The Role of Analytical Methods in Verifying Biodiesel Upgrades: Emphasis on Nanoparticle and Acetone Integration for Enhanced Performance, Combustion, and Emissions

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Abstract

This study is motivated by the challenges of global warming and energy issues, as well as the need to overcome the difficulties in injection and combustion that lead to high NOx emissions, to encourage research on improving the physicochemical properties of biodiesel as an alternative diesel fuel. In this context, the effects of adding acetone and magnesium oxide (MgO) as additives to the fuel obtained by blending biodiesel, produced from Pistacia terebinthus oil - a naturally occurring oil in Turkey notable for its high content of free fatty acids, renewable but non-edible, with diesel fuel, on engine performance, combustion, and emissions have been examined. Nanoparticles and acetone were used as additives in a blend of 80% diesel and 20% biodiesel (B20), and their effects on combustion parameters were evaluated. The fuels obtained by adding acetone and acetone + MgO resulted in decreases in the rate of pressure rise, instantaneous energy release rate, cylinder pressure, average gas temperature, and cumulative heat release rate. Regarding performance parameters, a general trend of increase in specific fuel consumption was observed, while a general trend of decrease was noted in brake thermal efficiency. CO emissions showed a reduction of 6.65% in the B20 fuel mixture with added acetone and 2.10% in the fuel mixture with added acetone + MgO compared to diesel fuel. Additionally, the inclusion of only acetone to the B20 fuel resulted in a 41.64% decrease in NOx emissions, while the addition of acetone + MgO resulted in a 46.03% decrease, but led to a 26.48% increase in HC emissions. These results demonstrate that improved biodiesel formulations have the potential to offer a viable alternative to traditional diesel fuel while addressing energy and environmental challenges.

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