INTERNATIONAL JOURNAL OF GREEN ENERGY
https://doi.org/10.1080/15435075.2020.1722132

Investigation the effect of adding graphene oxide into diesel/higher alcohols blends on a diesel engine performance

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ABSTRACT

This article aims to study the influence of the addition of graphene oxide nanoparticles (GO) to diesel/higher alcohols blends on the combustion, emission, and exergy parameters of a CI engine under various engine loads. The higher alcohols mainly n-butanol, n-heptanol, and n-octanol are blended with diesel at a volume fraction of 50%. Then, the 25 and 50 mg/L concentrations of GO are dispersed into diesel/higher alcohols blends using an ultrasonicator. The GO structures are examined using TEM, TGA, XRD and FTIR. The findings show that there is a reduction in $p_{max.}$ and HRR when adding higher alcohols with diesel fuel. Regarding engine emission, there is a significant improvement in emissions formation with adding higher alcohols. The addition of GO into diesel/higher alcohols blends improves the brake thermal efficiency by 15%. Moreover, the $p_{max.}$ and HRR are both enhanced by 4%. The CO, UHC and smoke formation are reduced considerably by 40%, 50 and 20%, respectively, while NO_x level is increased by 30% with adding GO. Finally, adding high percentages of n-butanol, n-heptanol, and n-octanol with diesel fuel with the presence of GO has the potential to achieve ultra-low CO, UHC, and smoke formation meanwhile keeping high thermal efficiency level.

ARTICLE HISTORY
Received 25 October 2019
Accepted 23 January 2020

KEYWORDS
Higher alcohols; graphene oxide; heat release rate; engine performance; exergy Parameters; emission characteristics

1. Introduction

There are mainly two challenges facing the research community in the world; including the fast depletion of fossil fuels and climate change problems due to global warming and pollution. The transportation sector is one of the major sectors consuming fuels and emitting toxic emissions. Diesel engines are the prime movers in heavy-duty engines, marine engines, off-road engines, and engine power generation unit, owing to their high thermal efficiency, durability and robust construction (Hasan and Rahman 2017). The biodiesel and alcohols are strongly proposed to be as alternative fuels for diesel engines, because of their attractive features' such as sustainability, nontoxicity, readily biodegradable, and no aromatic compounds. Biodiesel has a high cetane number, high flash point and outstanding lubricity behavior which make it the perfect substitution for diesel fuel (Hasan and Rahman 2017; Atabani and Da Silva César 2014; Banković-Ilić, Stamenković, and Veljković 2012; S Dharma et al. 2016). Alcohols, mostly methanol and ethanol were examined recently as oxygenated fuels in diesel engines for reducing the exhaust emissions (Trindade, da Silva, and Gonçalves Dos Santos 2017). Nevertheless, the researchers found that they have some specific difficulties which hinder their utilization in diesel engines, for instance, their lower heating value compared to diesel fuel, miscibility, and stability matters when blended with diesel fuel, low cetane number, high autoignition temperature and poor lubricating properties (Trindade, da Silva, and Gonçalves Dos Santos 2017).

Even though there have been significant efforts focusing on solving or alleviating the miscibility and stability issues, there are still some difficulties when utilizing ethanol and methanol in diesel engines (Bae and Kim 2017; Chyuan et al. 2014; Trindade, da Silva, and Gonçalves Dos Santos 2017), and their percentages in diesel mixtures are mainly restricted to 5–10% (Yilmaz and Sanchez 2012; (Çelebi and Ayd 2019). However, the higher alcohols can also be blended with diesel fuel at a high percentage with a minimum impact on the fuel distillation curve. The physiochemical characteristics of diesel, lower and higher alcohols are given in Table 1. The higher alcohols' densities, calorific values, and boiling points are comparable to diesel fuel that support their usage as a diesel fuel alternative (Rajesh Kumar and Saravanan 2016; Silitonga et al. 2018). Additionally, they have the advantage of a higher cetane number and lower latent heat of vaporization compared to methanol and ethanol and consequently, they have less combating with a cold-start issue (Mani et al. 2014).

Some researchers have studied the impacts of higher alcohols addition to diesel/biodiesel mixtures. Ghadikolaei, Cheung, and Yung (2018), Yusri et al. (2019), Goga et al. (2019), Yesilyurt, Eryilmaz, and Arslan (2018), Zaharin et al. (2017), Dharma et al. (2017), and Preuß, Munch, and

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