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Characterization and Performance Analysis of Novel Diesel-Methanol Fuel Blends: A Comprehensive Investigation

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Extended Abstract

With the rapid depletion of fossil-based fuels and the urgent need to mitigate global warming, the critical necessity for sustainable energy transitions and the development of viable alternatives to power our modern world has gained substantial attention in recent times. Transportation is one of the major industries in the world, where diesel plays a crucial operational role every day [1]. As of June 2023, global diesel consumption has reached 79,692.18 thousand-kilolitres/month [2]. A practical and promising solution to the problems posed by conventional diesel consumption is diesel blending. This approach not only fosters the adoption of cleaner energy alternatives but also aligns with sustainability objectives [3,4].

At the same time, methanol is a versatile and emerging fuel which can be made from both fossil-based and renewable sources. Its appeal as a fuel lies in its liquid state, facilitating easy transport and handling. Methanol is a promising candidate for diesel blending due to its high oxygen content, lower knocking tendency and lower emissions [5,6]. By promoting a blend of diesel with renewable and eco-friendly fuel sources, we pave the way towards a more sustainable, resilient, and environmentally conscious energy future. The objective of this study is to comprehensively analyse the performance and property profiles of diesel-methanol fuel blends.

The study focuses on utilizing specific cosolvent components, namely 1-decanol, 1-dodecanol, and n-butanol, to achieve successful blending of diesel and methanol. A total of 12 novel combinations were systematically tested to determine optimal blend proportions, facilitated by the cosolvent and its combinations. The determination of the fuel blend ratios was accomplished through ternary phase mixing experiments. The 12 resulting diesel-methanol fuel blends were thoroughly characterized, encompassing key properties such as calorific value, density, kinematic viscosity, sulphur content, cetane index, flash point, and pour point. Comparative analyses were conducted against the properties of pure diesel, providing valuable insights into the blend compositions and their potential applications. The characterization of the diesel-methanol fuel blends revealed that, in the majority of cases, the blends met acceptable limits, signifying their potential suitability for use as diesel fuel.

In regard to performance analysis of the diesel-methanol fuel blends, a 4-stroke, single-cylinder diesel engine was employed for this study, boasting a rated power of 3.5 kW at 1500 RPM. The investigation encompassed the evaluation of critical performance metrics: BTE (Brake Thermal Efficiency), BSFC (Brake Specific Fuel Consumption), and BP (Brake Power). Throughout the experimental phase, the engine was subjected to five distinct loading conditions: L1 (No load), L2 (25% load), L3 (50% load), L4 (75% load), and L5 (Full load), while maintaining a consistent engine speed of 1500 RPM and a compression ratio of 18:1. These conditions provided a comprehensive understanding of the engine's performance across varying load levels, shedding light on its efficiency and fuel consumption patterns. Across all loading conditions, a notable observation was that the majority of the diesel-methanol fuel blends exhibited either similar or higher BTE and BP when compared to pure diesel. Similarly, focusing on BSFC, it was observed that 10 out of the 12 diesel-methanol fuel blends demonstrated either similar or lower values compared to pure diesel.

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