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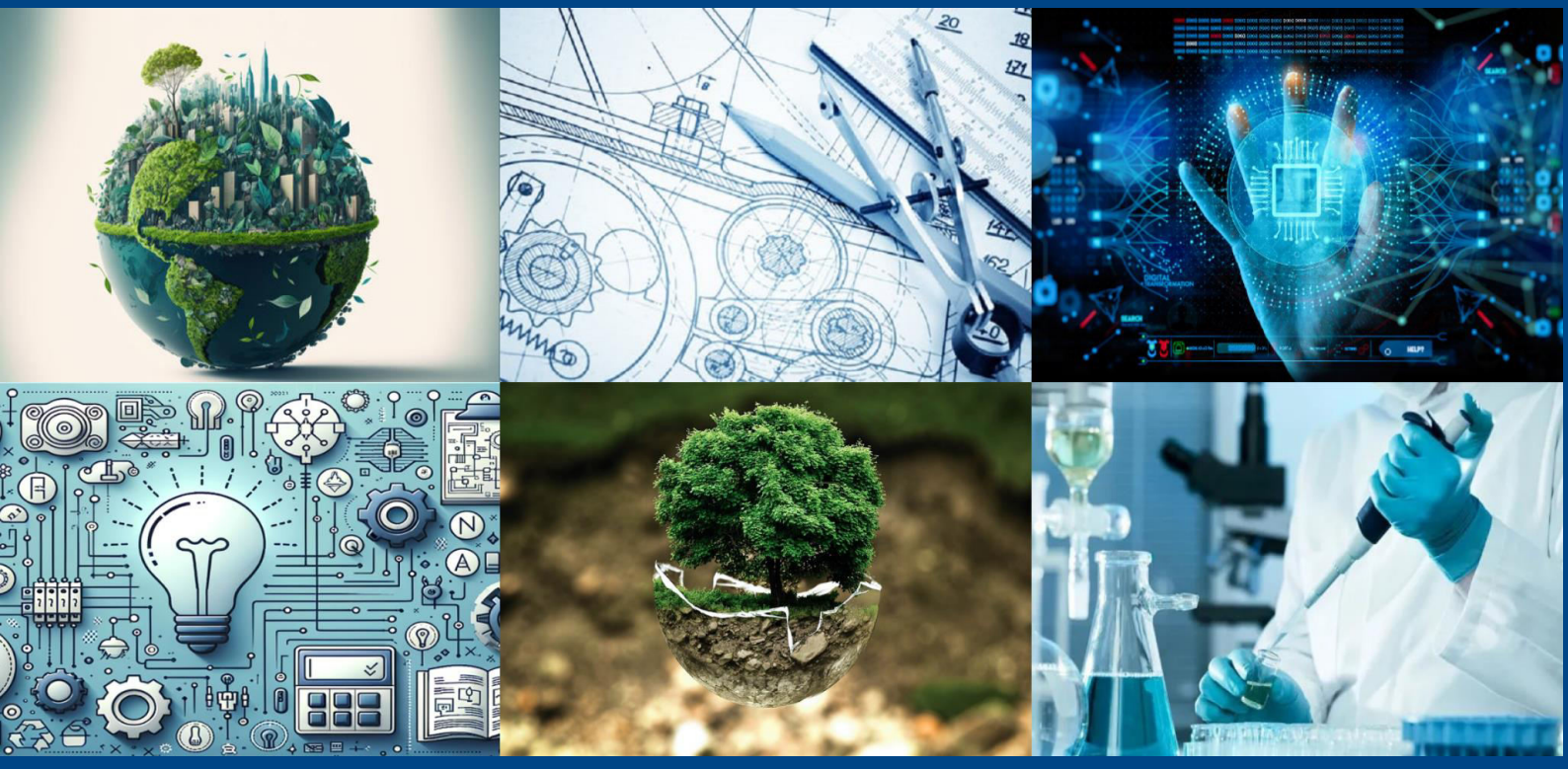

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Experimental Analysis of Bio based Rubber Processing Oil and its Characteristics Study

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ABSTRACT: The rubber industry extensively relies on petroleum-based processing oils, which pose significant environmental and health risks due to the presence of harmful polycyclic aromatic hydrocarbons (PAHs). This study investigates the synthesis and application of bio-based rubber processing oils derived from renewable sources such as rice husk oil as a sustainable alternative. The research focuses on the transesterification and hydrogenation processes to enhance the oil's properties while maintaining its compatibility with rubber compounds. Fabricated rubber sheets incorporating bio-based oils were tested for mechanical properties, including tensile strength, elongation, and hardness, and compared with conventional aromatic oils. Results indicate that bio-based oils exhibit competitive performance while significantly reducing environmental impact. This study highlights the potential of bio-based processing oils in promoting green manufacturing and sustainable rubber technology. The findings provide a viable pathway for reducing dependency on petroleum-derived oils in the tire manufacturing industry.

