental regulations and standards that call for the use of lubrication solutions that are more sustainable and kind to the environment.

Applications of All Kinds The combination of custard seed oil with SAE 20W-40 oil has the potential to be useful in a wide variety of contexts, including those involving agricultural, construction, and industrial machinery. It is essential to keep in mind

that the particular benefits will be contingent on the formulation and application of the bio lubricant blend in question, in addition to the quality of the

custard seed oil that is put to use. To guarantee that the mixture satisfies the performance requirements of the application that is intended for it to be used in, appropriate testing and analysis should be carried out.

Why bio-lubricant is required instead conventional lubricant of SAE 20W40

Bio lubricants are gaining popularity as an environmentally friendly alternative to traditional petroleum-based lubricants like SAE 20W40. The use of bio lubricants is driven by several factors, and while they may not always replace conventional lubricants, they have their own set of advantages:

Environmental Benefits: One of the primary reasons for using bio lubricants is their reduced environmental impact. Bio lubricants are typically derived from renewable resources such as vegetable oils, animal fats, or synthetic esters. They are biodegradable and pose fewer environmental risks in case of spills or leaks. They are also less toxic to aquatic life.

Sustainability: The production of bio lubricants often involves crops that can be sustainably grown, reducing the dependence on non-renewable resources like crude oil. This aligns with the goal of reducing carbon emissions and promoting sustainable practices.

Biodegradability: Bio lubricants break down more readily in the environment compared to conventional lubricants, reducing the risk of long-term environmental contamination.

Lower Toxicity: Bio lubricants are typically less toxic than petroleum-based lubricants, making them safer for users and reducing health risks associated with exposure.

Renewable Feedstocks: Bio lubricants can be made from a variety of renewable feedstocks, including plant oils, which can be sourced locally, reducing the need for long-distance transportation.

High Performance: Some bio lubricants have been engineered to offer performance characteristics similar to or even better than traditional lubricants. They may have excellent lubricity and thermal stability.

Specialty Applications: Bio lubricants are sometimes preferred for specific applications where traditional lubricants may not be suitable due to environmental regulations or concerns. For example, they may be used in environmentally sensitive areas or in food processing equipment.

However, it's essential to note that bio lubricants are not a one-size-fits-all solution, and their suitability depends on the specific application and requirements:

Compatibility: Bio lubricants may not be compatible with all equipment and materials, so compatibility testing is often necessary.

Cost: Bio lubricants can be more expensive than conventional lubricants, which can be a consideration for some users.

Temperature Sensitivity: Some bio lubricants may have limitations in extreme temperature conditions, so they may not be suitable for all applications.

Performance: While some bio lubricants offer excellent performance, others may have limitations in terms of viscosity, wear protection, or other properties compared to conventional lubricants.

In summary, bio lubricants are required in certain applications where environmental concerns, sustainability goals, or regulatory requirements make them a preferred choice. However, they may not replace traditional lubricants like SAE 20W40 in all applications, and the choice depends on a careful assessment of the specific needs and constraints of the situation.

4.1.2 Machine Expeller



Figure 4.4 : Crushing Machine for Oil Extraction

The mechanical process of machine expeller, also known as oil pressing, is used to extract oil from raw materials. In a single process, the raw ingredients are crushed under intense pressure. Nuts, seeds, and algae are commonly utilised as raw materials for food oil extraction, and they are fed continuously into the press. Friction during pressing raises the temperature of the raw material, which can reach temperatures of 120 °F (49 °C) for tougher nuts (which demand greater pressures).

4.2.1 Preparation of Biolubricants (Transesterification)

Transesterification is a common chemical reaction used to produce biodiesel from various vegetable oils, including custard apple seed oil, to create a bio lubricant. Here is a simplified procedure for making a bio lubricant from custard apple seed oil using transesterification:

Materials and Equipment:

- Custard apple seed oil (as the feedstock)
- Methanol (methanol-to-oil molar ratio of around 6:1)
- Sodium hydroxide (NaOH) or potassium hydroxide (KOH) as a catalyst
- A reactor vessel (stainless steel or glass)
- Magnetic stirrer
- Heat source (e.g., hot plate)
- Thermometer
- Biodiesel collection container
- Safety equipment, including gloves and safety goggles.
- Separatory funnel
- Water for washing and neutralizing the bio-lubricant.

Procedure:

Prepare the Catalyst Solution:

Dissolve the required amount of sodium hydroxide (NaOH) or potassium hydroxide (KOH). This will be your catalyst solution. Ensure safety precautions, as these chemicals are caustic.

Measure and Heat the Oil:

Measure the desired amount of custard apple seed oil and transfer it to the reactor vessel.

Heat the Oil:

Heat the custard apple seed oil in the reactor vessel to a temperature between 50-60°C. Maintain this temperature throughout the reaction.

Add the Catalyst Solution:

Carefully add the catalyst solution to the heated oil while stirring continuously. The amount of catalyst depends on the quality of oil and the specific conditions, but it's typically around 0.5-1% of the oil weight. The exact amount may require experimentation.

Perform Transesterification:

Continue to stir the mixture for about 1-2 hours, maintaining the temperature. The transesterification reaction will convert the triglycerides in the oil into biodiesel and bottom layer as bio-lubricant with glycerol. The glycerol may remove (which is low bottom of the container).

Separate Glycerol:

Allow the reaction mixture to cool. The glycerol will settle at the bottom. Carefully decant or remove the glycerol layer.

Wash the Bio-Lubricant:

Transfer the bio-lubricant to a separatory funnel and wash it with warm water to remove any residual impurities. Shake the funnel gently and allow it to settle. Drain the water and repeat the process until the water layer is clear.

Neutralize the Bio-lubricant:

Neutralize the bio-lubricant by washing it with a dilute solution of citric acid or sodium bicarbonate to remove any remaining catalyst residues. Wash it again with water to remove the neutralizing agents.

Dry the Bio-lubricant:

Dry the bio-lubricant by heating it to remove any remaining water content. This can be done by heating the bio-lubricant gently to a temperature of around 100°C while stirring.

Filter the Bio-lubricant:

Filter the final bio-lubricant product through a fine mesh filter to remove any remaining impurities.

The custard apple seed oil should now be converted into bio lubricant (middle of the bottom layer) and bio diesel (top layer). Remember to take safety precautions when handling chemicals, and ensure that your work area is well-ventilated. The quality of your bio-lubricant can vary based on the purity of your ingredients and the exact procedure, so experimentation and testing may be required to meet your specific lubricant needs.

Procedure for Blending:

Combining distinct kinds of oils or lubricants is what's meant by "blending" bio lubricants; the main aim is to produce a end product that possesses the qualities and features that are wanted. In this situation, wants to manufacture a bio lubricant mixture by combining 80% SAE 20W40 oil with 20% custard seed oil to create a 600 ml bio lubricant mixture. Here's a step-by-step procedure for blending these two components:

Materials and Equipment:

- lubricant SAE 20W40
- Oil made from custard seed.
- A cylinder or container with graduated markings that is used for measuring liquids
- a container for mixing, preferably one that is dry and clean.
- Rod for stirring or a blender
- Wear protective eyewear and gloves (when working with chemicals).
- Identifying labels for the finished product blend

Procedure:

- When dealing with oils and chemicals, you should always protect your eyes and skin by donning safety goggles and gloves. This will ensure that no harm comes to either.
- Measure the oils will need to determine how much SAE 20W40 oil and custard seed oil, will need to create a mix that is equal to 600 millilitres.
- For 80% SAE 20W40, divide 600 millilitres by 80% to get 480 millilitres of SAE 20W40 oil.
- For custard seed oil containing 20%: 20% of 600 millilitres equals 120 millilitres of custard seed oil.
- The first step in combining the oils is to fill the mixing container with 480 ml of SAE 20W40 oil.
- To the same container, add 120ml of oil extracted from custard seed.
- Use a stirring rod or a blender to fully combine the two oils, then mix them together in their entirety. Make sure that the oils are evenly distributed throughout the mixture by giving them a thorough blending.
- Indicate on the container the mix ratio (80% SAE 20W40 + 20% custard seed oil), the date it was blended, and any other pertinent information that may be applicable. This will assist you in identifying the contents and keeping track of how long they have been preserved for use.
- Put the finished bio lubricant into a clean, dry container that has a cover that fits tightly and put it away. To ensure that it keeps its shape, you should make sure that it is kept out of the direct sunshine and away from particularly high or low temperatures.

4.2.2 Flash Point

Point of Flash & Fire Equipment for measuring the flash points of lubricating oils, fuel oils, bitumen (apart from cutback bitumen), and particles suspended in liquids with a flash point higher than 49°C. The equipment is made up of a flexible shaft stirrer and a brass test cup with a handle and a detachable cup lid. It also has an oil test jet flame mechanism and a spring-operated rotating shutter. The assembly is supported by an air bath with a metal dome on top. The cup assembly is put within a brass-topped cast iron air bath. that has been chrome-plated and is equipped with an electric heater and temperature control.

Specification:

- Control: Fully Automatic Control
- Flash point: 49°C
- Power Source: 220V, 1Ph, 50Hz AC Supply



Figure 4.5 : Flash & Fire Point Test Apparatus

The lowest temperature at which a volatile material's vapours will ignite in the presence of an ignition source is known as the material's flash point. There is a

misconception that the temperature at which autoignition occurs spontaneously is the same as the flash point. The lowest temperature at which a material's vapours will continue to burn after the ignition source is withdrawn is known as the fire point. Since new vapours may not be created quickly enough to sustain combustion at the flash point, the fire point is higher than the flash point. The temperature of the ignition source is far higher than that of the flash or fire points, although neither of them directly depends on the other.

The flash point of a lubricant is an important feature that indicates how easily it can be ignited when it is brought into contact with a naked flame or another source of heat. It is the lowest temperature at which the lubricant vaporises sufficiently to form

a combustible mixture with air, leading to a momentary flash of fire when exposed to an open flame. This temperature is referred to as the flash point. The flash point is a very important safety criterion, particularly in contexts in which lubricants are subjected to high temperatures or are in close proximity to hazardous ignition sources.

Standardised testing procedures, such as the Cleveland Open Cup (COC) test or the Pensky-Martens Closed Cup (PMCC) test, are commonly utilised in order to ascertain the flash point of a substance. In these tests, a sample of the lubricant is gradually heated while an open flame or spark is intermittently introduced to the surface of the sample. The flash point is defined as the temperature at which a visible flash or flame can be noticed.

Depending on the specifics of their chemical make-up, various kinds of lubricants, such as those made from minerals, synthetic materials, or even biological materials, can have very different flash points. Lubricants with higher flash points are regarded safer for use in high-temperature or potentially hazardous conditions because they have a lower probability of igniting and are therefore less likely to cause an accident.

It is essential to have a solid understanding of the flash point of a lubricant in order to guarantee the safe handling, storage, and use of lubricants in a wide variety of industrial and automotive applications. In order to reduce the likelihood of fires and other accidents, regulatory bodies frequently specify minimum flash point criteria for various applications involving lubricants.

4.2.3 Fire Point

A fuel's fire point is the lowest temperature at which, when ignited by an open flame, its vapour will burn for at least five seconds. At the flash point, a substance will briefly ignite, which is a lower temperature, but it's possible that not enough vapour will be created to keep the fire going. Only material flash points are listed in the majority of material properties tables. Testing to determine if a fire point is safety essential is still necessary, even though it is generally accepted that fire points are around 10 °C higher than flash points.

The fire point of a lubricant is another significant quality that offers insight into the fire resistance and safety features of the substance. It is the lowest temperature at which the lubricant emits sufficient vapour to allow continuous combustion when it is exposed to an open flame or a heat source. This temperature is referred to as the smoke point. To put it another way, the temperature at which the lubricant will maintain a flame for at least five seconds after it has been ignited is referred to as the fire point.

In a manner analogous to that of the flash point, the fire point is often identified by means of standardised testing procedures, such as the Cleveland Open Cup (COC) test or the Pensky-Martens Closed Cup (PMCC) test. Both of these tests include the use of cups of varying sizes. In these tests, a sample of the lubricant is heated in a manner that is both controlled and consistent, and an open flame is brought to bear on the surface of the sample at regular intervals. The fire point is defined as the temperature at which the lubricant is capable of maintaining combustion for a period of at least five seconds.

In applications in which lubricants are subjected to high temperatures, potential ignition sources, or fire dangers, the fire point is a very important safety characteristic to take into consideration. It offers helpful guidance for selecting lubricants that are able to endure elevated temperatures without providing a threat of fire. It is generally accepted that lubricants with higher fire points are safer for use in high-temperature and demanding industrial situations.

In order to safeguard everyone's safety and cut down on the likelihood of fires and other mishaps, regulatory authorities and industry standards could come up with precise fire point requirements for lubricants that are used in different kinds of applications. For safe handling, storage, and application of lubricants in industrial, automotive, and other contexts, it is vital to have a solid understanding of both the flash point and the fire point of the lubricant.

4.2.4 Kinematic Viscosity

The resistance to flow under the influence of gravity is a key attribute of lubricants, and this resistance is measured by the kinematic viscosity. How smoothly a lubricant flows at a given temperature can be measured this way. Centistokes (cSt) are the units of measure for kinematic viscosity, and this property is commonly tested at either 40 degrees Celsius or 100 degrees Celsius, however this varies by application and industry norms.



Figure 4.6 : Red Wood Viscometer

A viscometer is a specialised piece of equipment used to quantify kinematic viscosity. Capillary viscometers, rotating viscometers, and falling ball viscometers are just a few examples of the many kinds of viscometers available. The fundamental concept is to time the pace at which a calibrated volume of the lubricant flows downhill through a calibrated tube or chamber.

Because the lubricant's thickness or fluidity might affect its performance in different contexts, knowing the kinematic viscosity value is crucial. High kinematic viscosity lubricants are more dense and move more slowly, while low kinematic viscosity lubricants are more fluid and move quickly.

Some important considerations related kinematic viscosity are as follows:

Choosing the right lubricant for a given piece of machinery and operating conditions is made easier by viscosity grades, such as ISO VG (Viscosity Grade), which are assigned to lubricants. These classifications are derived from temperature-dependent observations of kinematic viscosity.

Dependence on Temperature: A lubricant's kinematic viscosity can vary greatly depending on the operating temperature. As the temperature rises, it decreases,

making it important to take into account in applications where the temperature range is wide.

Considerations for Use: Lubricants with the optimum kinematic viscosity are essential for providing adequate protection to moving parts in equipment. Overly high viscosity can hinder flow and decrease efficiency, while inadequate viscosity can cause friction and wear.

Standards in the Industry The kinematic viscosity of lubricants may be subject to different standards and requirements depending on the industry and application. Manufacturers frequently include data sheets with information about viscosity for customers to use when making purchases.

In conclusion, a lubricant's kinematic viscosity is a key factor in determining how well it will perform its lubricating function. When it comes to keeping machinery running smoothly and reliably, knowing the viscosity needs of a given application and picking the right lubricant grade based on kinematic viscosity couldn't be more important.

4.2.5 Calorific Value

The calorific value of a substance is the amount of heat energy it releases when it burns or reacts with oxygen, and it is one of the most basic properties that can be measured. It is usually written as a ratio, such joules per gramme, kilojoules per kilogramme, or British thermal units per pound. The calorific value is an important factor in many contexts, especially the energy and fuel sectors.

Calorie counts mostly come in two varieties:

Greater heat energy emitted when a material is burned in an oxygen-rich environment is represented by the Higher Calorific Value (HCV) or Gross Calorific Value (GCV). Condensation of combustion-generated water vapour contributes heat energy.

HCV is usually more than twice as high as LCV.

Caloric content with fewer calories, or Net Caloric Content (NCC): The energy released as heat during combustion is taken into account by LCV, but the energy needed to vaporise any water byproducts is subtracted. Latent heat of vaporisation of water in the combustion products is taken into account, making this a more accurate measurement of the usable energy.



Figure 4.7 : Bomb Calorimeter

Among the many types of fuel, calorific value is crucial for:

Energy content of coal, natural gas, and petroleum products can be determined with its help. The energy efficiency and environmental impact of fossil fuels can vary greatly depending on the calorific value of the fuel.

Biodiesel, ethanol, and biogas are all examples of biofuels; these fuels are produced from renewable biological resources, and their energy content may be evaluated by measuring their calorific value.

Wood, biomass, and charcoal are examples of solid fuels commonly used in the kitchen and for home heating. Their calorific value is one indicator of whether or not they are useful for these purposes.

Production of Energy: The calorific value of fuels is crucial in determining the potential energy output and efficiency of combustion systems in power generation and industrial processes.

Calorific value is proportional to emissions released during combustion, which can have a negative effect on the environment. Fuels with a higher calorific value tend to provide more energy but may also cause more emissions, while fuels with a lower calorific value may be less energy-dense but may be better for the environment.

