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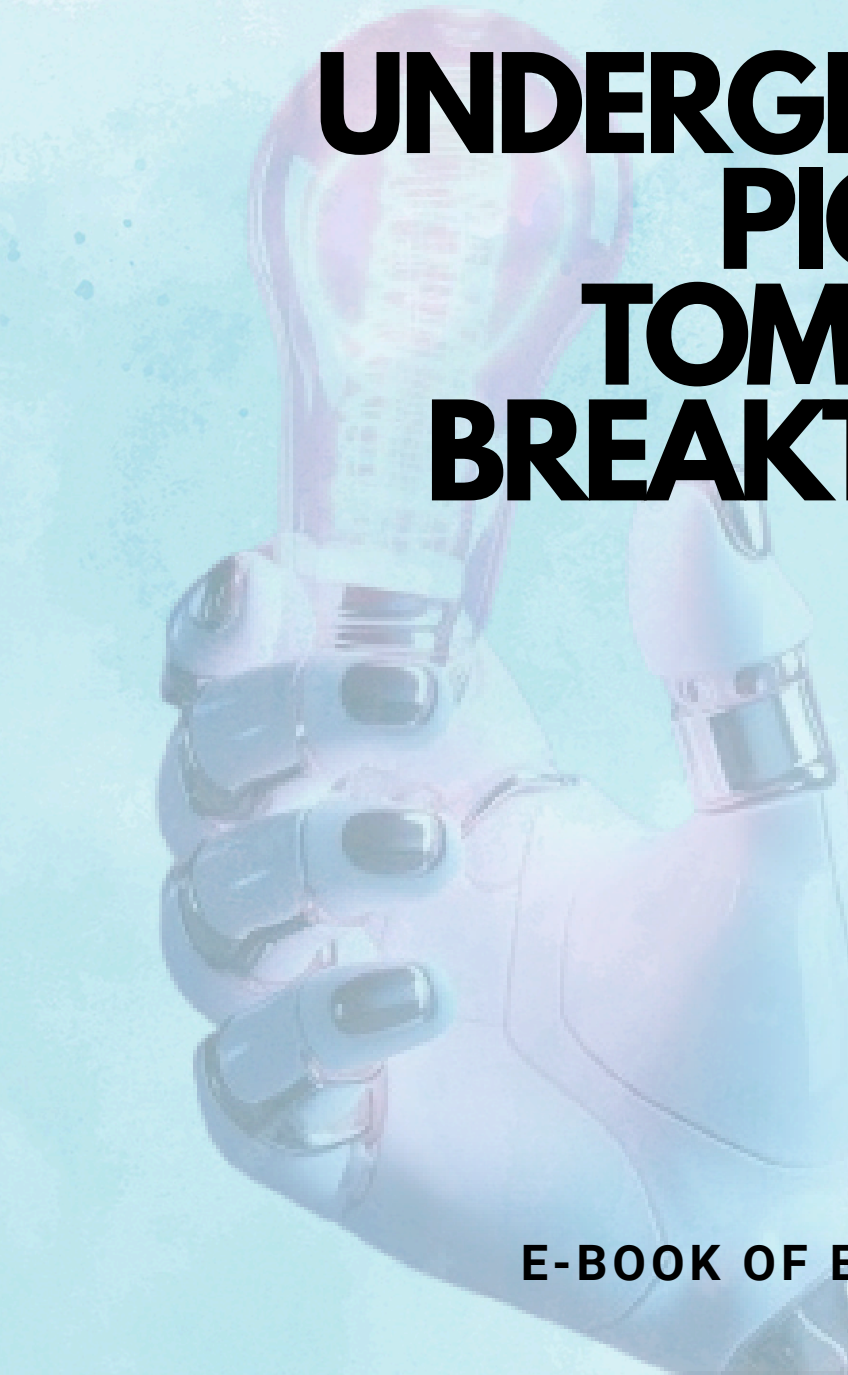

E-BOOK OF EXTENDED ABSTRACTS

ECOLUBE-S: SUSTAINABLE BIOLUBRICANT BASE STOCK DERIVED FROM SOYBEAN OIL

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ABSTRACT

The increasing need for lubricants in both the automotive and industrial fields emphasizes the importance of developing effective, high-performance solutions with low environmental impact. Conventional lubricants, mostly made from petroleum-based mineral oils, are non-renewable, pose ecological hazards, and are major contributors to pollution and greenhouse gas emissions. These challenges underscore the urgent need for environmentally sustainable alternatives. This innovation presents Ecolube-S**,** an advanced biolubricant base stock derived from soybean oil, an abundant and eco-conscious resource. Ecolube-S is synthesized via a two-step process: the hydrolysis of soybean oil yields soybean oil fatty acids, which are then esterified with trimethylolpropane (TMP). This modification enhances the thermal and oxidative stability of the lubricant, increasing its durability and efficiency in demanding operational environments. Ecolube-S is biodegradable, non-toxic, and helps lower ecological harm by reducing soil and water contamination. Its development aligns with green chemistry practices and supports the circular economy by adding value to agricultural by-products. Additionally, it offers superior lubrication performance, reducing friction and wear in engines and machinery, resulting in enhanced reliability and energy savings. By transitioning from petroleum-based lubricants to this renewable option, industries can maintain high efficiency while advancing environmental protection and long-term economic sustainability.

