An investigation on the influence of aluminium oxide nano-additive and honge oil methyl ester on engine performance, combustion and emission characteristics

Manzoor Elahi M. Soudagar a, *, Nik-Nazri Nik-Ghazali a, **, M.A. Kalam a, ***, Irfan Anjum Badruddin b, N.R. Banapurmath c, Mohamad Azlin Bin Ali a, Sarfaraz Kamangar a, Haeng Muk Cho d, Naveed Akram a

a Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603, Kuala Lumpur, Malaysia
b Department of Mechanical Engineering, College of Engineering, King Khalid University, Abha, 60413, Asir, Saudi Arabia
c Department of Mechanical Engineering, B.V.B. College of Engineering and Technology, Vidyavaghar, Hubli, 580031, India
d Division of Mechanical Engineering and Automotive Engineering, Kongju National University, 276, Buda-Dong, Cheonan-City, Chungnam, 330-717, South Korea

A R T I C L E   I N F O
Article history:
Received 26 March 2019
Received in revised form 25 July 2019
Accepted 5 August 2019
Available online 8 August 2019

Keywords:
Nanoparticles
Aluminium oxide
SDS surfactant
Honge oil methyl ester
Engine performance and emission characteristics

A B S T R A C T
The potential use of aluminium oxide nanoparticles as nanofuel additives was investigated on honge oil methyl ester and diesel fuel blend. The nanofuel blends were prepared by dispersing aluminium oxide in varying quantities in a HOME/B20 (20% biodiesel: 80% diesel). Sodium dodecyl sulfate (SDS), an anionic surfactant, was used for a stable dispersion of aluminium oxide nanoparticles in the fuel blends. HOME/B20 fuel with concentration levels of 20, 40, and 60 ppm of aluminium oxide nanoparticles (HOME20, HOME2040 and HOME2060) with varying ratios of SDS surfactants were prepared using ultrasonication technique. The investigated properties of diesel, honge oil biodiesel and nanofuel blends were in agreement with the ASTM D6751-15 standards. The dispersion and homogeneity were established and characterized by using the Ultraviolet–Visible (UV–Vis) spectrometry. The UV–Vis spectrometry results illustrated an increase in absorbance level with a relative increase in the concentration of surfactant. The highest absolute value of UV-absorbency was observed for a mass fraction of 1:4 (Al2O3:NPs to SDS ratio). The investigation was performed at a constant speed of 1500 rpm, and 8% of 0 kW, 1.04 kW, 3.12 kW, 4.6 kW and 5.20 kW. The fuel HOME2040 demonstrated an overall improvement in the engine parameters, the brake thermal efficiency (BTE) enhanced by 10.57%, while there was a decline in brake specific fuel consumption (BSFC) by 11.65% and the engine exhaust emission: HC, CO, and smoke reduced by 26.72%, 48.43%, and 22.84%, while the NOx increased by 11.27%. Similarly, the addition of aluminium oxide nanoparticles in HOME/B20 fuel blend resulted in decent reduction in the combustion duration (CD), ignition delay period (ID), improvement in the peak pressure, and a marginal increase in heat release rate (HRR) and cylinder pressure at maximum loading conditions. Based on the experimental results, it is concluded that the aluminium oxide nanoparticles in HOME/B20 fuel demonstrated an overall improvement in the engine characteristics.

© 2019 Elsevier Ltd. All rights reserved.

1. Introduction

The dependence of global energy on non-renewable fuel sources, such as liquid fossil fuels and their products, natural gas and coal, have increased to two-thirds of the global energy demands. This ever-increasing demand for fossil fuels has led to drastic environmental effects that are regional and global in scales such as climate change, air contamination, and oil spills [1,2]. The engine exhaust gases consist of highly unstable and volatile organic compounds (VOCs), due to incomplete combustion of fossil fuels. A certain number of VOCs critically affect human health as they contain formaldehyde, naphthalene, acetaldehyde, benzene, acrolein, and

https://doi.org/10.1016/j.renene.2019.08.025
0960-1481/© 2019 Elsevier Ltd. All rights reserved.