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Adding n-butanol, n-heptanol, and n-octanol to improve vaporization, combustion, and emission characteristics of diesel/used frying oil biodiesel blends in DICI engine

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Abstract

Diesel engines play a vital role in the transportation sector. Ternary blends of alcohol, biodiesel, and diesel have the potential to improve diesel engine combustion and emissions. In the current work, three different types of alcohols; n-butanol, n-heptanol, and n-octanol were added to biodiesel/diesel blends to improve diesel engine performance, combustion, and emissions. The biodiesel was produced from used frying oil (UFO) by ultrasonic enhanced transesterification to achieve the highest yield, lowest viscosity, and minimum production time. Three ternary fuels containing 10 vol % (n-butanol or n-heptanol or n-octanol), 10 vol% UFO biodiesel, and 80 vol% diesel were tested using diesel engine at 25%, 50%, and 75% load conditions. Thermogravimetric analysis of the ternary blends proved the enhancement in the vaporization characteristics compared with biodiesel and diesel fuels; the lighter the alcohol, the faster the vaporization rate but with longer ignition delay which enhanced the premixed burning mode. The specific fuel consumption increased by up to 6% with a slight reduction in thermal efficiency (≈1%) when n-octanol was used while n-butanol and n-heptanol showed comparable values to neat diesel. Ternary blends showed a reduction in smoke opacity, NO_x, CO, and CO_2 by up to 38%, 11%, 35%, and 14% compared with diesel, while the lowest emissions were attained for the addition of n-heptanol.

KEYWORDS

diesel engine, higher alcohols, ternary blends, thermogravimetric analysis, used frying oil biodiesel

1 | INTRODUCTION

Biofuels have attracted great attention from engine researchers and developers to resolve oil-crisis and its escalated prices cropped up in the 1970s.[1] The most suitable biofuels for diesel engine operation are commonly called biodiesel. There is great potential to add 20% by volume of biodiesel to conventional diesel fuel in the EU market by the year 2020.[2] Used frying oil (UFO) would be an exemplary choice as biodiesel feedstock due to its low price without concerns about food crises or production costs.[3,4] Besides, it is a useful way to get fuel from waste that effectively solves severe environmental problems.[5] Additionally, it is banned to drain UFO into sewers or to dump into landfills or diverting into an animal feed in several countries.[6] Meanwhile, the world produces large amounts of UFO annually; EU about 1 million tons,[7] US about 3 billion gallons,[8] Canada 0.14 million tons,[9] Turkey 0.35 million tons,[9] India 4 million tons,[5] China over 5 million tons.[10]

Mohamed Nour and Ahmed I Elseesy contributed equally to this work.