KEYWORDS: Rubber Processing Oil, Bio Based Oil, Mechanical Characteristics Properties.

I. INTRODUCTION

The rubber industry is a significant contributor to the global economy, with a wide range of applications in automotive, industrial, and consumer products. However, the industry's reliance on petroleum-based processing oils has raised concerns about environmental sustainability, climate change, and depletion of fossil fuels. In response, there is a growing interest in exploring eco-friendly alternatives, such as bio-based rubber processing oils.

Bio-based processing oils, derived from renewable biomass sources, offer a promising solution to reduce the ecological footprint of the rubber industry. These oils have the potential to replace petroleum-based oils in various applications, including tire manufacturing, industrial rubber products, and consumer goods. However, the successful adoption of bio-based processing oils depends on their performance, compatibility, and cost-effectiveness.
This project aims to investigate the characteristics and performance of bio-based rubber processing oils through an experimental analysis.

The primary objectives of this study are:
1. To evaluate the physical, chemical, and rheological properties of bio-based processing oils.
2. To compare the performance of bio-based processing oils with petroleum-based oils in rubber compounding and processing.
3. To identify the potential applications and limitations of bio-based processing oils in the rubber industry.

This project report presents the methodology, results, and discussions of our experimental analysis, highlighting the key findings, implications, and recommendations for future work. The report is organized into [number] sections, covering the introduction, literature review, methodology, results, discussion, conclusions, and recommendations.

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The findings of this study will contribute to the development of sustainable and environmentally friendly rubber processing technologies, ultimately reducing the dependence on fossil fuels and minimizing the ecological impact of the rubber industry.

II. FABRICATION AND ANALYSIS

The fabrication process of the experimental bio-based rubber processing oil involved a systematic approach, ensuring the effective synthesis and application of the material in rubber compounds. Initially, the selection of a suitable bio-based feedstock, such as rice husk oil, was carried out. The oil was extracted using the pyrolysis method, where rice husks were subjected to thermal decomposition in an oxygen-free environment, yielding a bio-oil with desirable properties for rubber processing. Post extraction, the bio-oil underwent a purification process to remove impurities and enhance its stability and performance.

Once the bio-oil was refined, it was incorporated into rubber formulations alongside other essential ingredients such as natural rubber, stearic acid, sulfur, carbon black, zinc oxide, and silica. The rubber sheets were fabricated in an industrial setting at a tire manufacturing facility. Different formulations were prepared by varying the concentration of bio-oil (5, 10, 15, and 20 phr) to analyze its effects compared to traditional petroleum-derived aromatic processing oils. These rubber compounds were then subjected to a vulcanization process, where heat and pressure were applied to achieve the required mechanical and physical properties.

The analysis phase involved evaluating the performance characteristics of rubber samples containing bio-oil and conventional 710 process oil. Various tests were conducted, including tensile strength, hardness (Shore A), elongation at break, and rheometric properties. The tensile strength results indicated that while the 710 process oil exhibited slightly higher values, the bio-oil-based formulations demonstrated comparable performance, with tensile strength ranging from 29.3 MPa to 30.7 MPa. The elongation at break values showed that rubber samples containing bio-oil had slightly reduced elasticity compared to their petroleum-based counterparts. However, this reduction was within an acceptable range for industrial applications.

In terms of hardness, samples containing rice husk oil exhibited lower Shore A hardness values compared to the 710 process oil specimens, suggesting a softer rubber compound. This characteristic may be beneficial for applications requiring improved flexibility. Rheometric analysis revealed that the curing characteristics of bio-oil-based rubber formulations were on par with conventional oils, with minor variations in cure time and scorch time. The overall findings highlighted that bio-oil derived from rice husks could serve as a viable alternative to petroleum-based processing oils, contributing to sustainability and environmental safety while maintaining essential mechanical properties.

