BIOFUELS, 2017
https://doi.org/10.1080/17597269.2017.1306679

Taylor & Francis
Taylor & Francis Group

Performance analysis and emissions profile of cottonseed oil biodiesel–ethanol blends in a CI engine

K. Nantha Gopal[a], B. Ashok[a], K. Senthil Kumar[b], R. Thundil Karuppa Raj[a], S. Denis Ashok[a], Vignesh Varatharajan[a] and Vivek Anand[a]

[a]School of Mechanical Engineering, VIT University, Vellore-632014, India; [b]Mechanical Engineering Section, Higher College of Technology, Muscat, Oman

ABSTRACT

Biodiesel is identified as a likely alternative fuel for Compression Ignition (CI) engines as it leads to an effective reduction in consumption of petroleum diesel, and of engine exhaust emissions. In the current study, the effects of preheating of intake air on performance, emissions and combustion behavior have been studied for various compositions of cottonseed oil biodiesel–ethanol blends in a compression ignition engine. The characteristics were compared for intake air temperatures of 30°C and 80°C, respectively. An increase in the air intake temperature caused variations in the ignition delay period of the biodiesel–ethanol blend by improving the vaporization characteristic of ethanol, and provides a better combustion. It was found experimentally that the carbon monoxide (CO) as well as the unburned hydrocarbon (HC) emissions decreased with an increase in the preheat temperature, and were found to be slightly lower than those of biodiesel-fueled CI engines. An increase in the relative amount of ethanol blended with the biodiesel was also found to decrease CO and HC emissions. However, in comparison with biodiesel fuel, the ethanol–biodiesel blends resulted in higher emissions of oxides of nitrogen (NO_x).

ARTICLE HISTORY
Received 27 August 2016
Accepted 12 February 2017

KEYWORDS
Cottonseed methyl ester; ethanol–cottonseed blends; emissions; diesel engines; intake air temperature; air preheating

Introduction

Compression-ignition (CI) engines installed predominantly in mechanical divisions of industry and commercial applications have high efficiency of fuel conversion, high brake power, low fuel consumption and the lowest maintenance cost [1–3]. Diesel fuel obtained from crude oil resources is becoming more expensive and strenuous to procure, as the world petroleum resources are on the verge of depletion [4]. The increased dependency on petroleum products has prompted quicker exhaustion of fossil fuels which has driven us to look for alternative sources of fuels. Biodiesels, from vegetable oils, have certain important properties comparable to those of diesel fuel. It is, thus, considered a suitable alternative source of energy for its application in internal combustion compression engines. It is renewable and biodegradable. Chemically, biodiesel is methyl esters of fatty acid produced from vegetable oils such as soybean, cottonseed, rubber seed, jatropha etc., and animal fats [5–7].

In recent times, many alternative fuels have emerged as potential replacements for conventional diesel. These alternative fuels need to be technically accepted, economically feasible, environmental friendly and easily available. Alcohols are used extensively as an alternative fuel in CI engines due to their characteristic reduction of emissions when blended with diesel. The limiting factors on alcohol usage in CI engines are poor characteristics of lubrication and high enthalpy of vaporization [8]. Many research activities regarding the operation of alcohol such as ethanol and methanol in CI engines, to improve combustion and performance, and reduce the emissions characteristics, have been performed. Hakan investigated the use of a diesel–alcohol (methanol and dodecanol) blends as a substitute fuel and studied its performance parameters in a CI engine. The methanol concentration varied from 2.5 to 15%, and 1% dodecanol was used for each blend. The experimental results suggest that with no alterations made to the diesel engine, alcohol blends resulted in a decrease in the specific consumption of fuel, and increased engine efficiency [9]. Murat et al. examined the consequences of using isobutanol–diesel fuel blends by studying the exhaust emissions. The concentration of isobutanol was varied from 5 to 20%. The results indicated that there was a significant decrease in the emissions of CO and NO_x. On the other hand, the unburned hydrocarbon (HC) emissions were found to increase when compared to that of diesel fuel [10]. Operating a diesel engine with ethanol as a fuel causes low emissions of smoke, oxides of nitrogen and HC. Ethanol is considered appropriate for petrol engines or spark ignition engines due to its remarkable knock resistance property, making it an effective

CONTACT B. Ashok ashok.b@vit.ac.in