The quantity of heat generated by the well-regulated combustion of a certain amount is used to calculate the calorific value of the item in a laboratory setting; this is called a "bomb calorimetry." For proper energy utilisation, emission regulation, and fuel selection, an accurate understanding of calorific value is crucial.

4.2.6 Density

Lubricant density is defined as the mass per unit volume of a certain lubricant. It is usually written as a ratio, such as kg/m³ or g/cm³, which refers to the density of a given volume. Density, or the amount of mass contained in a particular volume, is an essential characteristic of any lubricant. The chemical make-up and temperature of the lubricant might affect this characteristic.

You need to know both the mass and the volume of the lubricant sample in order to calculate the density. Density can be determined using the following formula:

$$\text{Density} = \text{Mass} / \text{Volume}$$

The density of a lubricant can be calculated as follows:

Lubricant weight can be determined by weighing a sample of the fluid with a known volume. If the density of the lubricant changes depending on the temperature, make sure the sample is kept at a constant temperature.

Taking the Decibel Reading: Measure the lubricant sample's volume, which is usually expressed in millilitres (mL) or cubic centimetres (cc). Any container with clearly marked increments of volume will do, but a graduated cylinder is ideal.

The Density Formula: To determine the density of the grease, use the given formula. Convert between compatible mass and volume units (such as grammes and millilitres or kilogrammes and cubic metres).



Figure 4.8 : Weighing Scale

A lubricant's density can change with the ingredients it contains and the ambient temperature. To help customers determine if a given lubricant is suitable for their needs, several producers list density figures for their products at various temperatures. For many uses, it is crucial to know the density of the lubricant being used, such as:

Engineers employ density measurements to determine loads and strains in various components and systems by calculating the mass of lubricants present.

Density can be used in volume calculations to approximate the amount of lubricant needed for a given system or application.

For shipping and warehousing purposes, it is helpful to have an idea of how dense a given lubricant is.

When evaluating the possible environmental impact of lubricants, it is helpful to have some idea of their density. This is especially true in the event of accidental spills or leaks.

Knowing the relative densities of different lubricants can help you achieve the desired properties and performance when blending or mixing.

Always take the temperature circumstances into account when dealing with or analysing lubricants, as the density of the lubricant may alter with temperature.

A thorough technique is required to investigate the qualities of a bio-lubricant combined with custard seed oil and compare them to those of regular SAE 20W-40 oil. Detailed procedures for determining the melting point, boiling point, density, heat capacity, and viscosity of a substance are outlined below.

1. Preparing a Sample:

Samples of the bio-lubricant blend can be made by combining SAE 20W-40 lubricant and custard seed oil at 5%, 10%, 15%, and 20% concentrations. Get together an unadulterated SAE 20W-40 oil sample for use as a benchmark.

2. The Flash Point Analysis

Determine the flash point of each sample using a flash point tester (usually in accordance with ASTM D93 or other applicable standards). The temperature at which the lubricant vaporises is known as its flash point. produces sufficient ignition conditions to cause a brief fire.

3. The Fire Point Analysis:

Each sample's fire point should be measured using a fire point tester (often based on ASTM D92 or comparable standards). Under controlled laboratory

conditions, a lubricant's fire point is highest in its temperature at which it maintain a flame.

4. Quantifying Density:

Use a hydrometer or density meter to determine the density of each lubricant sample.

5. Calorific Value Determination:

Ensure Measurements Conform to Applicable Standards, such as ASTM D4052 the calorific data, or the heat of combustion, each sample can be determined with the help of a bomb calorimeter or other appropriate equipment. The energy density of the lubricants is measured by this procedure.

6. Viscosity Measurements:

Using a viscometer and in accordance with applicable standards (e.g., ASTM D445), determine the viscosity of each lubricant sample at varying temperatures, such as 40°C and 100°C. The viscosity of a lubricant is a key parameter since it describes the fluid's resistance to flow.

7. Duplicates and Quality Assurance:

It is important to run numerous replicates of each test to ensure statistical significance and accurate results. To ensure accuracy, use only 100% pure SAE 20W-40 oil in your comparisons.

8. Analysis of the Data:

Examine the data to see how the bio-lubricant blends with 5%, 10%, 15%, and 20% custard seed oil compared to the pure SAE 20W-40 oil. Determine if there are any tendencies or changes in the properties of flash point, fire point, density, calorific value, and viscosity.

9. Summary and Analysis:

Produce a detailed report that encapsulates the findings and their significance. Determine if the lubricating performance is significantly impacted by the changes in flash point, fire point, density, calorific value, and viscosity caused by the addition of custard seed oil to SAE 20W-40 oil.

Recommendations for using bio-lubricant blends including custard seed oil in certain applications, along with any potential benefits and downsides in comparison to using traditional lubricant oil, should be provided based on the findings. You can evaluate the potential environmental and performance benefits of bio lubricant blends and conventional lubricant oil by using this methodology to thoroughly explore and compare their major attributes.

CHAPTER – 5

5.1 RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

5.1.1 Comparison of results

Table 5.1 : Different Ratio Blended Results

Characteristics	SAE 20w40	Custard Seed Oil (5%)	Custard Seed Oil (10%)	Custard Seed Oil (15%)	Custard Seed Oil (20%)
Kinematic Viscosity @40°C in cSt	15.5	18	21	23.5	26
Flash Point °C	235	213	193	172	150
Fire Point °C	250	226	208	185	162
Gross Calorific Value kj/kg	39,847.54	40,139.12	40,431.00	40,722.95	41,014.28
Density in kg/m ³	919	915	911	908	905

5.1.2 Kinematic Viscosity @40°C in cSt

Table 5.2 : Kinematic Viscosity Results

Kinematic Viscosity @40°C in cSt				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
15.5	18	21	23.5	26

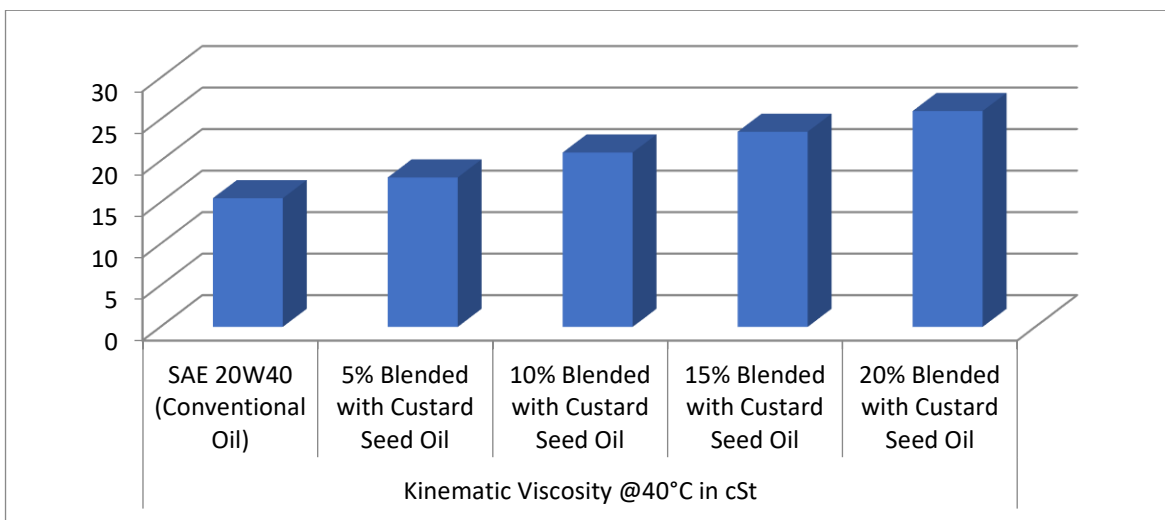


Figure 5.1 : KINEMATIC VISCOSITY GRAPH

5.1.3 Flash Point °C

Table 5.3 : Flash Point Results

Flash Point °C				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
235	213	193	172	150

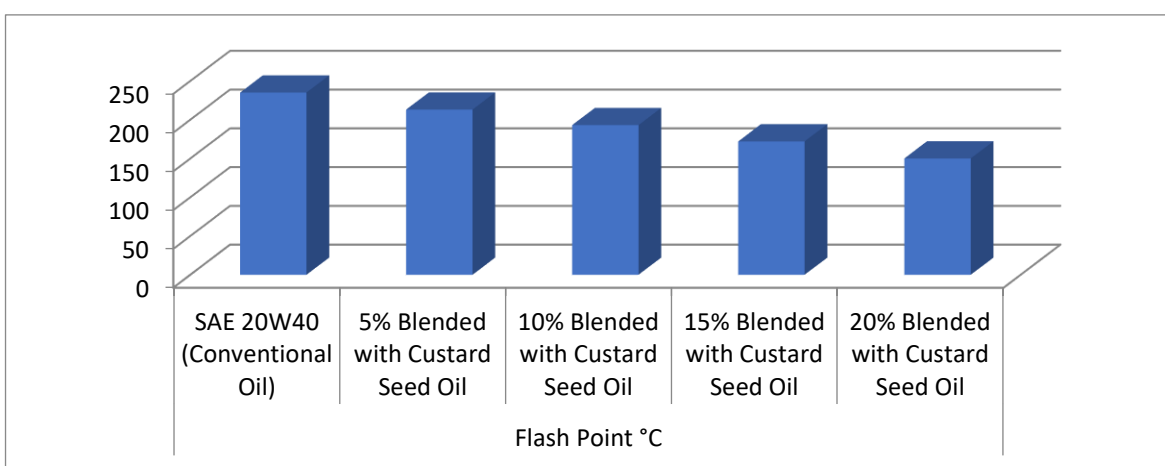


Figure 5.2 : FLASH POINT GRAPH

5.1.4 Fire Point °C

Table 5.4 : Fire Point Results

Fire Point °C				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
250	226	208	185	162

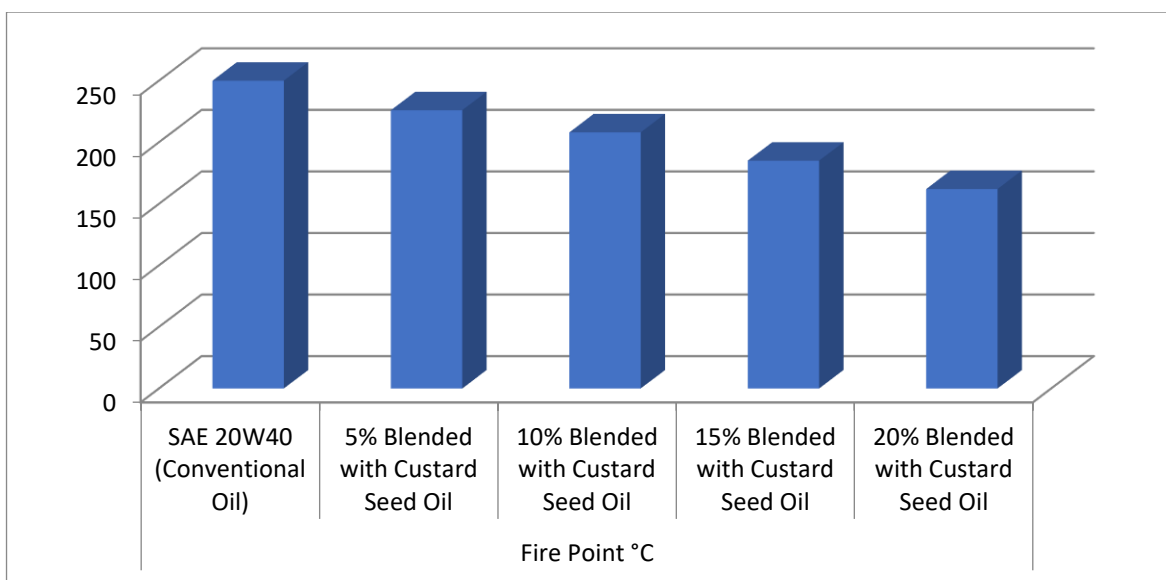


Figure 5.3 : FIRE POINT GRAPH

5.1.5 Gross Calorific Value kj/kg

Table 5.5 : Gross Calorific Value Results

Gross Calorific Value kj/kg				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
38847.54	40,139.12	40,431.00	40,722.95	41014.28

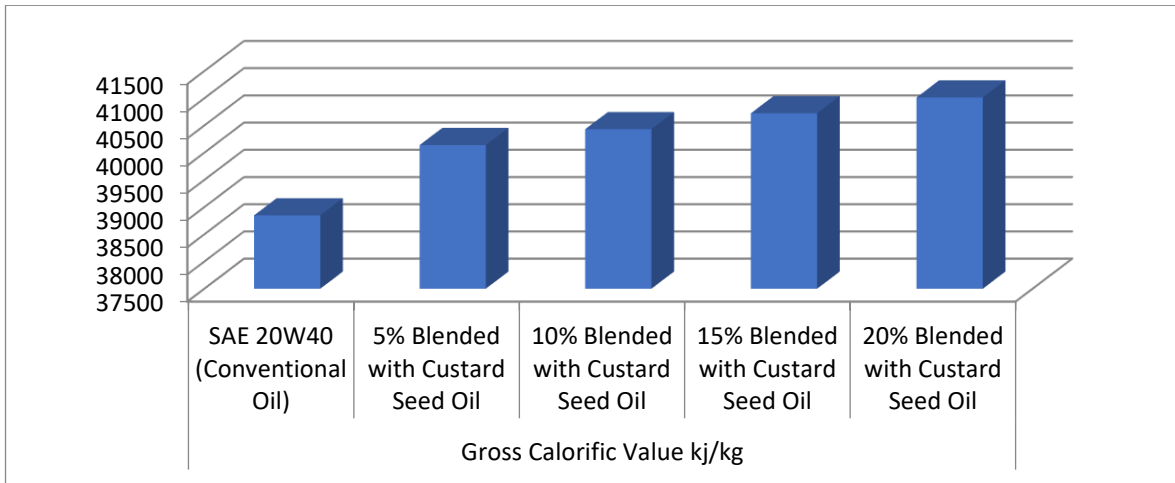


Figure 5.4 : GROSS CALORIFIC VALUE GRAPH

5.1.6 Density in kg/m³

Table 5.6 : Density Results

Density in kg/m ³				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
919	915	911	908	905

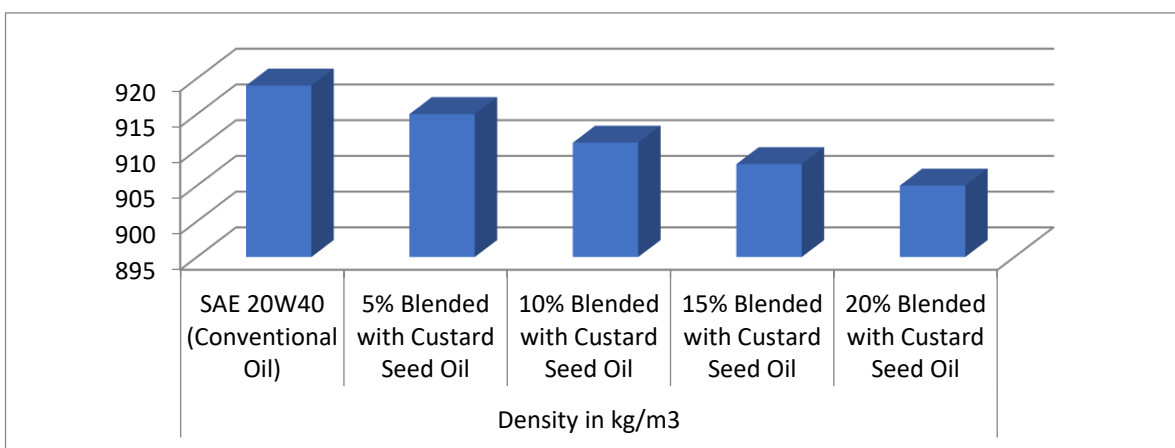


Figure 5.5 : DENSITY GRAPH

5.1.7 GCMS Comparison results

Raw Custard oil Peaks

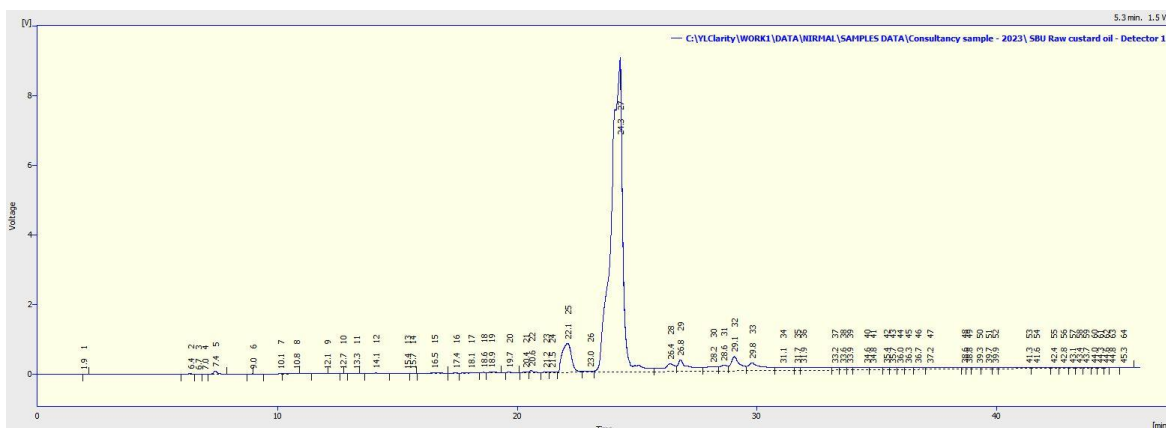


Figure 5.6 : GCMS Raw Custard oil peaks

10/27/2023 Chromatogram C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\Consultancy sample - 2023\SBU- Sathish sir\ SBU Raw custard oil.PRM Page 1 of 3