III. PROPOSED METHODOLOGY

The proposed methodology for this study involves the synthesis and evaluation of bio-based rubber processing oil as a sustainable alternative to conventional petroleum-derived oils. Initially, bio-based feedstocks such as rice husk oil are selected and processed using pyrolysis to extract the required oil. This extracted oil is then purified to eliminate impurities and enhance its stability. The next stage involves fabricating rubber sheets by incorporating the bio-based oil into the rubber compound, replacing conventional aromatic oils. The fabricated rubber sheets are subjected to various mechanical tests, including tensile strength, hardness, and elongation, to assess their performance characteristics.

A comparative analysis is then conducted between the bio-based oil specimens and conventional oil specimens to evaluate their effectiveness in improving the mechanical properties of rubber. The results will help determine the feasibility of utilizing rice husk oil as a sustainable processing oil in the rubber industry, reducing dependency on petroleum-based products while maintaining or enhancing material performance.

IV. COMPARISION

The project investigates the use of bio-based rubber processing oil as a sustainable alternative to petroleum-derived aromatic oils in the tire manufacturing industry. Aromatic oils, commonly used for improving processing and

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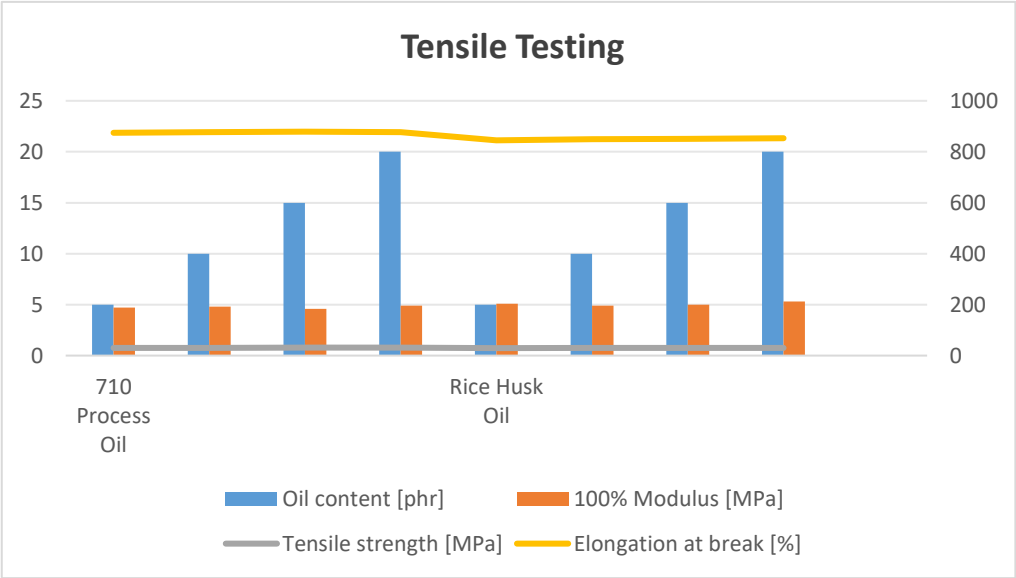
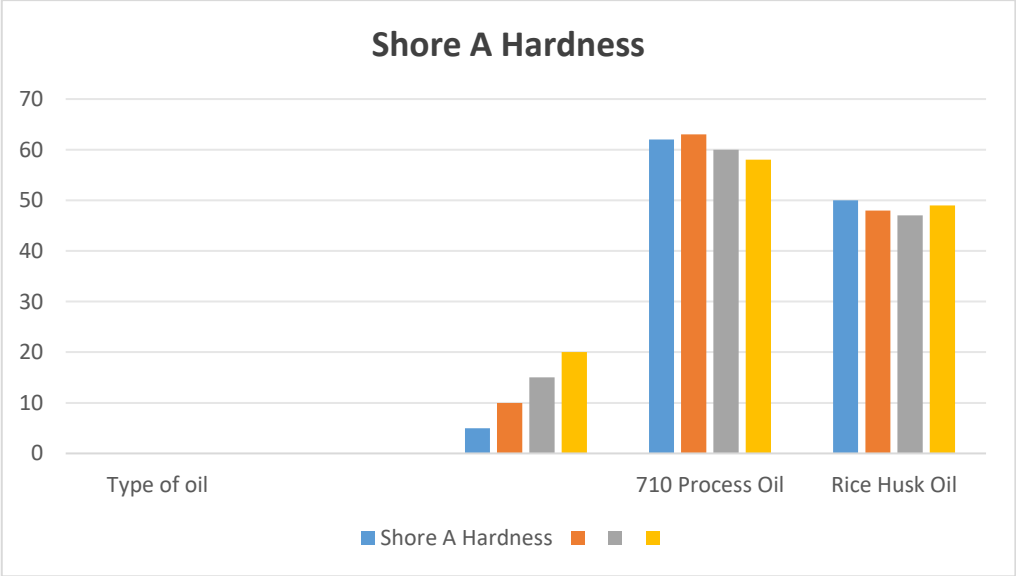
performance, contain polycyclic aromatic hydrocarbons (PAHs), which pose health and environmental risks. The study aims to replace these with bio-based oils, particularly rice husk oil, extracted through pyrolysis.

