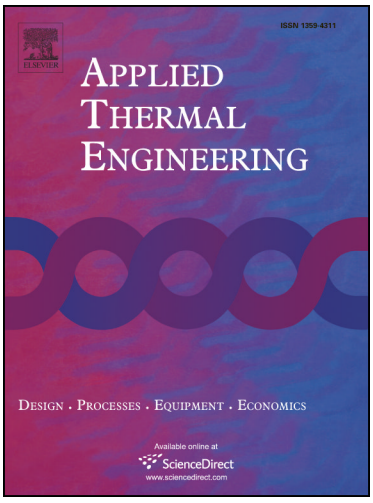

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Performance and emissions of diesel-biodiesel-ethanol blends in a light duty compression ignition engine

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Abstract

An approach to reduce CO_2 emissions while simultaneously keeping the soot emissions down from compression ignition (CI) engines is to blend in short chained oxygenates into the fuel. In this work, two oxygenated fuel blends consisting of diesel, biodiesel and EtOH in the ratio of 68:17:15 and 58:14:30 has been utilized and studied in a single cylinder light duty (LD) CI engine in terms of efficiency and emissions. The reasons of utilizing biodiesel in the fuel blend is due to the emulsifying properties it has while the origin of the fuel is biomass. When performing the experiments, the control parameters were set as close as possible to the original equipment manufacturer (OEM) EU5 calibration of the multi-cylinder engine to study the possibility of using such blends in close to stock LD CI engines. The oxygenates, in particular the fuel with the higher concentration of EtOH, showed an net indicated efficiency of ∼52 % at high load in comparison to diesel which never exceeded ∼48 %. Regarding the emissions, several trends were observed; the soot-NO_X trade-off diminished significantly when utilizing the fuel with the highest concentration of EtOH. The charge cooling effect reduces the NO_X emissions while the exhaust particles are reduced both in terms of mean diameter and quantity. At lower loads, the THC and CO emissions were higher for the oxygenated blends than for the diesel due to the earlier mentioned charge cooling negatively affecting the combustion process. However, this trend seized at the higher loads when the in-cylinder temperature is higher and oxidation of the fuel is enhanced.

Keywords: `Ethanol, FAME, Diesel, LD engine, Efficiency, Emissions`

1. Introduction

The quest of finding a more environmentally friendly fuel, for the commercial passenger cars, has in recent years resulted in several ideas of different combustion engine modifications and combustion strategies. While the spark ignition engine (SI) is used mainly due to the emission of cleaner exhaust gases thanks to the three way catalyst, the compression ignition (CI) engine has seen an overall increase in popularity due its higher efficiency [1]. The drawback of the CI engine is the high concentration of harmful components of its exhaust gases, being more expensive to eliminate, since the use of more advanced exhaust after treatment system (EATS) is a requirement to remove particulate matter (PM) and NO_X. Moreover, the EATS used for CI engines tend to be more expensive than a regular three-way catalyst and have a limited life span [2].

An approach to reduce the PM and NO_X emissions, increase the efficiency and possibly the life cycle of the EATS, is to change or modify the utilized fuel. Biodiesel produced from a variety of different plants, not only reduces the overall CO_2 emissions, but also the PM emissions due to its oxygen content which enables the fuel to oxidize more readily than conventional diesel [3]. However, several studies have shown that utilization of biodiesel causes a slight increase in NO_X emissions [3, 4, 5]. European Union now imposes a maximum of 7 vol.% in the commercial diesel fuel and it is expected that this limit will be increased to 10 vol.% in the future [6].

Biodiesel and diesel blends has successfully been tested in CI engines, showing somewhat varied results, due to the fact that biodiesel originates from many different types of biomass [7]. Properties, such as viscosity, specific density and flash point will vary between different types of biodiesel, and will therefore have different effects on emissions and efficiency when utilized as an CI engine fuel [7, 8]. The most common attribute is that biodiesel consists of fatty acid methyl esters (FAME) which has a lower calorific value than regular diesel; ∼37.3 MJ/kg in comparison to regular diesel, ∼43.2 MJ/kg [9, 10]. This results in an increased brake specific fuel consumption in relation to regular diesel.

Experiments in CI engines with fuel blends consisting of ethanol and diesel have been conducted. The blending of these two fuels can, however, be problematic if the ethanol content is above 5 vol.% due to the different molecular po-

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