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Chromatogram Info:

File Name	: C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\Consultancy sample - 2023\SBU- Sathish sir\ SBU Raw custard oil.PRM	File Created	: 10/27/2023 11:01:36 AM
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Project	: C:\YLC\arity\Projects\Work1.PRJ	By	: Administrator

Sample Info:

Sample ID	: WPBDs	Amount	: 0
Sample	: Aaru Akka - consultancy sample	ISTD Amount	: 0
Inj. Volume [mL]	: 0.2	Dilution	: 0.1

Method	: C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\FID METHODS\FAME method-2	By	: Administrator
Description	:		
Created	: 3/17/2018 9:53 AM	Modified	: 10/27/2023 11:01 AM

Column	:	Detection	:
Mobile Phase	:	Temperature	:
Flow Rate	:	Pressure	:
Note	:		

Autostop	: 46.00 min	External Start	: Start - Restart, Down
Detector 1	: Detector 1	Range 1	: Bipolar, 2500000 mV, 20 Samp. per Sec.
Subtraction Chromatogram	: (None)	Matching	: No Change

Base	: Not Used	Calibration File	: None	Calculation	: Uncal
Scale Factor	: Not Used	Units After Scaling	: Not Used	Uncal. Response	: 0
Unretained Time	: 0.00 min	Column Length	: 50.00 mm	Column Calc.	: From Width at 50% of Height
Result Table Reports	: All Peaks	Hide ISTD Peak	: Enabled		

Result Table :

Table 5.7 : GCMS Table Raw Custard Oil

PEAK	RETEN TIME (MIN)	AREA (mV.s)	HEIGHT (Mv)	AREA (%)	HEIGHT (%)	COMPOUND NAME
1	7.413	817.843	84.091	0.2	0.6	PALMATIC ACID
2	22.117	21822.244	834.411	5.3	6.4	OCTADECATRIENOIC ACID
3	24.310	296510.033	9034.701	72.1	69.1	HEXADECANOIC ACID
4	26.807	10462.649	333.682	2.5	2.6	DEHYDROABIETIC ACID
5	29.053	10655.075	411.862	2.6	3.2	7-OXO-DEHYDROABIETIC ACID
6	29.787	9894.699	229.381	2.4	1.8	7-OXO-DEHYDROABIETIC ACID

After test sample peaks

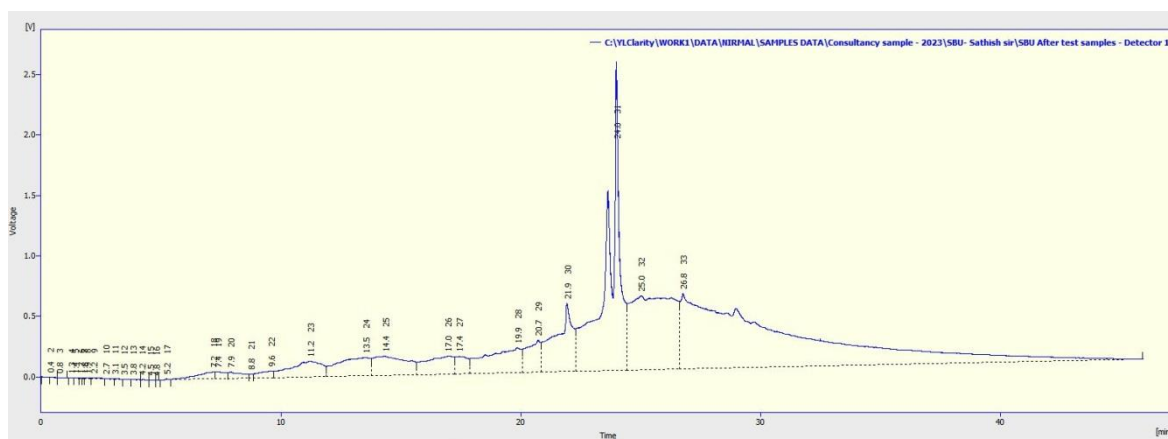


Figure 5.7 : GCMS 20% Blended sample oil peaks



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Chromatogram Info:

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Project : C:\YLC\arity\Projects\Work1.PRJ

File Created : 10/27/2023 1:14:34 PM
Acquired Date : 10/27/2023 1:08:54 PM
By : Administrator

Sample Info:

Sample ID : SBU- Ater test sample
Sample : Sathish Sir - consultancy sample
Inj. Volume [mL] : 0.2

Amount : 0
ISTD Amount : 0
Dilution : 0.1

Method : C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\FID METHODS\FAME method-2 By : Administrator

Description

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Mobile Phase :
Flow Rate :
Note :

Detection :
Temperature :
Pressure :

Autostop : 46.00 min
Detector 1 : Detector 1
Subtraction Chromatogram : (None)

External Start : Start - Restart, Down
Range 1 : Bipolar, 2500000 mV, 20 Samp. per Sec.
Matching : No Change

Base : Not Used
Scale Factor : Not Used
Unretained Time : 0.00 min
Result Table Reports : All Peaks

Calibration File : None
Units After Scaling : Not Used
Column Length : 50.00 mm
Hide ISTD Peak : Enabled

Calculation : Uncal
Uncal. Response : 0
Column Calc. : From Width at 50% of Height

A yield of 70 weight percent on average was used to manufacture the polyol esters. The fatty acid makeup of polyol esters, tetra esters, and triesters was summarised. Saturated fatty acid content was 80.9, 83.1, and 88.1% in TMP triesters, Di-TMP tetra esters, and PE tetra esters. TMP triesters, Di-TMP tetra esters, and PE tetra esters have unsaturated fatty acid percentages of 19.1, 16.9, and 11.9%, respectively. The polyol esters obtained from this investigation exhibited fatty acid compositions that were comparable to raw custard seed oil.

Result Table:**Table 5.8 : GCMS Table After Test Samples**

PEAK	RETEN TIME (MIN)	AREA (mV.s)	HEIGHT (Mv)	AREA (%)	HEIGHT (%)	COMPOUND NAME
1	21.947	28292.745	562.263	5.8	9.6	OCTADECATRIENOIC ACID
2	24.010	88141.680	2550.143	18.0	43.6	HEXADECANOIC ACID
3	25.030	76667.815	612.414	15.6	10.5	DIISOCTYL PHTHALATE
4	26.773	198006.690	623.600	40.3	10.7	DEHYDROABIETIC ACID

CHAPTER – 6

6.1 SUMMARY AND CONCLUSIONS

In this lab study, we analysed a bio lubricant mixture of custard seed oil (at a 5%,10%,15%,20% concentration) and SAE 20W40 (at an 95%,90%,85%,80% concentration). Key parameters such kinematic viscosity, flash point, fire point, calorific value, and density were the focus of the study. The findings shed light on the functionality and versatility of this bio lubricant mixture. And analysed the GCMS tests of raw custard oil & 20% Blended bio lubricant mixture. Based on the results of the experiment, it appears that a mixture of custard seed oil (at a concentration of 20%) and SAE 20W40 conventional oil (at a concentration of 80%) makes a suitable bio lubricant. It has a calorific value that could be useful in some situations, as well as a favourable kinematic viscosity and an acceptable flash and fire point for safety. It has an average density for a lubricant. However, this blend's viability must be assessed in light of particular application needs, environmental considerations, and sector norms. It's possible that more study and testing is needed to verify its effectiveness in practical applications. In conclusion, this study adds to our knowledge of the characteristics of the bio lubricant blend and sheds light on its possible future applications as a green and effective lubricant. More research and use of this mixture could improve its efficiency and environmental friendliness in a number of sectors. When used in internal combustion engines, bio lubricants derived from custard seed oil can have a number of effects and benefits, including on engine performance as a whole, pollution levels, and the longevity of individual engine parts. Bio lubricants, such as those made from custard seed oil, can improve engine performance by lowering friction. This can improve fuel economy by reducing the amount of energy wasted in the form of friction within the engine. Smoother operation, less wear on engine parts, and increased performance are all possible benefits of bio lubricants' enhanced lubricating qualities. Lower emissions could result from using some bio lubricants, such as those made from custard seed oil. Better lubrication qualities can reduce friction and improve engine smoothness,

both of which can help reduce emissions, especially in older engines. Reduced Wear and Tear on Components Enhanced lubrication can reduce friction and wear on engine elements including cylinders, pistons, and bearings, potentially prolonging their service life.

Corrosion Protection: Bio lubricants often provide enhanced corrosion protection, safeguarding engine parts and extending their useful life. It's worth noting, nevertheless, that the benefits and drawbacks of utilizing bio lubricants derived from custard seed oil in internal combustion engines may depend on a number of factors. Formulation and Blend: The bio lubricant's lubricating and engine-protecting properties can be greatly affected by the quantity of custard seed oil in the blend and the additives employed. The efficiency of the bio lubricant can be affected by factors such as the engine's load, temperature, and operating conditions. It's possible that under harsh conditions the performance of some bio lubricants will vary. It is essential that the bio lubricant be compatible with the engine's components. It's possible that seal swelling or material degradation could occur if a bio lubricant isn't suitable with a certain material. In conclusion, increased engine performance, lower emissions, and longer component life due to better lubrication and less wear are all possible benefits of employing bio lubricants derived from custard seed oil in internal combustion engines. The precise advantages, however, would be conditional on things like the precise mix composition, the operating conditions, and the materials used in the engine. In order to improve the efficiency of these bio lubricants and determine whether or not they are suitable for use in a variety of engines and environments, testing and continued research are required.

6.2 FUTURE SCOPE

After studying bio lubricants with different custard seed oil mixes for automobile IC engines, several important areas for research and application exist: Optimizing Blend Ratios: Research can determine the best custard seed oil blend ratios for bio lubricants. Increased sustainability must be balanced with maintaining or improving important qualities including viscosity, density, and

flash/fire points for automotive IC engines. Comprehensive performance testing under varied engine situations is essential. These blends must be tested in real-world circumstances with variable temperatures, loads, and speeds to determine their practicality. Impact on Engine Wear and Longevity: Investigation into these bio lubricants' long-term effects on engine components is crucial. This includes studying engine part wear and longevity with varied custard seed oil blend percentages. In addition to chemical qualities, bio lubricants' environmental impact must be studied. This includes assessing their biodegradability, emission reduction potential, and ecological impact in car IC engines. Additive Development: Test these bio lubricants with additives or modifiers to improve performance. Additives can regulate viscosity, increase lubrication, and change flash and fire points without affecting sustainability. Material Compatibility Studies: Custard seed oil-based bio lubricants must be tested with engine materials. Practical use requires that these lubricants do not damage engine components. Industrial implementation and scale-up: Custard seed oil-based bio lubricants for automotive IC engines must be tested for economic viability and large-scale manufacture. Industrial implementation's pros and cons must be understood for general adoption. This research will examine custard seed oil-based bio lubricants' chemical characteristics, performance, and environmental and economic impacts. These fields of research will help build sustainable, effective, and practical bio lubricants for automobile IC engines.

REFERENCES

1. **Ashokkumar S et al (2020)**, Comparison and Analysis of Custard Apple Seed Oil with Engine Lubricant.
2. **Doddabasawa and Ravi Kumar, (2014)**, Bio diesel production and physico-chemical property of custard apple seed.
3. **Ebtisam k. Heikal et al (2016)**, Manufacture of environment friendly bio-lubricant from vegetable oil.
4. **Ibrahim n. dibal et al (2017)**, Production of bio lubricant from custard oil.
5. **K.K Sharma, Anuj Kumar et al (2023)**, Comparative study of engine performance and emission test of Custard Apple seed oil Bio-lubricant dispersed with micro walled carbon nano tube with synthetic lubricants.
6. **Leelamani Pillai et al (2020)**, Synthesis and Characterization of Custard Apple seed oil Bio Lubricant.
7. **Omkaresh.B.R, et al (2015)**, Biodiesel Production from Custard Apple seed Oil and its Performance Test on CI Engine.
8. **Priyanka Chand,et al (2008)**, Thermogravimetric Quantification of Biodiesel Produced via Alkali Catalyzed Transesterification of Soybean oil.
9. **SiddalingappaR.Hotti, et al (2014)**, Biodiesel Production Process Optimization from Sugar Apple Seed Oil and Its Characterization.
10. **Subash V et al (2023)**, Manufacturing and Characterization of Bio-pesticide from Custard Apple Seeds.
11. **Waleed Abuhaimeed et al (2017)**, Using Biofuels as Lubrication Oil.

sb ashik

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EXPERIMENTAL INVESTIGATION ON BIO LUBRICANT WITH CUSTARD SEED OIL

¹ Submitted in partial fulfillment of the requirements for the award of Bachelor of
Technology degree in Chemical Engineering

by

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DEPARTMENT OF CHEMICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SANJAI KUMAR K (40690012)** and **SYED ASHIK S B (40690015)** who carried out the project entitled **"EXPERIMENTAL INVESTIGATION ON BIO LUBRICANT WITH CUSTARD SEED OIL"** under our supervision from July 2023 to October 2023.

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This is to certify that this Project Report entitled "**Experimental Investigation on Bio-Lubricant with Custard Seed Oil**" is a Bonafide work of **Mr. K. SANJAI KUMAR (Reg.No: 40690012) & Mr. S. B. SYED ASHIK (Reg.No: 40690015)** in partial fulfillment of the requirements For the award of "**Bachelor of Technology in Chemical Engineering**" who can carry out the Project under my supervision from July 2023 to November 2023. After the completion of the project, a journal publication of the work carried out shall be done.




Dr. Mohamed Abbas S., B.E., M.E., Ph.D.,

HEAD

Research and Developments

DECLARATION

I, **SANJAI KUMAR K (Reg.No.40690012)** hereby declare that the Project Report entitled **“EXPERIMENTAL INVESTIGATION ON BIO LUBRICANT WITH CUSTARD SEED OIL”** done by us under the guidance of **Dr.S.SATHISH, M.E.,Ph.D.** Associate Professor, Department of Chemical Engineering, Sathyabama University and **Dr.S.MOHAMED ABBAS., B.E., M.E., Ph.D.**, Head, Product and Research & Developments, Hoist Industries is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in **Chemical Engineering.**

DATE :

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

|

DECLARATION

I, **SYED ASHIK S B** (Reg.No. 40690015) hereby declare that the Project Report entitled “**EXPERIMENTAL INVESTIGATION ON BIO LUBRICANT WITH CUSTARD SEED OIL**” done by us under the guidance of **Dr.S.SATHISH, M.E.,Ph.D.** Associate Professor, Department of Chemical Engineering, Sathyabama University and **Dr.S.MOHAMED ABBAS., B.E., M.E., Ph.D.**, Head, Product and Research & Developments, Hoist Industries is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in **Chemical Engineering**.

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ABSTRACT

Key features of a bio lubricant mix of 80% SAE 20W40 conventional oil and 20% custard seed oil were the focus of this experimental study. Variables such as kinematic viscosity, fire point, density, and calorific value. were tested. To create the bio lubricant mixture, custard seed oil and standard SAE 20W40 oil were carefully combined. The effectiveness and qualities of the resulting lubricant blend were then evaluated using a battery of tests. A viscometer was used to ascertain the lubricant's kinematic viscosity, a crucial property in determining its ability to flow and create a film. The mixture's viscosity was measured and compared to that of standard lubricants based on the results. Important safety indicators like the flash point and fire point were measured with specialised equipment. These analyses determined the hottest and longest-burning operating temperatures at which the lubricant vaporised.

