



Solubility and combustion characterization of methanol/jet A-1 blends enhanced with n-octanol and diethyl ether in lean prevaporized premixed burner

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ABSTRACT

This study investigates the stability of mixtures and combustion characteristics of methanol and hydrous methanol blended with Jet A-1 fuel, utilizing n-octanol and diethyl ether (DEE) as co-solvents and ignition boosters in a lean premixed prevaporized (LPP) combustion system. Phase stability studies were performed at ambient temperatures of 10, 20, and 30 °C, revealing that n-octanol efficiently stabilized methanol–Jet A-1 mixtures. The temperature of 30 °C achieved excellent miscibility. Two blends, namely JMOD1 (80 % Jet A-1 + 5 % Methanol+10 % octanol+5 % DEE volume fraction) and JMOD2 (75 % Jet A-1 + 10 % Methanol+10 % octanol+5 % DEE), were subsequently assessed in the LPP combustor alongside pure Jet A-1 (J100) as a reference fuel. The results indicated that JMOD mixes demonstrated more consistent flame patterns, lower peak temperatures, and diminished wall hot spots in comparison to J100. This enhancement is attributable to the elevated oxygen content in methanol, diethyl ether, and n-octanol, which exhibits flame-stabilizing properties. JMOD blends demonstrated a significant capacity to diminish flame peak temperatures and improve combustion uniformity. The results endorse the viability of methanol blends as an alternative fuel for gas turbine applications.

1. Introduction

Recently, alcohols have attained a focus of study and development due to their potential as sustainable and renewable fuels. Alcohols have been recognized as viable substitutes for traditional fossil fuels, offering a significant step toward sustainable and clean combustion in engines, burners, and gas turbine applications [1]. Their main advantages are their availability, ability to be produced on a large scale, and distinctive physical and chemical properties. Difficult cold starting, ignition inefficiencies within the condition of low-load, and combustion instability are the main challenges facing the utilization of alcohol as a fuel [2].

Methanol is a single-carbon hydroxyl alcohol [1]. Its ability to boost engine power output and decrease soot formation has led to its long-term commercial use [1]. The oxygen content is usually 50 % by mass, which reduces toxic emissions and promotes clean combustion [3]. However, when used directly in combustion, it has several drawbacks, including a low cetane number, a delayed ignition, a lower heating value (19.9 MJ/kg associated with 43.46 MJ/kg for Jet A-1), and phase

separation when blended with other fuels or biodiesel.

There are numerous methods for incorporating methanol into combustion systems to overcome these limitations. Each method provides special advantages as well as challenges depending on the specific application, engine type, the base fuel, and the operating requirements. The two main methods are direct blending with the base fuel and vaporizing it through the intake airline [4]. The direct blending method is simple, where methanol is blended with the base fuel at different blending ratios. However, this approach needs a stabilizing agent due to the immiscibility of methanol and hydrocarbon fuels. Therefore, surfactants and co-solvents have been utilized to obtain stable fuel mixtures.

Higher alcohols, including n-octanol, have been documented to exhibit miscibility with diesel and biodiesel [1]. They could improve the chemical and physical characteristics of the basic fuel, subsequently leading to enhanced engine performance [2]. They possess certain positive characteristics that mitigate some detrimental characteristics of lower alcohols as fuels [2]. The primary advantages include a high cetane number and higher calorific values in comparison to methanol.

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