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Engine performance and emission formation of a diesel engine fueled with biodiesel B15 at different injection timings

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Abstract. Biodiesel could now be considered as an alternative fuel for compression ignition engines and it can be used directly or in blends with diesel without engine modification. Biodiesel is non-toxic, contains no aromatics is sulphur-free, biodegradable and an oxygenated and renewable fuel. In the present work, a numerical study was performed to determine the engine performance and exhaust gas emissions of a direct injection DI, four-cylinder, diesel engine by using pure diesel and biodiesel B15 fuel (15% sunflower oil mixed with 85% diesel, by volume) operating at different fuel injection timings. The results were acquired at engine speed 3000 rpm under full load conditions. A comparison between the numerical results and experimental data regarding the in-cylinder pressure was done in order to check the usefulness of this model. The results have shown that the engine performance of biodiesel B15 was slightly lower than that of pure diesel fuel. Concerning gas emissions; lower soot emission, higher NOx emissions of biodiesel B15 were obtained compared to those of diesel fuel at same operating conditions.

1. Introduction

Today, in most countries; biodiesel fuel is obtained from vegetable oils or animals fat and is one of the alternative fuels suitable for a diesel engine that could be used in pure form or as a mix with diesel fuel at a different volumetric percentage. Biodiesel B5 (5% biodiesel mixed with 95% diesel fuel, by volume) is used as a regular fuel in most countries, at the gas station pump. The international development specifications for a wide variety of products (ASTM) approved B5 for safe operation in any CI engine [1,2,3,4]. Biodiesel's high oxygenation (10-12% O2, in content) could benefit the combustion process, which leads to improvement of the engine performance and a reduction of exhaust gas emissions [5-6]. Biodiesel has a higher cetane number than diesel fuel which leads to a reduction of chemical ignition delay. However, there is drawback of biodiesel is viscosity. Biodiesel has 2-3 times higher viscosity value compared to that of diesel fuel which has an effect on spray pattern, break up and penetration [7,8].

Kannan [7] experimentally studied the effect of a mix with 40% waste cooking palm oil (WCO) methyl ester, 50% diesel and 10% ethanol on engine performance, combustion characteristics and emissions of a four-stroke, single cylinder, DI diesel engine. The experimental study was done at two injection timings (25.5° and 28° before top dead center (bTDC), at different injection pressures (220 bar to 300 bar, increment 20 bar). The results have shown that the optimum engine performance registers at injection pressure equal to 240 bar and injection timing of 25.5° bTDC when fueled with biodiesel-diesel-ethanol blend. The brake thermal efficiency was improved by 2%, while brake specific fuel consumption (BSFC) decreased up to 0.9 MJ/kWh when using biodiesel-diesel-ethanol