Utilising a bomb calorimeter, the lubricant's calorific value was determined, which is a measure of its energy density upon combustion. This study shed light on the energy efficiency of the lubricant. We weighed a standard volume of the mixture to determine its density, a key feature that influences lubricant distribution and performance. The density of the mixture was calculated using these data. The bio lubricant blend's viability for different uses was evaluated by comparing test results to those of custard seed oil and SAE 20W40 conventional oil. In sum, the results of this study reveal important information on the functionality and characteristics of a bio lubricant mix, illuminating its potential as an eco-friendly and long-term replacement for conventional lubricants. These results may be used to inform future research and product improvements in the area of bio-based lubricants.

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CHAPTER – 1

1.1 INTRODUCTION

As a result of growing environmental concerns, there is a growing interest in the development of products and processes that are renewable, biodegradable, and friendly to the environment. This interest has been fueled by the search for sustainable development. The growing demands, the diminishing energy reserves from fossil fuels, the cost of production, and the overall damage to the environment fueled the search for renewable sources of energy and other products, which has resulted in significant discoveries. Among these discoveries are significant breakthroughs in areas such as solar energy and wind power. Solar, hydro, and vegetable power have all made major contributions towards fulfilling the requirements for renewable energy on a worldwide scale. The biodegradable fuel and lubricants that are created from vegetable and cereal-based oils typically consist of between 60 and 99% base oil, with the remaining portion consisting of additives in varying proportions depending on the level of performance that is needed. Over the course of the past quarter century, there has been an increase in the utilisation of vegetable oil-based lubricants that are both ecologically friendly and biodegradable. In spite of this, the dependence on edible vegetables and cereals for the production of biodegradable fuel and lubricants has far-reaching implications for sustainable development. The use of fossil fuels and lubricants presents the greatest environmental risk because millions of tonnes of waste are annually discharged into the environment as a consequence of leaks and careless disposal practises. Furthermore, some of this waste is not biodegradable, which means that it contaminates the environment. Both the search for renewable raw materials that may be utilised for the production of lubricants and the creation of products that are biodegradable are the primary challenges that researchers face in the lubricant sector. The utilisation of vegetable and cereal oils, each of which contains three hydroxyl groups and long chains of unsaturated free fatty acids attached at the

hydroxyl group by ester linkages, must strike a balance between the needs for human and animal consumption and the derive for energy generation. These oils contain three hydroxyl groups and long chains of unsaturated free fatty acids. In spite of the fact that vegetable and cereal oils are frequently used in the production of biofuel, these types of oils are not widely used in the production of lubricant base oils. This is largely due to the fact that vegetable and cereal oils have undesirable physical properties, such as a high melting point and inadequate stability after thermal oxidation. The stability of bio-oils in respect to heat, oxidation, and hydrolysis can be improved by modifying their chemical characteristics; however, the impacts of lubricants that have had their chemical properties modified in this way on the environment have not been thoroughly explored and recorded. The carboxyl groups of the fatty acids undergo the most significant alterations, which account for around 90% of the total, whereas oleochemical reactions on the fatty acid chain account for approximately 10% of the total. Several experiments, employing a wide variety of vegetable and cereal oils, have been conducted. The oils derived from vegetables and cereals can be divided into two categories: those that are consumable by humans and other animals, and those that are not. The non-edible (castor seed) seed oil that had a homogeneous catalyst was used in our effort to achieve sustainable development. This allowed us to design a bio-lubricant that strikes a balance between the requirements for human consumption and the requirements for sustainable energy. This research is centred on the development of biodegradable lubricants from renewable sources using the seed of a plant that is not edible (castor seed). The purpose of this research is to alleviate the pressure brought on by the rising demand for consumable oils and to ensure that sustainability is maintained. The overarching goal of this body of study in the field of research is to lessen our reliance on fossil fuels, with the intention of fostering more environmentally responsible and sustainable forms of growth. Castor seed oil may be converted into lubricant, which will not only save foreign currency but also provide work possibilities. The effect of the profits as a multiplier might be duplicated by using a different kind of seed that is not edible.

1.2 BIO LUBRICANT

Lubricants are crucial in a variety of different industries because of the pivotal role they play in reducing the amount of friction and wear that occurs between moving parts. This, in turn, extends the lifespan of machinery and improves its overall efficiency. Despite the fact that it is typically obtained from sources that are based on petroleum, there is an increasing emphasis around the world on sustainability, environmental responsibility, and reducing our dependence on fossil fuels. Because of this, bio lubricants have been developed, and their use is becoming more widespread.

Bio lubricants, also known as biodegradable lubricants or eco-friendly lubricants, are a category of lubricants that are produced from renewable, biodegradable, and environmentally beneficial sources. Other names for this type of lubricant include "eco-friendly lubricants" and "biodegradable lubricants." They have a smaller impact on the environment and are easier to biodegrade compared to traditional lubricants that are based on petroleum, which is the primary factor driving their greater number of benefits.

The following are some of the key characteristics of bio lubricants:

Renewable Sources: Bio lubricants are often manufactured using renewable resources such as vegetable oils (for example, soybean, rapeseed, and sunflower oil), animal fats, and synthetic esters. This lessens the reliance that we have on dwindling stocks of fossil fuels.

The capacity of bio lubricants to degrade naturally is one of the most important aspects that contribute to the success of these products. They pose less of a threat to the environment over the long term compared to conventional lubricants, which can be persistent pollutants due to the fact that they decompose naturally in the environment.

Low Toxicity: Bio lubricants often have lower levels of toxicity as compared to their counterparts that are based on petroleum, which makes them safer for human health as well as ecosystems.

High Lubricity: A great number of bio lubricants have high lubrication capabilities, which reduces the amount of friction and wear that occurs between the various machine parts and improves the overall performance of the equipment.

Reduced Emissions of Greenhouse Gases: In comparison to the extraction and processing of petroleum, the manufacturing of bio lubricants typically results in a lower overall emission of greenhouse gases.

enhanced Thermal and Oxidative Stability: Under certain conditions, bio lubricants can demonstrate enhanced thermal and oxidative stability, which can result in extended oil change intervals and lower maintenance costs.

Applications: Because bio lubricants are so adaptable, they can be used in a broad variety of settings, including hydraulic systems, industrial settings, maritime settings, and automotive settings. They are utilised frequently in fields that are especially sensitive to the environment, such as agriculture and forestry.

Concerns and Things to Take into Account:

Bio lubricants have numerous advantages, but they also have certain disadvantages, such as the fact that their temperature stability is limited applications and that they may not be compatible with the machinery that is already in use. However, research and development initiatives are currently underway with the objective of overcoming these obstacles and expanding the usage of bio lubricants across a variety of industries.

To summarise, bio lubricants offer a sustainable and environmentally responsible alternative to the conventional petroleum-based lubricants that are currently on the market. Bio lubricants are becoming an essential component of the efforts being made to lessen the negative effects that lubrication operations have on the environment while simultaneously preserving high-performance

standards as the sustainability of both industry and consumers becomes a higher priority.

1.3 VARIOUS KINDS OF BIO-LUBRICANTS

Vegetable-Based Oils: These oils are among the most widely used types of bio lubricants, and they are derived from plants such as soybeans, canola, and sunflowers. They have excellent lubricating qualities and find widespread use in a variety of industries including metalworking, automotive, and hydraulic systems because of this.

Lubricants Derived from Animal Fats Additionally, animal fats as lard or tallow can be utilised in the manufacturing process of bio lubricants. They are especially effective in applications in which conditions of high loads and harsh temperatures are present.

Synthetic Esters Synthetic esters are lubricants that have been developed chemically and can be customised to meet the requirements of a variety of applications. They see widespread application in high-performance contexts, such as the aviation and military industries, respectively.

Polyalkylene Glycols (PAGs): Bio lubricants based on PAGs are renowned for their superior thermal stability and anti-wear qualities. They are put to use in demanding applications such as compressors and industrial gear that operates at high temperatures.

Bio-Based Greases: Greases are a type of semi-solid lubricant, and there are a variety of bio-based alternatives to choose from. They are frequently used in applications that demand a more viscous lubricant, such as bearings, gears, and other similar components.

CHAPTER – 2

2.1 LITERATURE SURVEY

Doddabasawa and Ravi Kumar, (2014), Bio diesel production and physico-chemical property of custard apple seed,

Two essential elements in the process of producing biodiesel are moist and free fatty acids. Greater moisture content and free fatty acids have the tendency to react with the catalyst, resulting in the creation of soap. Incomplete production of soap transesterification. Determination of free fatty acid decides the transesterification process and catalyst to be used. Alkyl method is used when the FFA is less than 3 per cent which is less expensive and faster than the acid catalyst.

Ebtisam k. Heikal, etal (2016), Manufacture of environment friendly bio-lubricant from vegetable oil,

The TMP ester synthesized methyl ester from palm oil and jatropha oil shown good potential as base stock in biodegradable lubricant formation. Bio lubricant from natural oil, especially nonedible oil is promising for special and environmental application.

Ibrahim n. dibal, etal (2017) Production of bio lubricant from custard oil,

The bio diesel produced from custard oil is blended with sodium lauryl sulphate to improve the property of bio lubricant. The sample of A and B were esterified with interval of one hour. The five iterations consist of three turn drastic esterification method and mild esterification method for two times. The process was repeated twice in the determination of percentage FFA values to reduce variation.

Omkaresh.B.R, etal, (2015) Biodiesel Production from Custard Apple seed Oil and its Performance Test on CI Engine,

This study examines the transesterification of non-edible seed oils, such as custard apple, karanja, and mauha oil, using methanol and a potassium hydroxide catalyst at 65°C to produce fatty acid methyl ester, or biodiesel. The characteristics of the biodiesels that are generated and their blends for various ratios (B10, B20, B30, B50, and B100) are equivalent to those of the ASTM biodiesel standards. The generated biodiesel, which has the best qualities out of the three, is put to the test to see if it can replace diesel engine fuel. Engine tests for various biodiesel mixes with regular diesel have been carried out at 1500 rpm, with a set compression ratio of 17.5, a fixed injection pressure of 200 psi and variable braking power.

Priyanka Chand, etal (2008), Thermogravimetric Quantification of Biodiesel Produced via Alkali Catalyzed Transesterification of Soybean oil.

The purpose of this work was to show how thermogravimetric analysis (TGA) may be used as a screening technique to monitor the generation of biodiesel through the transesterification of soybean oil with methanol. As benchmarks, several weight ratios of commercially available biodiesel and soybean oil were combined. Furthermore, base-catalyzed soybean oil transesterification with methanol was intermittently interrupted to form mixes with varying ratios of biodiesel to soybean oil. Using TGA, the mixtures generated by the two methods were examined between 25 and 500 °C.

SiddalingappaR.Hotti, etal (2014) Biodiesel Production Process Optimization from Sugar Apple Seed Oil and Its Characterization,

This research describes the characterisation and manufacturing of biodiesel from renewable, non-food sugar apple seed oil. Studies on the transesterification of oil using methanol and sodium hydroxide as a catalyst to produce biodiesel were conducted. For the purpose of producing sugar apple biodiesel (SABD), process variables including catalyst concentration, reaction time, and reaction

temperature were optimised. 95.15% of the biodiesel was produced at ideal process conditions. It was discovered that the fuel qualities of the generated biodiesel were nearly identical to those of diesel fuel and also satisfied ASTM criteria.

Waleed Abuhaimeed, et al (2017), Using Biofuels as Lubrication Oil,

The purpose of this article is to identify the characteristics of several vegetable oil-based biofuel lubricants. The effects of the lubricating oil's temperature and viscosity on changes in its qualities were determined via inquiry. Three vegetable oils—palm, corn, and almond—are evaluated in experiments built around SVM test machines. The findings display the density, absolute viscosity, and kinematic viscosity of the oils.

Lubricants are used to lessen the amount of heat produced by moving parts by decreasing the friction between them. Forces may be transmitted, foreign particles could be moved, and surfaces could be heated or cooled. (Trotsek, 2017) Lubricity is characterized by decreased friction. Lubrication is essential for lowering friction and wear. Common culprits include parts that slide, move, or rotate (Tung & McMillan, 2004). In addition, it can reduce the temperature of the region where the two metals are in close contact. Friction is a major source of wasted energy.

One third of the world's total energy is lost due to friction between sliding and moving elements. The quality and type of lubricating oil are crucial variables in reducing friction. Power, manufacturing, and transportation sectors all spend significant amounts of resources on reducing friction. High costs are incurred when mechanical components, transmission systems, and associated processes need to be replaced (Holmberg & Erdemir, 2007). Industries, machinery, and motor oil all make use of lubricants (Ahmed et al., 2016). A lubricant helps keep moving contact surfaces from wearing down and losing heat. It is used as a transformer insulator.

It functions as a barrier to prevent corrosion and reduce oxidation between two mating surfaces. In addition to protecting against smut, dusty powder, water, and grime, it also works as a sealant. High in The qualities of an excellent lubricant are strong resistance to oxidation, thermal stability, hydraulic stability, and corrosion avoidance. (Singh et al., 2017). Other desirable.

Characteristics include a low freezing point and high boiling point (so it remains liquid over a wide temperature range) and a high viscosity index. Mineral oil based and synthetic lubricants are the two main categories of conventional lubricants. High levels of refining, purification, and processing are used to create mineral oils. Hydrocarbons are distilled out of crude oil during the refining process. In their role as hydrodynamic lubricants, they transport additives for boundary or solid-film lubrication (Singh et al., 2017). Mineral oil is a petroleum byproduct that has seen increasing use as a lubricant in a wide range of contexts and as a component in a variety of beauty and hygiene products in recent years. Its high consumption can be attributed to its widespread use as a lubricant. The use of crude mineral oil as a lubricant is widespread in the transportation sector, particularly in the automobile, train, and aviation industries (Sadriwala et al., 2020). During oil changes, waste mineral oil is frequently released into the environment, contributing to pollution and negatively impacting ecosystems worldwide. Mineral oil contains chemicals, some of which have been linked to cancer and mutation. The public health problems associated with mineral oil disposal receive minimal attention in many poor countries. It has been linked to higher infant mortality rates (IMR) and child malnutrition (Salimon et al., 2010). Not being fully miscible with diesel and other basic fuels means that any that leak into the combustion chamber will only partially burn, creating pollutants if used in IC engines. As a result, using mineral oils will raise the amount of smoke and UBHCs released by the engines. Since mineral oils cause severe environmental pollution through the contamination of combustion products and damage the cylinder surface by the enhanced rubbing action of metallic compounds added to the lubricant, they are being phased out of use (Syahrullail

et al., 2013). However, vegetable oils can replace mineral oil-based alternatives in some contexts, such as lubrication.

42 Plants and their seeds are the source of vegetable oils. 2 Polar lipids (phospholipids and galactolipids), monoacylglycerols, diacylglycerols, free fatty acids, and polyisoprenoids make up the rest of the composition. Triacylglycerols account for 91%–96%. Table 1 displays a variety of vegetable oils and their respective uses. Lubrication is a prospective and possible use for vegetable-based oils. In Table 2,

2 We can see the differences between mineral oils and vegetable oils. Vegetable oil bio-lubricants outperform mineral oil in terms of lubricity, flash point, volatility, and viscosity index. Most mineral oils have a viscosity index between 90 and 100, while vegetable oils that aren't meant for human consumption have an index closer to 220. When operating at high temperatures, the lubricating coating is best preserved by vegetable oil-based lubricants with a high viscosity index. According to Alves et al. (2013), lubricants' volatility and fire-resistance properties are established by their flash and fire points. Energy savings of 16 percent or more are achieved, and operational temperatures are lowered. Bio-based lubricants have low pour and cloud points, excellent heat stability, and a high flash point because of the high concentration of polyunsaturated fatty acids they contain. They are biodegradable, have a high heat content, and low sulphur content. Multi-purpose oils, insulating oils, aviation oils, greases, metal grinding oils, and oils for other applications can all be made from vegetable oils instead of mineral oils (Singh et al., 2015). When compared to traditional lubricants, vegetable oils' biodegradability is the most crucial benefit (Erhan & Asadauskas, 2000a, 2000b a, b; Kumar et al., 2011). If the organisms or their enzymes in renewable raw materials created through aerobic or anaerobic processes can break down the lubricant, then the lubricant is considered biodegradable (Haase et al., 1989). When biodegradation rates of 80% or more are achieved within 28 days, or 60% or more are achieved after 28 days, a lubricant is termed degradable (Reeves et al., 2017). The biodegradability of a lubricant depends on

a number of factors. At the outset, the bio-lubricant disappears and a new compound is formed, which may or may not be totally biodegradable. Infrared spectroscopy is used to examine the C-H bond and quantify this primary bond's disintegration (Perin et al., 2008). Second, the organic molecule figures out how fast it will biodegrade into CO₂ and water (within 28 days) (Battersby & Morgan, 1997).

