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Full Length Article

Experimental evaluation of the performance and emissions of a direct-injection compression-ignition engine fueled with n-hexanol–diesel blends

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ABSTRACT

The recent developments in the sustainable production of n-hexanol, in addition to its distinctive physicochemical properties, have encouraged its application in direct-injection compression-ignition (DICI) engines. However, there has been limited research on the substitution of commercial diesel fuel with n-hexanol in DICI engines. This study investigated the impact of blending ratio of an n-hexanol–diesel mixture (up to 50% v/v) on combustion, performance, and emission characteristics of a DICI engine. A single-cylinder 4-stroke air-cooled naturally aspirated diesel engine was used to conduct these investigations. Blending ratios of 10%, 20%, 30%, 40%, and 50% by volume were used in this study without modifying the fuel system. The experiments were performed for two distinct engine settings, namely, at a speed of 900 rpm at 10% engine load and at a speed of 1500 rpm at four engine loads of 25%, 50%, 75%, and 100%. The results demonstrate that the addition of n-hexanol to diesel increased the ignition delay, improved the premixed burn mode, and inhibited the diffusion burn mode. In addition, the total cumulative heat released increased by 9% and 4% for the Hex50 blend (50% n-hexanol and 50% diesel) at engine loads of 75% and 100%, respectively. However, the brake thermal efficiency obtained for commercial diesel fuel was 0.6% greater than that of the n-hexanol–diesel blends. The brake-specific fuel consumption of the Hex50 blend at engine load of 100% was 6.4% higher than that of diesel. NO_x emissions and smoke opacity reduced by 26% and 54%, respectively, for Hex50 at an engine load of 100%. Thus, n-hexanol can be used with a maximum substitution rate of 50% in the DICI engines, resulting in substantial environmental benefits and negligible technical issues.

1. Introduction

The development of alternative fuels is an important field of research that plays a key role in improving the performance of internal combustion engines and reducing emissions [1–3]. Different types of biodiesels and lower alcohols, such as ethanol and methanol, are widely considered as alternatives to diesel fuel; their impact on the performance of diesel engines and the resulting emissions have been studied through extensive testing over past decades [4–8]. However, this group of fuels has various problems that cannot be ignored; for instance, biodiesels have cold flow characteristics, and the low energy content of lower alcohols leadzs to ignition difficulties. Although researchers have not reached a consensus on the ideal alternative to diesel fuel, studies have shown that the partial substitution of normal diesel fuel in direct-injection compression-ignition (DICI) engines with higher alcohols can potentially enhance soot oxidation, decrease NO_x emissions, improve engine performance, and reduce the reliance on diesel oil [9–12]. Long-chain (fusel) alcohols, also known as higher alcohols, with chains consisting of more than three carbon atoms, are preferred over short-chain alcohols (e.g., methanol and ethanol) owing to the former's high calorific value, low volatility, low corrosion, high water tolerance, improved miscibility/blending stability with diesel, higher blending fractions with diesel, and longer hydrocarbon chains [13–15]. However, higher alcohols have lower oxygen content and are expensive to produce in

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