Fuel 88 (2009) 629–636

Contents lists available at ScienceDirect

Fuel

journal homepage: www.elsevier.com/locate/fuel

Performance and combustion characteristics of a DI diesel engine fueled with waste palm oil and canola oil methyl esters

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ARTICLE INFO

Article history:
Received 5 June 2008
Received in revised form 18 September 2008
Accepted 22 September 2008
Available online 20 October 2008

Keywords:
Alternative fuel
Cylinder gas pressure
Injection line pressure
Heat release
Emissions

ABSTRACT

This study discusses the performance and combustion characteristics of a direct injection (DI) diesel engine fueled with biodiesels such as waste (frying) palm oil methyl ester (WPOME) and canola oil methyl ester (COME). In order to determine the performance and combustion characteristics, the experiments were conducted at the constant engine speed mode (1500 rpm) under the full load condition of the engine. The results indicated that when the test engine was fueled with WPOME or COME, the engine performance slightly weakened; the combustion characteristics slightly changed when compared to petroleum based diesel fuel (PBDF). The biodiesels caused reductions in carbon monoxide (CO), unburned hydrocarbon (HC) emissions and smoke opacity, but they caused to increases in nitrogen oxides (NO_x) emissions.

1. Introduction

Increasing global concern due to air pollution caused by internal combustion engines has generated much interest in the environmental friendly diesel fuels. In the last two decades, the researchers and manufacturers have provided major reductions in the exhaust emission levels of the diesel engines. However, increasing number of diesel vehicles will probably bring the same air pollution problem again in the next years. These forecasts have triggered various research studies in many countries to replace petroleum based diesel fuel (PBDF) with oxygenated fuels such as biodiesel, ethanol etc. Nowadays, some diesel engine manufacturers allow using neat biodiesel or its blends instead of PBDF. The guarantees only apply to biodiesel that fulfills the ASTM D 6751-03 for USA and EN 14214 for European Union [1].

Although the fuel properties of biodiesel show some variations when different feedstocks are used, it has higher cetane number, near-zero aromatic, and free sulphur compared to conventional diesel fuels [2,3]. The fuel properties of biodiesel are affected by its fatty acids content which causes differences in the injection, combustion, performance and emissions characteristics of the engine. Canakci and Van Gerpen [4] prepared two different biodiesels from soybean oil and yellow grease with 9% free fatty acids to investigate the effect of biodiesel on a direct injection (DI) diesel engine (John Deere 4276 T). They found that the brake specific fuel consumption (*bsfc*) for both biodiesels increased approximately 14% when compared with No. 2 diesel fuel. They also observed that the biodiesels have earlier start of injection timing and shorter ignition delay compared with No. 2 diesel fuel. In another study, similar results were obtained by Hansen and Jensen [5] who tested commercial rapeseed oil (also called canola) methyl ester in a DI diesel engine (Volvo THD 103KF). In past, Purcell et al. [6] conducted on engine performance tests in a diesel engine (Caterpillar 3304) using neat soybean oil-based biodiesel and B30. The blend (B30) had 4% less power and 4% higher fuel consumption than No. 2 diesel fuel; while the neat biodiesel had 9% less power and 13% higher fuel consumption than No. 2 diesel fuel. Nowadays, similar results was reported by Murillo et al. [7] who experienced the commercial biodiesel and its blends (10%, 30% and 50%) with conventional diesel fuel in a DI diesel engine (8D Renault). The authors stated that the obtained brake power with the use of B10 and B30 reduced less than 5%, in the usage of B50 and neat biodiesel reduction approached 8% compared to the conventional diesel fuel.

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0016-2361/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.fuel.2008.09.023