CHAPTER – 3

3.1 AIM OF THE INVESTIGATION

- To study the key points of SAE 20W40 lubricant oil.
- To prepare the custard seed oil.
- To prepare the bio-lubricant with the composition of 5%, 10%, 15%, 20% blended with SAE 20W40 conventional lubricant.
- Analyze the chemical properties of bio-lubricant with above said blend ratios.
- Compared the obtained test results with conventional bio-lubricant.
- Analyze the GCMS peaks results.

3.2 SCOPE

As issues of sustainability and the environment gain prominence, it is becoming clear that bio lubricants are necessary and crucial. The necessity and significance of bio lubricants can be seen in the following examples:

Petroleum-based materials, like those used to make conventional lubricants, are not biodegradable and can have a negative effect on the natural environment. However, bio lubricants are better for the environment because they are biodegradable and created from sustainable materials.

The usage of environmentally friendly items is mandated by law in a growing number of jurisdictions, both domestic and international. Using bio lubricants is one way for businesses to lessen their environmental effect and show compliance with these rules.

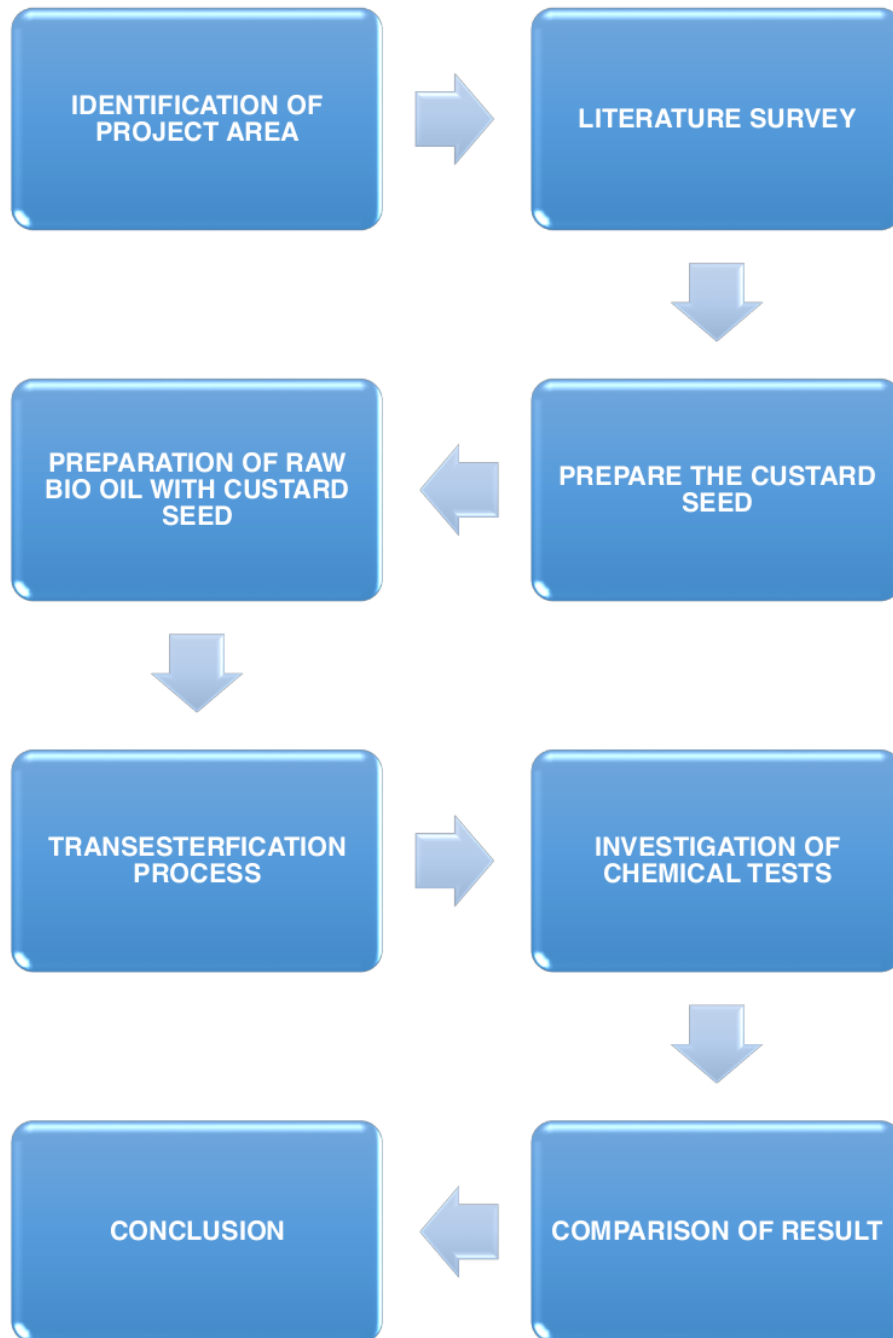
Bio lubricants are safer to use since they are less combustible than conventional lubricants. This is of paramount importance in sectors where the possibility of fire or explosion exists.

Bio lubricants have been demonstrated to work better in high temperatures and under heavy loads, expanding its usefulness in a variety of settings.

Since bio lubricants tend to last longer than conventional lubricants, you may find that you save money in the long run by not having to replace them as often. In fields where expensive gear and equipment are used, this is of paramount importance.

In sum, bio lubricants are obviously necessary and crucial. They outperform conventional lubricants in terms of safety, performance, and cost, and they are better for the environment. More and more businesses are switching to bio lubricants, which is great news for the environment and the health of our planet.

3.3 METHODOLOGY



CHAPTER – 4

4.1 MATERIALS AND METHODS; ALGORITHMS USED



Figure 4.1 : Custard Apple

Some fruits go by the moniker "custard apple," as does the tree that bears them, *Annona reticulata*. The fruits can be irregular, spherical, heart-shaped, or oblong in form. Depending on the cultivar, the size varies from 7 centimetres (2.8 in) to 12 centimetres (4.7 in). Depending once again on the type, mature fruit has crimson highlights and a brown or yellowish colour with variable degrees of reticulation. The meat might be hard and taste awful, or it can be luscious and quite scented. Like 'regular' custard, it has a lovely, sweet flavour.

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Custard apple may also be the name of some similar fruits produced by related trees: Ramphal Custard-apple.



Figure 4.2 : Custard Apple Seeds Dried

This shrub's leaves are combined to create a wonderful remedy that relieves colds and coughs. For those with anaemia, the fruit is quite beneficial on its own. However, it's the seeds of this fruit that catch you off guard. Custard apple seeds are located inside the fruit pulp and have a dark brown hue.

BENEFITS OF CUSTARD APPLE SEEDS

1. **Removes Head Lice:** Are you annoyed of witnessing lice and nits itch your head? Has everything, including the medicinal shampoos, failed? Examine the custard apple seeds. Simply take a small amount, powder it, and combine it to create a paste, add a little water. Allow the head to rest for 10 minutes after application. Use cold, running water to rinse. If you follow this method two times per week for a month, your head will be totally lice-free and you will see amazing results.

2. Insect Repellent: Do you find your home overrun with ants and other insects? Once more, the custard apple seeds can save your bacon. After adding some powdered seeds to some water, let it sit for a few days. You are now prepared to make your own DIY bug repellent. Disperse the mixture throughout the house, paying particular attention to the areas that are affected. The outcomes will be remarkable and immediate.
3. The same combination may also be used as a weed killer and pesticide in your home garden. For ten to fifteen days, sprinkle a portion of the infected plant on a daily basis to completely eradicate the leaf-eating insects.
4. Pharmaceutical Usage: Because of this fruit's proven abortifacient qualities, pharmaceutical companies employ its seeds extensively. It is employed in the production of drugs intended to cause abortions.
5. Commercial Farm Pesticides: Custard apple and neem seeds are combined to create a powerful, poisonous pesticide that is employed in commercial farming. Thus, the insecticide generated from these seeds is organic and safe for the environment. For human health, using insecticide derived from custard apple seeds is quite advantageous.
6. Production of Biogas: These small marvels are used commercially in countries like as Germany and many other European countries to produce biogas. This fruit's seeds have trapped methyl-ester-rich fatty acids that cause the gas to be produced.
7. Another Unusual Use: Because custard apple seeds are poisonous, several nations employ them as fish bait.

4.1.1 SAE 20W40 Lubricant Oil

The Society of Automotive Engineers (SAE) has designated SAE 20W40 as a standard motor oil grade. Multi-grade or multi-viscosity motor oils are what these fits into the temperature range in which the oil retains its viscosity is indicated by the "20W" portion of its label.

The number "20" indicates the oil's viscosity at 20 degrees Fahrenheit or less. Oil with a lower viscosity number is more suited for cold starts and freezing temperatures.

The "40" indicates the oil's working temperature or higher temperature viscosity. More protective at high temperatures is oil with a higher viscosity rating.



Figure 4.3 : SAE 20W40 Lubricant Oil

The following is a common interpretation of SAE 20W40 motor oil:

Performance in Cold Temperatures: SAE 20W40 motor oil is a versatile choice due to its high cold-start performance. Since engine wear is reduced at engine starter, the "20W" implies that it flows adequately even in cold weather.

Performance at Operating Temperatures: SAE 20W40 Motor Oil has a similar viscosity to SAE 40 Oil at Operating Temperatures. Under typical driving circumstances, engine parts are well-lubricated and protected in this way.

Older petrol and diesel engines, as well as some types of agricultural and industrial machinery, frequently call for SAE 20W40. It's popular in temperate regions since it can withstand a variety of temperatures and protect engines from extremes in operation.

The viscosity index of SAE 20W40 varies from brand to brand and formulation to formulation. Oils with a higher VI maintain their lubricating properties throughout a wider temperature range because their viscosity is less sensitive to variations in temperature.

Checking for the right API (American Petroleum Institute) service grade, like API SN for petrol engines or API CI-4 for diesel engines, is crucial when purchasing motor oil. These grades reveal how well the oil performs and whether or not it is suitable for use in a given vehicle's engine.

Although SAE 20W40 may be appropriate for many engines, it is always best to check the manufacturer's guidelines for your specific model. Engine damage or decreased performance may result from utilising oil that isn't designed for use in that particular machine. Maintaining your engine's health requires regular oil changes using oil of the proper grade and quality.

IMPORTANCE OF SAE 20W40

SAE 20W40 lubricant oil is important for various reasons in the automotive and industrial sectors. Here are some of the key importance and applications of SAE 20W40 lubricant oil:

Engine Protection: SAE 20W40 oil provides vital lubrication to internal engine components, such as pistons, crankshafts, and bearings. This lubrication reduces friction, minimizes wear and tear, and extends the life of the engine.

Temperature Versatility: It has a good balance of viscosity characteristics, making it suitable for use in a wide range of temperatures. The "20W" portion of the designation means it flows well in cold weather, reducing engine wear during startup, while the "40" portion indicates its viscosity at operating temperatures.

Cold-Start Performance: SAE 20W40 is designed to flow readily at low temperatures, which is crucial for effective lubrication during cold starts. It helps protect the engine from wear and damage, especially in regions with cold winters.

High-Temperature Protection: At high operating temperatures, SAE 20W40 provides the necessary film strength and viscosity to protect engine components from heat-related wear and damage. It maintains adequate lubrication even under extreme conditions.

Compatibility: SAE 20W40 is compatible with many types of engines, including older gasoline and diesel engines. It can be used in a variety of vehicles, including cars, trucks, agricultural machinery, and industrial equipment.

Versatility: Due to its versatility, SAE 20W40 is often used in applications where a single oil type is required to work across a range of temperatures and conditions.

Fuel Efficiency: Proper lubrication with SAE 20W40 can help improve engine efficiency by reducing friction. A well-lubricated engine operates more efficiently and may contribute to better fuel economy.

Engine Longevity: Regular use of SAE 20W40 oil can contribute to the longevity and reliability of an engine. It helps prevent premature wear and damage to engine components, reducing the need for costly repairs.

Minimizing Sludge and Deposits: High-quality SAE 20W40 oils often contain additives that help prevent the deposits and sludge buildup in the engine. This keeps the engine clean and maintains its performance.

Industry Standards: SAE 20W40 lubricants meet industry standards and specifications, ensuring that they provide the required level of protection and performance for different applications.

It's important to note that while SAE 20W40 oil is versatile and suitable for many applications, it's essential to use the oil recommended by the manufacturer for your specific vehicle or equipment. Different engines and applications may have varying requirements, and using the correct oil is crucial for optimal performance and engine longevity.

CHARACTERISTICS

SAE 20W40 lubricant oil has specific characteristics that make it suitable for various applications. These characteristics are determined by its viscosity, temperature performance, and other properties. Here are the key characteristics of SAE 20W40 lubricant oil:

Viscosity Range: SAE 20W40 is a multi-viscosity or multi-grade oil. The "20W" part indicates its viscosity at low temperatures, where it behaves like a 20-weight oil. The "40" part indicates its viscosity at high temperatures, where it behaves like a 40-weight oil. This dual-viscosity characteristic makes it versatile for use in a wide range of temperatures.

Cold-Start Performance: The "20W" viscosity rating means that SAE 20W40 flows well at lower temperatures. This is important for cold-start performance, ensuring that the oil can quickly reach and lubricate engine components when the engine is started in cold weather.

High-Temperature Protection: At high operating temperatures, SAE 20W40 provides the necessary thickness and film strength to protect engine components from wear and friction. It maintains adequate lubrication even under extreme conditions.

Versatility: SAE 20W40's ability to perform well in both cold and hot conditions makes it versatile for use in various applications, including older gasoline and diesel engines, agricultural machinery, and industrial equipment.

Engine Protection: It provides essential lubrication to internal engine components, reducing friction and minimizing wear and tear. This lubrication is vital for prolonging the life of the engine.

Compatibility: SAE 20W40 is compatible with many types of engines and equipment, making it a widely used choice across different industries.

Fuel Efficiency: Proper lubrication with SAE 20W40 can help improve engine efficiency by reducing friction. A well-lubricated engine operates more efficiently and may contribute to better fuel economy.

Cleanliness: High-quality SAE 20W40 oils often contain additives that help prevent the formation of sludge and buildup in the engine. This keeps the engine clean and maintains its performance.

Industry Standards: SAE 20W40 lubricants meet industry standards and specifications, ensuring that they provide the required level of protection and performance for different applications.

It's important to note that the specific characteristics of SAE 20W40 lubricant oil may vary slightly between different brands and formulations. When selecting an oil for a specific application, it's essential to consider the manufacturer's recommendations and specifications to ensure optimal performance and engine longevity.

DRAWBACKS OF CONVENTIONAL LUBRICANTS

The use of standard lubricants, such as SAE 20W-40 oil, might present challenges and drawbacks depending on the circumstance. Some typical problems with SAE 20W-40 oil include Because of its variable viscosity, SAE 20W-40 oil may not be the best choice for use at extremely high or low

temperatures. In colder temperatures, it can thicken up and become difficult to move and lubricate, whereas in warmer temperatures, it can thin out and be less effective at protecting moving components.

It has been found that SAE 20W-40 oil may not flow as freely at startup in cold conditions, which can lead to engine wear and decreased fuel efficiency.

Shear Stability: The capacity of SAE 20W-40 oil to preserve engine components may decline with time and in high-shear circumstances due to a decrease in the oil's viscosity. Pollution and greenhouse gas emissions are caused by the production and use of conventional lubricants since they are primarily made from fossil fuels. Without proper management, they pose a threat to soil and water quality since they do not biodegrade. Many common lubricants have components and additives that are harmful to people and animals. The human body can react negatively to exposure to certain chemicals.

When compared to synthetic or high-performance oils, SAE 20W-40 oil often requires more regular oil changes, which raises both maintenance costs and environmental effect. **Reduced Lubrication Efficiency in Extreme Temperatures:** SAE 20W-40 may not function as well in extremely cold or extremely hot settings.

Traditional lubricants have poor oxidation stability, which means that engine sludge and deposits can accumulate over time, limiting efficiency and perhaps causing damage.

Because of the increased friction and decreased lubrication efficacy, using SAE 20W-40 oil might decrease fuel efficiency in specific situations. **Problems with Compatibility:** Some engines, especially newer high-performance ones, may not work with SAE 20W-40 oil because they need different, synthetic lubricants.

It's worth noting that SAE 20W-40 oil's potential drawbacks can shift depending on the context of use and the quality of the oil itself. Many times, these problems can be avoided by following the manufacturer's recommendations for lubricant

use. In some situations, these issues can be mitigated, and improved performance and fewer negative effects on the environment can be gained, by switching to synthetic or bio-based lubricants.

