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PST007 - *LUBRIGREEN*: ECO-FRIENDLY BIOLUBRICANT BASE STOCK FROM SOYBEAN OIL

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ABSTRACT

The rising demand for lubricants in automotive and industrial sectors highlights the need for efficient, high-performance products with minimal environmental impact. Conventional lubricants, primarily derived from petroleum-based mineral oils, are non-renewable, environmentally hazardous, and contribute significantly to pollution and greenhouse gas emissions. These issues underscore the urgent need for sustainable alternatives. This innovation introduces *LubriGreen*, a novel biolubricant base stock synthesized from soybean oil, an abundant and eco-friendly raw material. *LubriGreen* is produced through a two-step process: hydrolysis of soybean oil to obtain soybean oil fatty acids, followed by esterification with neopentyl glycol, resulting in soybean oil neopentyl glycol (SBONPG) ester. This chemical modification improves the lubricant's thermal and oxidative stability, extending its service life and efficiency under demanding conditions. *LubriGreen* is biodegradable, non-toxic, and significantly reduces environmental risks by minimizing soil and water contamination. Its adoption supports green chemistry principles and contributes to the circular economy by adding value to agricultural products. Furthermore, it delivers excellent lubrication properties, reducing friction and wear in machinery and engines, thereby improving operational reliability and energy efficiency. By replacing petroleum-based lubricants with this renewable alternative, industries can achieve high performance while promoting environmental sustainability and economic resilience.

Keywords – biolubricant, environmental sustainability, renewable sources, soybean oil

INTRODUCTION

In today's industrial landscape, conventional petroleum-based lubricants pose significant environmental and health risks. These lubricants are non-renewable, contribute to pollution, and accelerate greenhouse gas emissions. The global shift towards sustainability has intensified the demand for eco-friendly alternatives, positioning biolubricants, which are derived from renewable, biodegradable resources, as a viable solution. This innovation introduces LubriGreen, a green biolubricant base stock synthesized from soybean oil, a widely available and environmentally sustainable

resource. While soybean oil offers many advantages, its direct use is limited due to low oxidative stability, largely attributed 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 this, the soybean oil undergoes a two-step chemical modification: hydrolysis to extract fatty acids, followed by esterification with neopentyl glycol. The product is a soybean oil neopentyl glycol (SBONPG) ester, also known as *LubriGreen*. This modification significantly enhances the lubricant's oxidative and thermal stability, making it suitable for demanding industrial and automotive applications. *LubriGreen* is biodegradable, non-toxic, and helps reduce soil and water contamination, supporting SDG 12: Responsible Consumption and Production. By replacing petroleum-based lubricants with a plant-based alternative, this innovation contributes to SDG 13: Climate Action by lowering carbon emissions and promoting a cleaner environment. Additionally, *LubriGreen* aligns with SDG 7: Affordable and Clean Energy by improving energy efficiency through better lubrication performance, and with SDG 9: Industry, Innovation and Infrastructure by fostering sustainable industrial practices and adding value to agricultural resources through green technology. Through this project, we aim to drive innovation in lubricant technology while advancing global sustainability goals and contributing to a greener, more resilient future.

OBJECTIVE

The objectives of this product are:

i. To develop *LubriGreen*, a biodegradable, non-toxic, and environmentally friendly biolubricant base stock as a sustainable substitute for conventional mineral oil-based lubricants**.**
ii. To contribute to the advancement of green technology by formulating a high-performance biolubricant that complies with environmental regulations and promotes sustainable practices in industrial and automotive sectors**.**

DESCRIPTION OF THE PROJECT

LubriGreen is a high-performance, sustainable biolubricant base stock engineered from chemically modified soybean oil. It stands out with its excellent physicochemical properties, including a low pour point of -11°C and a high flash point of 238°C, enabling reliable performance across a broad temperature range. These characteristics enhance cold-start capabilities and thermal stability, making *LubriGreen* ideal for demanding industrial and automotive applications. Its unique molecular structure, which features branched carbon chains and bent configurations, offers superior lubrication, effectively reducing friction, wear, and corrosion. These properties extend the lifespan of machinery and improve energy efficiency. Beyond performance, *LubriGreen* prioritizes environmental responsibility. It is biodegradable, non-toxic, and poses minimal risk to ecosystems by reducing pollution and carbon footprint. Its long service life, low maintenance requirements, and compatibility with existing systems make it a practical and scalable solution for industries seeking to transition from petroleum-based lubricants to greener alternatives. By integrating renewable resources with advanced chemical engineering, *LubriGreen* offers a forward-thinking solution that promotes sustainable industrial practices while maintaining operational excellence.

NOVELTY

This project introduces a structurally enhanced biolubricant through the strategic esterification of soybean oil with neopentyl glycol, resulting in a branched molecular architecture that offers superior oxidative stability, thermal resistance, and lubrication efficiency compared to conventional vegetable oil-based lubricants. This innovative molecular design directly addresses the limitations of standard biolubricants, such as rapid degradation and poor high-temperature performance, making it viable for high-demand industrial and automotive applications. What distinguishes this innovation is not only its advanced chemical formulation, but also its commitment to local resource valorization, transforming agricultural by-products into high-value green technology. This directly supports the circular bioeconomy and promotes rural economic development, reducing environmental impact and dependency on fossil resources. Furthermore, LubriGreen's drop-in compatibility with existing machinery allows for immediate, low-cost adoption without requiring system modifications, accelerating the transition toward sustainable lubrication solutions in line with SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). Its performance also contributes to improved energy efficiency, aligning with SDG 7 (Affordable and Clean Energy), while reinforcing SDG 9 (Industry, Innovation and Infrastructure) through the promotion of eco-innovation in lubricant technology.

CONCLUSION

This innovation successfully demonstrates the synthesis of a high-performance biolubricant base stock from soybean oil through chemical modification with neopentyl glycol**.** The resulting product exhibits a higher flash point and excellent low-temperature flow properties, making it suitable for a wide range of industrial and automotive applications. As a biodegradable, renewable, and non-toxic lubricant, it presents a safer and more sustainable alternative to conventional petroleum-based lubricants. The success of this process confirms that plant-based oils can be effectively engineered to meet modern performance standards, supporting environmentally responsible innovation. Overall, this biolubricant offers a viable, eco-friendly solution that bridges the gap between performance and sustainability in lubricant technology.

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