Keywords: Biolubricant, biodegradable, renewable, soybean oil

INTRODUCTION

The widespread use of petroleum-based lubricants in industrial and automotive sectors has raised significant environmental and sustainability concerns, owing to their non-biodegradability, toxicity, and reliance on limited fossil fuel resources. In response, there is a growing global interest in developing biolubricants derived from renewable plant oils as a greener and more sustainable alternative. Plant oils such as soybean, canola, and palm are abundant, biodegradable, and non-toxic, making them ideal candidates for lubricant base stock production. This innovation aligns with several United Nations Sustainable Development Goals (SDGs), specifically SDG 7 (Affordable and Clean Energy)**,** SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action)**.** By shifting toward biobased lubricants, this innovation contributes to reducing greenhouse gas emissions, minimising environmental pollution, and promoting the use of renewable resources in industrial processes. However, the direct application of plant oils in lubrication systems is often limited by issues such as low oxidative stability and poor performance under extreme temperatures due to the presence of β-hydrogen in the glycerol backbone in triacylglycerol structure (Nor et al. (2019), Nor et al. (2022), Khairuddin et al. (2024)). To overcome these limitations, chemical modifications such as esterification with polyols such as trimethylolpropane (TMP) are employed to enhance the physicochemical properties of the oil, resulting in high-performance biolubricants suitable for a wide range of industrial applications. The objectives of this innovation are to formulate Ecolube-S, a sustainable biolubricant base stock that is biodegradable, non-toxic, and eco-

friendly, serving as an alternative to conventional mineral oil-based lubricants and to support the progress of green technology by developing a high-performance biolubricant that aligns with environmental standards and encourages sustainable applications in both industrial and automotive sectors.

RESULTS AND DISCUSSION

Ecolube-S is a sustainable, high-performance biolubricant base stock derived from chemically modified soybean oil. A high-quality biolubricant must possess excellent physicochemical properties to perform effectively in industrial applications. To evaluate the performance of the Ecolube-S, its properties were compared with a commercial synthetic lubricant, SAE 20 (Perodua Genuine Oil). The flash point of the Ecolube-S was recorded at 272°C, compared to 230°C for SAE 20. The higher flash point of the Ecolube-S indicates greater thermal stability, which is essential for high-temperature operations. According to Nor et al. (2022), another key parameter in assessing biolubricant potential is the pour point, the lowest temperature at which a lubricant remains flowable. A low pour point is crucial for engines operating in cold environments. The Ecolube-S exhibited a pour point of -19 °C, which is comparable to that of SAE 20 (-20 °C). These results demonstrate that the synthesised Ecolube-S has desirable lubrication characteristics, which are a high flash point and a low pour point, making it a viable biolubricant base stock for use in both petrol and diesel engines, particularly in environments where temperatures do not fall below -19°C. These features enhance cold-start performance and bolster thermal stability, making Ecolube-S well-suited for rigorous industrial and automotive applications.

In terms of novelty, this project introduces a biolubricant base stock with enhanced molecular architecture, achieved through the esterification of soybean oil with trimethylolpropane. This results in a branched structure that significantly improves oxidative stability, thermal resistance and lubrication efficiency. What sets this innovation apart is its dual focus on advanced molecular design and sustainable resource utilisation. By converting agricultural by-products into high-value green technology, the project directly supports the circular bioeconomy and encourages rural economic growth, while decreasing reliance on fossil resources. This aligns with multiple Sustainable Development Goals (SDGs): SDG 12, promoting responsible consumption and production; SDG 13, supporting climate action through reduced carbon emissions; SDG 7, enhancing energy efficiency and access to clean energy; and SDG 9, driving industry innovation and infrastructure development through eco-friendly technological advancements.

CONCLUSION

This innovation presents the successful synthesis of a high-performance biolubricant base stock (Ecolube-S) derived from soybean oil through chemical modification with trimethylolpropane. Ecolube-S exhibits a high flash point and excellent low-temperature flow behavior, making it suitable for a wide range of industrial and automotive applications. As a biodegradable, renewable, and non-toxic alternative, it addresses environmental, and sustainability concerns associated with conventional petroleum-based lubricants. The findings demonstrate that plant-based oils can be effectively engineered to meet modern performance standards, supporting the advancement of green technology. Overall, this biolubricant offers a viable, eco-friendly solution that integrates performance, safety and sustainability in lubrication systems.

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