One of the most frequent kinds of motor oil used in internal combustion engines is designated by the SAE as 20W-40. In internal combustion engines, some of the most common and important uses and applications of SAE 20W-40 lubricant include the following:

Lubrication of the Engine: SAE 20W-40 oil is most commonly utilized for the purpose of providing lubrication to the moving parts of internal combustion engines. These parts include the bearings, crankshaft, camshaft, and pistons. It does this by forming a protective film that cuts down on friction and wear, which in turn helps the engine to last longer.

Temperature Range: Because SAE 20W-40 is formulated to function successfully in a moderate temperature range, it is an excellent choice for a wide variety of automobiles and pieces of machinery that are used in regions with moderate climates. The "20W" portion of the classification reflects the fluid's low-temperature viscosity (flow) properties, whereas the "40" component of the classification indicates the fluid's high-temperature viscosity.

traditional Engines: This viscosity grade is frequently used in traditional gasoline and diesel engines, particularly older ones, where the original equipment manufacturer (OEM) advises or mandates using that particular grade. However, its application can change depending on the design of the engine and the weather circumstances.

SAE 20W-40 is a type of motor oil that is frequently used in light to medium-duty vehicles. These kinds of vehicles include cars, trucks, vans, and even certain minor pieces of industrial equipment.

Agricultural and Industrial Equipment: It is also utilized in a wide variety of equipment, including as tractors, construction machinery, and other industrial engines, amongst other sorts of equipment. This viscosity grade is appropriate for the lubricating requirements of these engines because they frequently run at operating temperatures that are constant. It's possible that some fleets of vehicles, such as delivery trucks, buses, and other

commercial vehicles, utilize SAE 20W-40 motor oil because it's compatible with their engines and the conditions under which they operate.

Stationary Engines: SAE 20W-40 may be an option worth considering for lubrication consistency maintenance in applications involving stationary engines, such as power generators and other types of machinery that remain in one place. **Option That Is More Economical:** SAE 20W-40 motor oil is a cost-effective solution for engines that do not require the advanced performance characteristics of synthetic lubricants and is typically more cheap than synthetic oils. It is essential to keep in mind that the selection of motor oil for an internal combustion engine should be in accordance with the recommendations of the engine's manufacturer as well as the conditions under which the engine operates. For best engine performance and longevity, it is vital to examine the owner's handbook and follow the directions provided by the manufacturer. Since many modern engines have specific requirements for the oil viscosity and performance characteristics, this makes it essential to review the manual. Certainly, in regard to the application of lubricant according to SAE 20W-40 standards in internal combustion engines, the following are some extra factors to consider:

High-Mileage Engines: SAE 20W-40 motor oil is occasionally used in high-mileage engines, which tend to have more wear and tear than other types of engines. These older engines may benefit from improved lubrication and protection thanks to the increased viscosity of the oil.

Agricultural Machinery: SAE 20W-40 oil is frequently used in agricultural applications, such as tractors and other types of farm equipment, because it is compatible with older types of machinery and is able to handle the stresses that are associated with farming operations.

Compatibility: The gaskets and seals that are typically found in older engines are generally compatible with SAE 20W-40's viscosity. However, it is essential to

check for compatibility with the particular materials being used and to review the instructions provided by the engine manufacturer.

Change Intervals: Compared to synthetic oils, SAE 20W-40 oil may require more frequent oil changes than synthetic oils. The frequency of these changes is determined by the engine and the operating circumstances. It is essential to do routine maintenance in order to keep the engine in good health. Use During the Summer Because of its higher-temperature viscosity characteristics, SAE 20W-40 is ideally suited for use during the summer or in locations that are warmer. It is possible that the fluid will not flow as well when the temperature is lower, which could lead to problems during the startup process.

Minimized Oil Consumption The use of SAE 20W-40 can be beneficial for some older engines that have a propensity to eat oil. This is because the viscosity of SAE 20W-40 can aid reduce oil consumption. **Blends Made to Order** In certain instances, mechanics or engine enthusiasts may make custom oil blends by blending SAE 20W-40 with different oils in order to accommodate special conditions or fulfil the requirements of a particular engine.

Heavy-Duty Applications: Even though SAE 20W-40 is most frequently used in light duty to medium-duty vehicles and equipment, it is also sometimes utilized in heavy duty applications, provided that the engine's design and the operating conditions are compatible with its use. When selecting the right motor oil, it is vital to take into consideration the recommendations of the manufacturer, as well as the environment and operating circumstances, as well as the age and design of the engine. Synthetic oils with the necessary viscosity and performance characteristics may provide improved protection and fuel economy for modern engines. On the other hand, SAE 20W-40 oil may be more reliable and compatible with older engines and machinery, which could be to their advantage.

When used as a bio lubricant, the combination of custard seed oil with the conventional lubricant SAE 20W-40 can have a number of beneficial effects. The following are a few of the potential advantages: Environmental Friendliness

Because custard seed oil is derived from a renewable resource, it is considered to be more environmentally friendly than lubricants that are derived from petroleum. It lessens reliance on fossil fuels, which in turn reduces carbon emissions and the overall negative impact on the environment.

Biodegradability: Custard seed oil is biodegradable, which means that it decomposes in a natural way and produces fewer harmful effects on the environment when it is released into the environment or discarded. **Reduced Toxicity** Bio lubricants, such as custard seed oil, often have a lower level of toxicity compared to lubricants derived from petroleum, making them safer for both people and wildlife. **Improved Lubrication qualities:** When combined with other types of lubricants, custard seed oil can enhance the lubrication qualities of a mixture, hence reducing the amount of friction and wear that occurs in machinery and engines. **Improvements to a Lower Viscosity Index** Because custard seed oil can assist increase the viscosity index of the lubricant, it can provide better lubrication in a wider range of temperatures. This is especially helpful in applications in which temperature changes are common. **Enhanced Protection Against Corrosion** Because custard seed oil contains a number of naturally occurring additives, the bio-lubricant blend might provide enhanced protection against corrosion. **Potential Cost Savings** Although custard seed oil can be more expensive than conventional lubricants, combining it with SAE 20W-40 oil can result in potential cost savings when compared to the use of fully synthetic bio lubricants. **Longer Lifespan of Equipment:** Increased lubrication and less wear can result in a longer life span for equipment, which in turn lowers the expenses of both maintenance and replacement. **Compliance with Regulations** It's possible that using a bio lubricant mix will make it easier to comply with environmental regulations and standards that call for the use of lubrication solutions that are more sustainable and kind to the environment. **Applications of All Kinds** The combination of custard seed oil with SAE 20W-40 oil has the potential to be useful in a wide variety of contexts, including those involving agricultural, construction, and industrial machinery. It is essential to keep in mind

that the particular benefits will be contingent on the formulation and application of the bio lubricant blend in question, in addition to the quality of the

custard seed oil that is put to use. To guarantee that the mixture satisfies the performance requirements of the application that is intended for it to be used in, appropriate testing and analysis should be carried out.

Why bio-lubricant is required instead conventional lubricant of SAE 20W40

Bio lubricants are gaining popularity as an environmentally friendly alternative to traditional petroleum-based lubricants like SAE 20W40. The use of bio lubricants is driven by several factors, and while they may not always replace conventional lubricants, they have their own set of advantages:

Environmental Benefits: One of the primary reasons for using bio lubricants is their reduced environmental impact. Bio lubricants are typically ³⁶derived from renewable resources such as vegetable oils, animal fats, or synthetic esters. They are biodegradable and pose fewer environmental risks in case of spills or leaks. They are also less toxic to aquatic life.

Sustainability: The production of bio lubricants often involves crops that can be sustainably grown, reducing the dependence on non-renewable resources like crude oil. This aligns with the goal of reducing carbon emissions and promoting sustainable practices.

Biodegradability: Bio lubricants break down more readily in the environment compared to conventional lubricants, reducing the risk of long-term environmental contamination.

Lower Toxicity: Bio lubricants are typically less toxic than petroleum-based lubricants, making them safer for users and reducing health risks associated with exposure.

Renewable Feedstocks: Bio lubricants can be made from a variety of renewable feedstocks, including plant oils, which can be sourced locally, reducing the need for long-distance transportation.

High Performance: Some bio lubricants have been engineered to offer performance characteristics similar to or even better than traditional lubricants. They may have excellent lubricity and thermal stability.

Specialty Applications: Bio lubricants are sometimes preferred for specific applications where traditional lubricants may not be suitable due to environmental regulations or concerns. For example, they may be used in environmentally sensitive areas or in food processing equipment.

However, it's essential to note that bio lubricants are not a one-size-fits-all solution, and their suitability depends on the specific application and requirements:

Compatibility: Bio lubricants may not be compatible with all equipment and materials, so compatibility testing is often necessary.

Cost: Bio lubricants can be more expensive than conventional lubricants, which can be a consideration for some users.

Temperature Sensitivity: Some bio lubricants may have limitations in extreme temperature conditions, so they may not be suitable for all applications.

Performance: While some bio lubricants offer excellent performance, others may have limitations in terms of viscosity, wear protection, or other properties compared to conventional lubricants.

In summary, bio lubricants are required in certain applications where environmental concerns, sustainability goals, or regulatory requirements make them a preferred choice. However, they may not replace traditional lubricants like SAE 20W40 in all applications, and the choice depends on a careful assessment of the specific needs and constraints of the situation.

4.1.2 Machine Expeller



Figure 4.4 : Crushing Machine for Oil Extraction

The mechanical process of machine expeller, also known as oil pressing, is used to extract oil from raw materials. In a single process, the raw ingredients are crushed under intense pressure. Nuts, seeds, and algae are commonly utilised as raw materials for food oil extraction, and they are fed continuously into the press. Friction during pressing raises the temperature of the raw material, which can reach temperatures of 120 °F (49 °C) for tougher nuts (which demand greater pressures).

4.2.1 Preparation of Biolubricants (Transesterification)

Transesterification is a common chemical reaction used to produce biodiesel from various vegetable oils, including custard apple seed oil, to create a bio lubricant. Here is a simplified procedure for making a bio lubricant from custard apple seed oil using transesterification:

Materials and Equipment:

- Custard apple seed oil (as the feedstock)
- Methanol (methanol-to-oil molar ratio of around 6:1)
- Sodium hydroxide (NaOH) or potassium hydroxide (KOH) as a catalyst
- A reactor vessel (stainless steel or glass)
- Magnetic stirrer
- Heat source (e.g., hot plate)
- Thermometer
- Biodiesel collection container
- Safety equipment, including gloves and safety goggles.
- Separatory funnel
- Water for washing and neutralizing the bio-lubricant.

Procedure:

Prepare the Catalyst Solution:

Dissolve the required amount of sodium hydroxide (NaOH) or potassium hydroxide (KOH). This will be your catalyst solution. Ensure safety precautions, as these chemicals are caustic.

Measure and Heat the Oil:

Measure the desired amount of custard apple seed oil and transfer it to the reactor vessel.

Heat the Oil:

Heat the custard apple seed oil in the reactor vessel to a temperature between 50-60°C. Maintain this temperature throughout the reaction.

Add the Catalyst Solution:

Carefully add the catalyst solution to the heated oil while stirring continuously. The amount of catalyst depends on the quality of oil and the specific conditions, but it's typically around 0.5-1% of the oil weight. The exact amount may require experimentation.

Perform Transesterification:

Continue to stir the mixture for about 1-2 hours, maintaining the temperature. The transesterification reaction will convert the triglycerides in the oil into biodiesel and bottom layer as bio-lubricant with glycerol. The glycerol may remove (which is low bottom of the container).

Separate Glycerol:

Allow the reaction mixture to cool. The glycerol will settle at the bottom. Carefully decant or remove the glycerol layer.

Wash the Bio-Lubricant:

Transfer the bio-lubricant to a separatory funnel and wash it with warm water to remove any residual impurities. Shake the funnel gently and allow it to settle. Drain the water and repeat the process until the water layer is clear.

Neutralize the Bio-lubricant:

Neutralize the bio-lubricant by washing it with a dilute solution of citric acid or sodium bicarbonate to remove any remaining catalyst residues. Wash it again with water to remove the neutralizing agents.

Dry the Bio-lubricant:

Dry the bio-lubricant by heating it to remove any remaining water content. This can be done by heating the bio-lubricant gently to a temperature of around 100°C while stirring.

Filter the Bio-lubricant:

Filter the final bio-lubricant product through a fine mesh filter to remove any remaining impurities.

The custard apple seed oil should now be converted into bio lubricant (middle of the bottom layer) and bio diesel (top layer). Remember to take safety precautions when handling chemicals, and ensure that your work area is well-ventilated. The quality of your bio-lubricant can vary based on the purity of your ingredients and the exact procedure, so experimentation and testing may be required to meet your specific lubricant needs.

Procedure for Blending:

Combining distinct kinds of oils or lubricants is what's meant by "blending" bio lubricants; the main aim is to produce a end product that possesses the qualities and features that are wanted. In this situation, wants to manufacture a bio lubricant mixture by combining 80% SAE 20W40 oil with 20% custard seed oil to create a 600 ml bio lubricant mixture. Here's a step-by-step procedure for blending these two components:

Materials and Equipment:

- lubricant SAE 20W40
- Oil made from custard seed.
- A cylinder or container with graduated markings that is used for measuring liquids
- a container for mixing, preferably one that is dry and clean.
- Rod for stirring or a blender
- Wear protective eyewear and gloves (when working with chemicals).
- Identifying labels for the finished product blend

Procedure:

- When dealing with oils and chemicals, you should always protect your eyes and skin by donning safety goggles and gloves. This will ensure that no harm comes to either.
- Measure the oils will need to determine how much SAE 20W40 oil and custard seed oil, will need to create a mix that is equal to 600 millilitres.
- For 80% SAE 20W40, divide 600 millilitres by 80% to get 480 millilitres of SAE 20W40 oil.
- For custard seed oil containing 20%: 20% of 600 millilitres equals 120 millilitres of custard seed oil.
- The first step in combining the oils is to fill the mixing container with 480 ml of SAE 20W40 oil.
- To the same container, add 120ml of oil extracted from custard seed.
- Use a stirring rod or a blender to fully combine the two oils, then mix them together in their entirety. Make sure that the oils are evenly distributed throughout the mixture by giving them a thorough blending.
- Indicate on the container the mix ratio (80% SAE 20W40 + 20% custard seed oil), the date it was blended, and any other pertinent information that may be applicable. This will assist you in identifying the contents and keeping track of how long they have been preserved for use.
- Put the finished bio lubricant into a clean, dry container that has a cover that fits tightly and put it away. To ensure that it keeps its shape, you should make sure that it is kept out of the direct sunshine and away from particularly high or low temperatures.

4.2.2 Flash Point

Point of Flash & Fire Equipment for measuring the flash points of lubricating oils, fuel oils, bitumen (apart from cutback bitumen), and particles suspended in liquids with a flash point higher than 49°C. The equipment is made up of a flexible shaft stirrer and a brass test cup with a handle and a detachable cup lid. It also has an oil test jet flame mechanism and a spring-operated rotating shutter. The assembly is supported by an air bath with a metal dome on top. The cup assembly is put within a brass-topped cast iron air bath. that has been chrome-plated and is equipped with an electric heater and temperature control.

Specification:

- Control: Fully Automatic Control
- Flash point: 49°C
- Power Source: 220V, 1Ph, 50Hz AC Supply



Figure 4.5 : Flash & Fire Point Test Apparatus

The lowest temperature at which a volatile material's vapours will ignite in the presence of an ignition source is known as the material's flash point. There is a

misconception that the temperature at which autoignition occurs spontaneously is the same as the flash point. The lowest temperature at which a material's vapours will continue to burn after the ignition source is withdrawn is known as the fire point. Since new vapours may not be created quickly enough to sustain combustion at the flash point, the fire point is higher than the flash point. The temperature of the ignition source is far higher than that of the flash or fire points, although neither of them directly depends on the other.

The flash point of a lubricant is an important feature that indicates how easily it can be ignited when it is brought into contact with a naked flame or another source of heat. It is the lowest temperature at which the lubricant vaporises sufficiently to form

a combustible mixture with air, leading to a momentary flash of fire when exposed to an open flame. This temperature is referred to as the flash point. The flash point is a very important safety criterion, particularly in contexts in which lubricants are subjected to high temperatures or are in close proximity to hazardous ignition sources.

Standardised testing procedures, such as the Cleveland Open Cup (COC) test or the Pensky-Martens Closed Cup (PMCC) test, are commonly utilised in order to ascertain the flash point of a substance. In these tests, a sample of the lubricant is gradually heated while an open flame or spark is intermittently introduced to the surface of the sample. The flash point is defined as the temperature at which a visible flash or flame can be noticed.

Depending on the specifics of their chemical make-up, various kinds of lubricants, such as those made from minerals, synthetic materials, or even biological materials, can have very different flash points. Lubricants with higher flash points are regarded safer for use in high-temperature or potentially hazardous conditions because they have a lower probability of igniting and are therefore less likely to cause an accident.