The comparative analysis involved fabricating rubber sheets using both 710 process oil (a conventional petroleum-based oil) and rice husk oil. Various tests were conducted, including tensile strength, hardness, elongation at break, and cure characteristics. The results showed that while rice husk oil had slightly lower tensile strength than 710 process oil, it exhibited improved modulus values, indicating better rigidity. However, the hardness of rice husk oil specimens was lower than that of petroleum-based samples, suggesting softer rubber compounds.

Overall, the study supports the feasibility of bio-based processing oils in the rubber industry, offering an eco-friendly alternative with competitive mechanical properties. The findings align with global trends toward sustainable materials, demonstrating the potential of renewable oils to reduce dependency on petroleum while maintaining industry standards.

V. RESULT AND DISCUSSION





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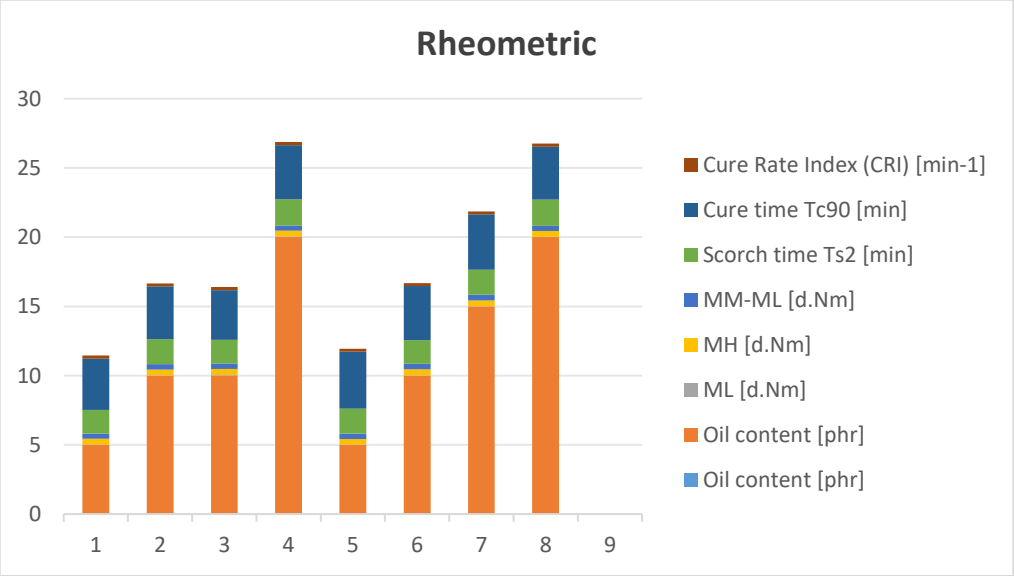

VI. CONCLUSION

In this study, we successfully analyzed the feasibility of bio-based rubber processing oil as a sustainable alternative to conventional petroleum-derived oils. The experimental results demonstrated that rice husk oil exhibits comparable mechanical and curing properties to traditional processing oils while significantly reducing environmental impact. By replacing petroleum-based oils with bio-based alternatives, the rubber industry can lower its carbon footprint, enhance biodegradability, and contribute to eco-friendly manufacturing practices. Future research can further optimize the formulation and explore large-scale industrial applications to ensure economic viability and long-term sustainability.

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