It is essential to have a solid understanding of the flash point of a lubricant in order to guarantee the safe handling, storage, and use of lubricants in a wide variety of industrial and automotive applications. In order to reduce the likelihood of fires and other accidents, regulatory bodies frequently specify minimum flash point criteria for various applications involving lubricants.

²¹ 4.2.3 Fire Point

A fuel's fire point is the lowest temperature at which, when ignited by an open flame, its vapour will burn for at least five seconds. ¹⁷ At the flash point, a substance will briefly ignite, which is a lower temperature, but it's possible that not enough vapour will be created to keep the fire going. Only material flash points are listed in the majority of material properties tables. Testing to determine if a fire point is safety essential is still necessary, even though it is generally accepted that fire points are around 10 °C higher than flash points.

The fire point of a lubricant is another significant quality that offers insight into the fire resistance and safety features of the substance. ¹⁷ It is the lowest temperature at which the lubricant emits sufficient vapour to allow continuous combustion when it is exposed to an open flame or a heat source. This temperature is referred to as the smoke point. To put it another way, the temperature at which the lubricant will maintain a flame for at least five seconds after it has been ignited is referred to as the fire point.

In a manner analogous to that of the flash point, the fire point is often identified by means of standardised testing procedures, such as the ¹⁰ Cleveland Open Cup (COC) test or the Pensky-Martens Closed Cup (PMCC) test. Both of these tests include the use of cups of varying sizes. In these tests, a sample of the lubricant is heated in a manner that is both controlled and consistent, and an open flame is brought to bear on the surface of the sample at regular intervals. ²¹ The fire point is defined as the temperature at which the lubricant is capable of maintaining combustion for a period of at least five seconds.

In applications in which lubricants are subjected to high temperatures, potential ignition sources, or fire dangers, the fire point is a very important safety characteristic to take into consideration. It offers helpful guidance for selecting lubricants that are able to endure elevated temperatures without providing a threat of fire. It is generally accepted that lubricants with higher fire points are safer for use in high-temperature and demanding industrial situations.

In order to safeguard everyone's safety and cut down on the likelihood of fires and other mishaps, regulatory authorities and industry standards could come up with precise fire point requirements for lubricants that are used in different kinds of applications. For safe handling, storage, and application of lubricants in industrial, automotive, and other contexts, it is vital to have a solid understanding of both the flash point and the fire point of the lubricant.

4.2.4 Kinematic Viscosity

The resistance to flow under the influence of gravity is a key attribute of lubricants, and this resistance is measured by the kinematic viscosity. How smoothly a lubricant flows at a given temperature can be measured this way. Centistokes (cSt) are the units of measure for kinematic viscosity, and this property is commonly tested at either 40 degrees Celsius or 100 degrees Celsius, however this varies by application and industry norms.



Figure 4.6 : Red Wood Viscometer

A viscometer is a specialised piece of equipment used to quantify kinematic viscosity. Capillary viscometers, rotating viscometers, and falling ball viscometers are just a few examples of the many kinds of viscometers available. The fundamental concept is to time the pace at which a calibrated volume of the lubricant flows downhill through a calibrated tube or chamber.

Because the lubricant's thickness or fluidity might affect its performance in different contexts, knowing the kinematic viscosity value is crucial. High kinematic viscosity lubricants are more dense and move more slowly, while low kinematic viscosity lubricants are more fluid and move quickly.

Some important considerations related kinematic viscosity are as follows:

Choosing the right lubricant for a given piece of machinery and operating conditions is made easier by viscosity grades, such as ISO VG (Viscosity Grade), which are assigned to lubricants. These classifications are derived from temperature-dependent observations of kinematic viscosity.

Dependence on Temperature: A lubricant's kinematic viscosity can vary greatly depending on the operating temperature. As the temperature rises, it decreases,

making it important to take into account in applications where the temperature range is wide.

Considerations for Use: Lubricants with the optimum kinematic viscosity are essential for providing adequate protection to moving parts in equipment. Overly high viscosity can hinder flow and decrease efficiency, while inadequate viscosity can cause friction and wear.

Standards in the Industry The kinematic viscosity of lubricants may be subject to different standards and requirements depending on the industry and application. Manufacturers frequently include data sheets with information about viscosity for customers to use when making purchases.

²² In conclusion, a lubricant's kinematic viscosity is a key factor in determining how well it will perform its lubricating function. When it comes to keeping machinery running smoothly and reliably, knowing the viscosity needs of a given application and picking the right lubricant grade based on kinematic viscosity couldn't be more important.

²⁴ 4.2.5 Calorific Value

The calorific value of a substance is the amount of heat energy it releases when it burns or reacts with oxygen, and it is one of the most basic properties that can be measured. It is usually written as a ratio, such joules per gramme, kilojoules per kilogramme, or British thermal units per pound. The calorific value is an important factor in many contexts, especially the energy and fuel sectors.

Calorie counts mostly come in two varieties:

Greater heat energy emitted when a material is burned in an oxygen-rich environment is represented by the ³⁴ Higher Calorific Value (HCV) or Gross Calorific Value (GCV). Condensation of combustion-generated water vapour contributes heat energy.

HCV is usually more than twice as high as LCV.

Caloric content with fewer calories, or Net Caloric Content (NCC): The energy released as heat during combustion is taken into account by LCV, but the energy needed to vaporise any water byproducts is subtracted. Latent heat of vaporisation of water in the combustion products is taken into account, making this a more accurate measurement of the usable energy.



Figure 4.7 : Bomb Calorimeter

Among the many types of fuel, calorific value is crucial for:

Energy content of coal, natural gas, and petroleum products can be determined with its help. The energy efficiency and environmental impact of fossil fuels can vary greatly depending on the calorific value of the fuel.

Biodiesel, ethanol, and biogas are all examples of biofuels; these fuels are produced from renewable biological resources, and their energy content may be evaluated by measuring their calorific value.

Wood, biomass, and charcoal are examples of solid fuels commonly used in the kitchen and for home heating. Their calorific value is one indicator of whether or not they are useful for these purposes.

Production of Energy: The calorific value of fuels is crucial in determining the potential energy output and efficiency of combustion systems in power generation and industrial processes.

Calorific value is proportional to emissions released during combustion, which can have a negative effect on the environment. Fuels with a higher calorific value tend to provide more energy but may also cause more emissions, while fuels with a lower calorific value may be less energy-dense but may be better for the environment.

The quantity of heat generated by the well-regulated combustion of a certain amount is used to calculate the calorific value. of the item in a laboratory setting; this is called a "bomb calorimetry." For proper energy utilisation, emission regulation, and fuel selection, an accurate understanding of calorific value is crucial.

4.2.6 Density

Lubricant density ⁴¹ is defined as the mass per unit volume of a certain lubricant. It is usually written as a ratio, such as kg/m³ or g/cm³, which refers to the density of a given volume. Density, or the amount of mass contained in a particular volume, is an essential characteristic of any lubricant. The chemical make-up and temperature of the lubricant might affect this characteristic.

You need to know both the mass and the volume of the lubricant sample in order to calculate the density. Density can be determined using the following formula:

$$\text{Density} = \text{Mass} / \text{Volume}$$

The density of a lubricant can be calculated as follows:

Lubricant weight can be determined by weighing a sample of the fluid with a known volume. If the density of the lubricant changes depending on the temperature, make sure the sample is kept at a constant temperature.

Taking the Decibel Reading: Measure the lubricant sample's volume, which is usually expressed in millilitres (mL) or cubic centimetres (cc). Any container with clearly marked increments of volume will do, but a graduated cylinder is ideal.

The Density Formula: To determine the density of the grease, use the given formula. Convert between compatible mass and volume units (such as grammes and millilitres or kilogrammes and cubic metres).



Figure 4.8 : Weighing Scale

A lubricant's density can change with the ingredients it contains and the ambient temperature. To help customers determine if a given lubricant is suitable for their needs, several producers list density figures for their products at various temperatures. For many uses, it is crucial to know the density of the lubricant being used, such as:

Engineers employ density measurements to determine loads and strains in various components and systems by calculating the mass of lubricants present.

Density can be used in volume calculations to approximate the amount of lubricant needed for a given system or application.

For shipping and warehousing purposes, it is helpful to have an idea of how dense a given lubricant is.

When evaluating the possible environmental impact of lubricants, it is helpful to have some idea of their density. This is especially true in the event of accidental spills or leaks.

Knowing the relative densities of different lubricants can help you achieve the desired properties and performance when blending or mixing.

Always take the temperature circumstances into account when dealing with or analysing lubricants, as the density of the lubricant may alter with temperature.

A thorough technique is required to investigate the qualities of a bio-lubricant combined with custard seed oil and compare them to those of regular SAE 20W-40 oil. Detailed procedures for determining the melting point, boiling point, density, heat capacity, and viscosity of a substance are outlined below.

1. Preparing a Sample:

Samples of the bio-lubricant blend can be made by combining SAE 20W-40 lubricant and custard seed oil at 5%, 10%, 15%, and 20% concentrations. Get together an unadulterated SAE 20W-40 oil sample for use as a benchmark.

2. The Flash Point Analysis

Determine the flash point of each sample using a flash point tester (usually in accordance with ASTM D93 or other applicable standards). The temperature at which the lubricant vaporises is known as its flash point. produces sufficient ignition conditions to cause a brief fire.

3. The Fire Point Analysis:

Each sample's fire point should be measured using a fire point tester (often based on ASTM D92 or comparable standards). Under controlled laboratory

conditions, a lubricant's fire point is highest in its temperature at which it maintain a flame.

4. Quantifying Density:

Use a hydrometer or density meter to determine the density of each lubricant sample.

5. Calorific Value Determination:

Ensure Measurements Conform to Applicable Standards, such as ASTM D4052 the calorific data, or the heat of combustion, each sample can be determined with the help of a bomb calorimeter or other appropriate equipment. The energy density of the lubricants is measured by this procedure.

6. Viscosity Measurements:

Using a viscometer and in accordance with applicable standards (e.g., ASTM D445), determine the viscosity of each lubricant sample at varying temperatures, such as 40°C and 100°C. The viscosity of a lubricant is a key parameter since it describes the fluid's resistance to flow.

7. Duplicates and Quality Assurance:

It is important to run numerous replicates of each test to ensure statistical significance and accurate results. To ensure accuracy, use only 100% pure SAE 20W-40 oil in your comparisons.

8. Analysis of the Data:

Examine the data to see how the bio-lubricant blends with 5%, 10%, 15%, and 20% custard seed oil compared to the pure SAE 20W-40 oil. Determine if there are any tendencies or changes in the properties of flash point, fire point, density, calorific value, and viscosity.

9. Summary and Analysis:

Produce a detailed report that encapsulates the findings and their significance. Determine if the lubricating performance is significantly impacted by the changes in flash point, fire point, density, calorific value, and viscosity caused by the addition of custard seed oil to SAE 20W-40 oil.

Recommendations for using bio-lubricant blends including custard seed oil in certain applications, along with any potential benefits and downsides in comparison to using traditional lubricant oil, should be provided based on the findings. You can evaluate the potential environmental and performance benefits of bio lubricant blends and conventional lubricant oil by using this methodology to thoroughly explore and compare their major attributes.

CHAPTER – 5

5.1 RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

5.1.1 Comparison of results

Table 5.1 : Different Ratio Blended Results

Characteristics	SAE 20w40	Custard Seed Oil (5%)	Custard Seed Oil (10%)	Custard Seed Oil (15%)	Custard Seed Oil (20%)
Kinematic Viscosity @40°C in cSt	15.5	18	21	23.5	26
Flash Point °C	235	213	193	172	150
Fire Point °C	250	226	208	185	162
Gross Calorific Value kj/kg	39,847.54	40,139.12	40,431.00	40,722.95	41,014.28
Density in kg/m ³	919	915	911	908	905

5.1.2 Kinematic Viscosity @40°C in cSt

Table 5.2 : Kinematic Viscosity Results

Kinematic Viscosity @40°C in cSt				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
15.5	18	21	23.5	26

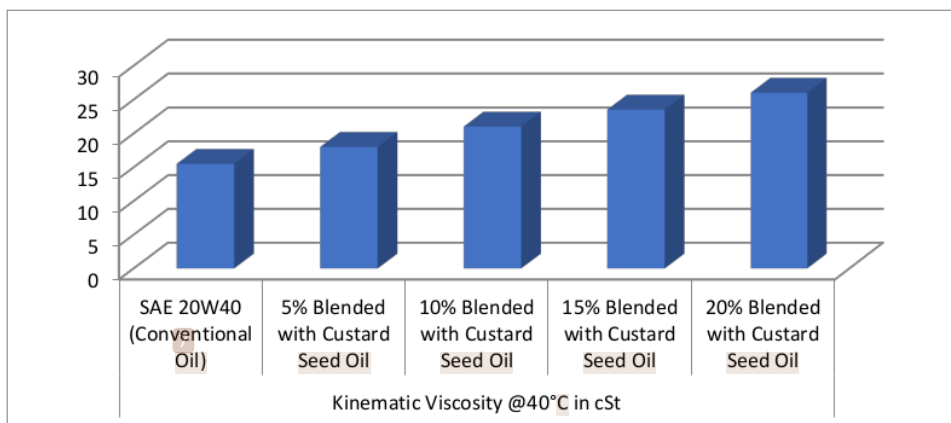


Figure 5.1 : KINEMATIC VISCOSITY GRAPH

5.1.3 Flash Point °C

Table 5.3 : Flash Point Results

Flash Point °C				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
235	213	193	172	150

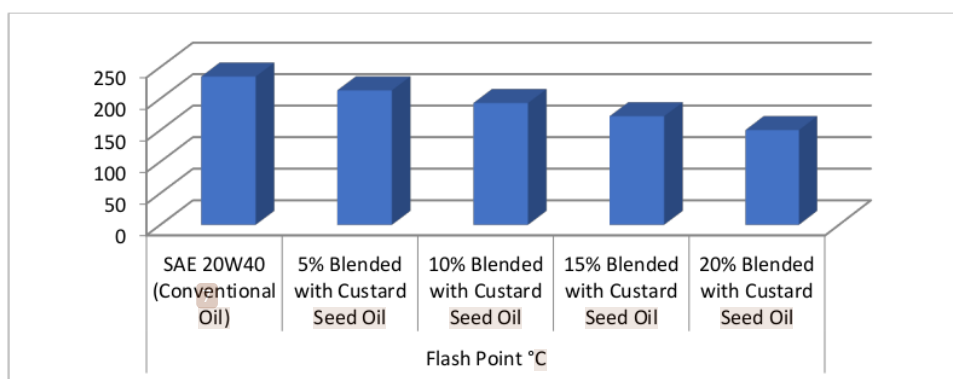


Figure 5.2 : FLASH POINT GRAPH

5.1.4 Fire Point °C

Table 5.4 : Fire Point Results

Fire Point °C				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
250	226	208	185	162

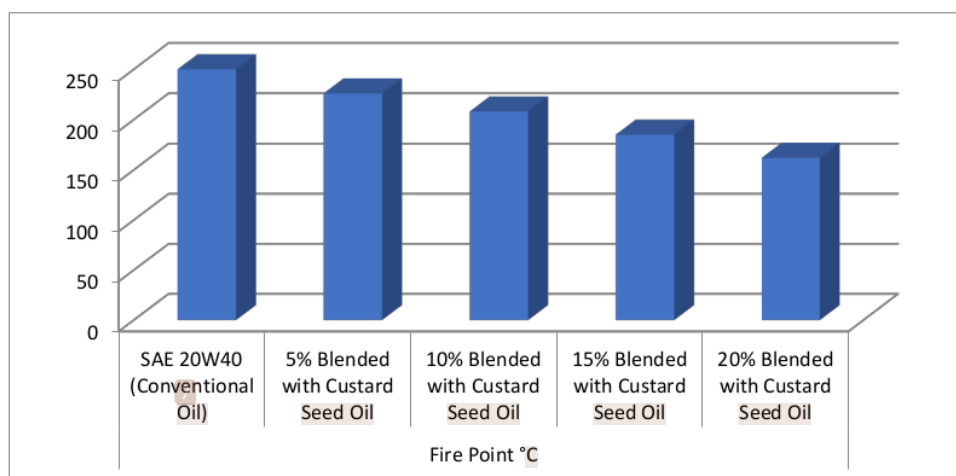


Figure 5.3 : FIRE POINT GRAPH

5.1.5 Gross Calorific Value kj/kg

Table 5.5 : Gross Calorific Value Results

Gross Calorific Value kj/kg				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
38847.54	40,139.12	40,431.00	40,722.95	41014.28

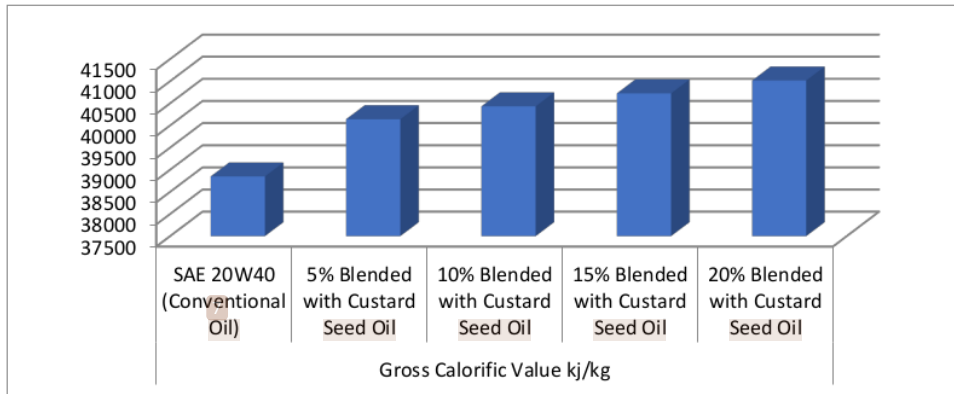


Figure 5.4 : GROSS CALORIFIC VALUE GRAPH

5.1.6 Density in kg/m³

Table 5.6 : Density Results

Density in kg/m ³				
SAE 20W40 (Conventional Oil)	5% Blended with Custard Seed Oil	10% Blended with Custard Seed Oil	15% Blended with Custard Seed Oil	20% Blended with Custard Seed Oil
919	915	911	908	905

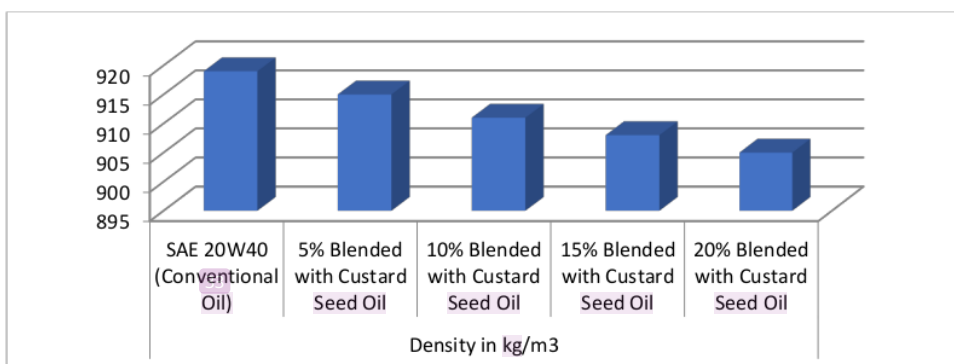


Figure 5.5 : DENSITY GRAPH

5.1.7 GCMS Comparison results

Raw Custard oil Peaks

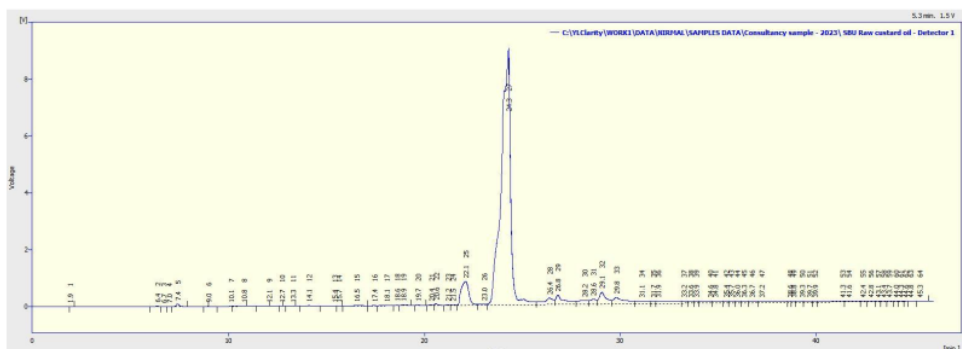


Figure 5.6 : GCMS Raw Custard oil peaks

10/27/2023 Chromatogram C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\Consultancy sample - 2023\SBU- Sathish sir\ SBU Raw custard oil.PRM Page 1 of 3



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Chromatogram Info:

File Name	: C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\Consultancy sample - 2023\SBU- Sathish sir\ SBU Raw custard oil.PRM	File Created	: 10/27/2023 11:01:36 AM
Origin	: Acquired, Acquisition started 10/27/2023 10:08:29 AM	Acquired Date	: 10/27/2023 10:54:34 AM
Project	: C:\YLC\arity\Projects\Work1.PRJ	By	: Administrator

Sample Info:

Sample ID	: WPBDs	Amount	: 0
Sample	: Aaru Akka - consultancy sample	ISTD Amount	: 0
Inj. Volume [mL]	: 0.2	Dilution	: 0.1

Method	: C:\YLC\arity\WORK1\DATA\NIRMAL\SAMPLES DATA\FID METHODS\FAME method-2	By	: Administrator
Description	:		
Created	: 3/17/2018 9:53 AM	Modified	: 10/27/2023 11:01 AM

Column	:	Detection	:
Mobile Phase	:	Temperature	:
Flow Rate	:	Pressure	:
Note	:		

Autostop	: 46.00 min	External Start	: Start - Restart, Down
Detector 1	: Detector 1	Range 1	: Bipolar, 2500000 mV, 20 Samp. per Sec.
Subtraction Chromatogram	: (None)	Matching	: No Change

Base	: Not Used	Calibration File	: None	Calculation	: Uncal
Scale Factor	: Not Used	Units After Scaling	: Not Used	Uncal. Response	: 0
Unretained Time	: 0.00 min	Column Length	: 50.00 mm	Column Calc.	: From Width at 50% of Height
Result Table Reports	: All Peaks	Hide ISTD Peak	: Enabled		

Result Table :

Table 5.7 : GCMS Table Raw Custard Oil

PEAK	RETEN TIME (MIN)	AREA (mV.s)	HEIGHT (Mv)	AREA (%)	HEIGHT (%)	COMPOUND NAME
1	7.413	817.843	84.091	0.2	0.6	PALMATIC ACID
2	22.117	21822.244	834.411	5.3	6.4	OCTADECATRIENOIC ACID
3	24.310	296510.033	9034.701	72.1	69.1	HEXADECANOIC ACID
4	26.807	10462.649	333.682	2.5	2.6	DEHYDROABIETIC ACID
5	29.053	10655.075	411.862	2.6	3.2	7-OXO-DEHYDROABIETIC ACID
6	29.787	9894.699	229.381	2.4	1.8	7-OXO-DEHYDROABIETIC ACID

After test sample peaks

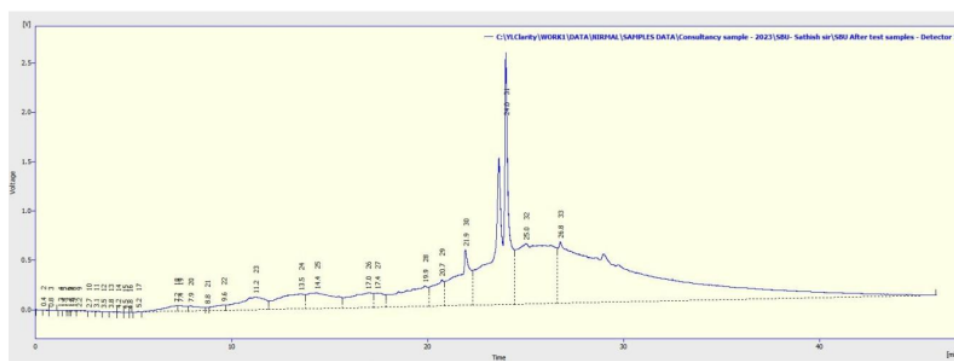


Figure 5.7 : GCMS 20% Blended sample oil peaks



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Chromatogram Info:

File Name : C:\YLC\Clarify\WORK1\DATA\NIRMAL\SAMPLES DATA\Consultancy sample - 2023\SBU- Sathish sir\SBU After test samples.PRM File Created : 10/27/2023 1:14:34 PM
Origin : Acquired, Acquisition started 10/27/2023 12:22:48 PM Acquired Date : 10/27/2023 1:08:54 PM
Project : C:\YLC\Clarify\Projects\Work1.PRJ By : Administrator

Sample Info:

Sample ID : SBU- Ater test sample Amount : 0
Sample : Sathish Sir - consultancy sample ISTD Amount : 0
Inj. Volume [mL] : 0.2 Dilution : 0.1

Method : C:\YLC\Clarify\WORK1\DATA\NIRMAL\SAMPLES DATA\FID METHODS\FAME method-2 By : Administrator
Description :
Created : 3/17/2018 9:53 AM Modified : 10/27/2023 1:14 PM

Column : Detection :
Mobile Phase : Temperature :
Flow Rate : Pressure :
Note :

Autostop : 46.00 min External Start : Start - Restart, Down
Detector 1 : Detector 1 Range 1 : Bipolar, 2500000 mV, 20 Samp. per Sec.
Subtraction Chromatogram : (None) Matching : No Change

Base : Not Used Calibration File : None Calculation : Uncal
Scale Factor : Not Used Units After Scaling : Not Used Uncal. Response : 0
Unretained Time : 0.00 min Column Length : 50.00 mm Column Calc. : From Width at 50% of Height
Result Table Reports : All Peaks Hide ISTD Peak : Enabled

A yield of 70 weight percent on average was used to manufacture the polyol esters. The fatty acid makeup of polyol esters, tetra esters, and triesters was summarised. Saturated fatty acid content was 80.9, 83.1, and 88.1% in TMP triesters, Di-TMP tetra esters, and PE tetra esters. TMP triesters, Di-TMP tetra esters, and PE tetra esters have unsaturated fatty acid percentages of 19.1, 16.9, and 11.9%, respectively. The polyol esters obtained from this investigation exhibited fatty acid compositions that were comparable to raw custard seed oil.

Result Table:**Table 5.8 : GCMS Table After Test Samples**

PEAK	RETEN TIME (MIN)	AREA (mV.s)	HEIGHT (Mv)	AREA (%)	HEIGHT (%)	COMPOUND NAME
1	21.947	28292.745	562.263	5.8	9.6	OCTADECATRIENOIC ACID
2	24.010	88141.680	2550.143	18.0	43.6	HEXADECANOIC ACID
3	25.030	76667.815	612.414	15.6	10.5	DIISOCTYL PHTHALATE
4	26.773	198006.690	623.600	40.3	10.7	DEHYDROABIETIC ACID

CHAPTER – 6

6.1 SUMMARY AND CONCLUSIONS

In this lab study, we analysed a bio lubricant mixture of custard seed oil (at a 5%,10%,15%,20% concentration) and SAE 20W40 (at an 95%,90%,85%,80% concentration). Key parameters such kinematic viscosity, flash point, fire point, calorific value, and density were the focus of the study. The findings shed light on the functionality and versatility of this bio lubricant mixture. And analysed the GCMS tests of raw custard oil & 20% Blended bio lubricant mixture. Based on the results of the experiment, it appears that a mixture of custard seed oil (at a concentration of 20%) and SAE 20W40 conventional oil (at a concentration of 80%) makes a suitable bio lubricant. It has a calorific value that could be useful in some situations, as well as a favourable kinematic viscosity and an acceptable flash and fire point for safety. It has an average density for a lubricant. However, this blend's viability must be assessed in light of particular application needs, environmental considerations, and sector norms. It's possible that more study and testing is needed to verify its effectiveness in practical applications. In conclusion, this study adds to our knowledge of the characteristics of the bio lubricant blend and sheds light on its possible future applications as a green and effective lubricant. More research and use of this mixture could improve its efficiency and environmental friendliness in a number of sectors. When used in internal combustion engines, bio lubricants derived from custard seed oil can have a number of effects and benefits, including on engine performance as a whole, pollution levels, and the longevity of individual engine parts. Bio lubricants, such as those made from custard seed oil, can improve engine performance by lowering friction. This can improve fuel economy by reducing the amount of energy wasted in the form of friction within the engine. Smoother operation, less wear on engine parts, and increased performance are all possible benefits of bio lubricants' enhanced lubricating qualities. Lower emissions could result from using some bio lubricants, such as those made from custard seed oil. Better lubrication qualities can reduce friction and improve engine smoothness,

both of which can help reduce emissions, especially in older engines. Reduced Wear and Tear on Components Enhanced lubrication can reduce friction and wear on engine elements including cylinders, pistons, and bearings, potentially prolonging their service life.

Corrosion Protection: Bio lubricants often provide enhanced corrosion protection, safeguarding engine parts and extending their useful life. It's worth noting, nevertheless, that the benefits and drawbacks of utilizing bio lubricants derived from custard seed oil in internal combustion engines may depend on a number of factors. Formulation and Blend: The bio lubricant's lubricating and engine-protecting properties ³⁹ can be greatly affected by the quantity of custard seed oil in the blend and the additives employed. The efficiency of the bio lubricant can be affected by factors such as the engine's load, temperature, and operating conditions. It's possible that under harsh conditions the performance of some bio lubricants will vary. It is essential that the bio lubricant be compatible with the engine's components. It's possible that seal swelling or material degradation could occur if a bio lubricant isn't suitable with a certain material. In conclusion, increased engine performance, lower emissions, and longer component life due to better lubrication and less wear are all possible benefits of employing bio lubricants derived from custard seed oil in internal combustion engines. The precise advantages, however, would be conditional on things like the precise mix composition, the operating conditions, and the materials used in the engine. In order to improve the efficiency of these bio lubricants and determine whether or not they are suitable for use in a variety of engines and environments, testing and continued research are required.

6.2 FUTURE SCOPE

After studying bio lubricants with different custard seed oil mixes for automobile IC engines, several important areas for research and application exist: Optimizing Blend Ratios: Research can determine the best custard seed oil blend ratios for bio lubricants. Increased sustainability must be balanced with maintaining or improving important qualities including viscosity, density, and

flash/fire points for automotive IC engines. Comprehensive performance testing under varied engine situations is essential. These blends must be tested in real-world circumstances with variable temperatures, loads, and speeds to determine their practicality. Impact on Engine Wear and Longevity: Investigation into these bio lubricants' long-term effects on engine components is crucial. This includes studying engine part wear and longevity with varied custard seed oil blend percentages. In addition to chemical qualities, bio lubricants' environmental impact must be studied. This includes assessing their biodegradability, emission reduction potential, and ecological impact in car IC engines. Additive Development: Test these bio lubricants with additives or modifiers to improve performance. Additives can regulate viscosity, increase lubrication, and change flash and fire points without affecting sustainability. Material Compatibility Studies: Custard seed oil-based bio lubricants must be tested with engine materials. Practical use requires that these lubricants do not damage engine components. Industrial implementation and scale-up: Custard seed oil-based bio lubricants for automotive IC engines must be tested for economic viability and large-scale manufacture. Industrial implementation's pros and cons must be understood for general adoption. This research will examine custard seed oil-based bio lubricants' chemical characteristics, performance, and environmental and economic impacts. These fields of research will help build sustainable, effective, and practical bio lubricants for automobile IC engines.

REFERENCES

1. **Ashokkumar S et al (2020)**, Comparison and Analysis of Custard Apple Seed Oil with Engine Lubricant.
2. **Doddabasawa and Ravi Kumar, (2014)**, Bio diesel production and physico-chemical property of custard apple seed.
3. **Ebtisam k. Heikal et al (2016)**, Manufacture of environment friendly bio-lubricant from vegetable oil.
4. **Ibrahim n. dibal et al (2017)**, Production of bio lubricant from custard oil.
5. **K.K Sharma, Anuj Kumar et al (2023)**, Comparative study of engine performance and emission test of Custard Apple seed oil Bio-lubricant dispersed with micro walled carbon nano tube with synthetic lubricants.
6. **Leelamani Pillai et al (2020)**, Synthesis and Characterization of Custard Apple seed oil Bio Lubricant.
7. **Omkaresh.B.R, et al (2015)**, Biodiesel Production from Custard Apple seed Oil and its Performance Test on CI Engine.
8. **Priyanka Chand,et al (2008)**, Thermogravimetric Quantification of Biodiesel Produced via Alkali Catalyzed Transesterification of Soybean oil.
9. **SiddalingappaR.Hotti, et al (2014)**, Biodiesel Production Process Optimization from Sugar Apple Seed Oil and Its Characterization.
10. **Subash V et al (2023)**, Manufacturing and Characterization of Bio-pesticide from Custard Apple Seeds.
11. **Waleed Abuhaimed et al (2017)**, Using Biofuels as Lubrication Oil.

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