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Combined effect of compression ratio and diethyl ether (DEE) port injection on performance and emission characteristics of a DI diesel engine fueled with upgraded biogas (UBG)-biodiesel dual fuel

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ABSTRACT

In this present investigation, a single cylinder, four stroke, direct injection (DI) diesel engine was modified to operate on dual fuel mode with upgraded biogas (UBG)-Karanja methyl ester (KME). In dual fuel mode, diethyl ether (DEE) was injected as an ignition improver through the air intake manifold of the engine to initiate early combustion of biogas in the combustion chamber. During UBG-KME-DEE operation the compression ratio (CR) of the engine was varied from 16.5 to 18.5 in steps of 1. During investigation, the engine load was varied from 0% to 100% in steps of 25. The DEE injection quantity and the KME injection timing was kept constant at 6% (vol%) and 24.5 °CA bTDC (found to be optimum from previous study by the authors) respectively. The results indicated that UBG-KME-DEE operation with CR 18.5 gave optimum result than those of other CRs. For UBG-KME-DEE-CR18.5 the BTE increased and BSFC decreased by about 7% and 2.2% respectively, than that of KME. A reduction in the specific CO, specific HC, and smoke emissions of 42.2%, 39.5%, and 42.8% was observed for UBG-KME-DEE-CR18.5 in comparison to diesel at full load respectively. However, the specific NO emission for UBG-KME-DEE-CR18.5 was 7.6% higher than that of diesel, but it was 1.2% lower than that of KME, at full load.

1. Introduction

In the recent decades, denser volumes of harmful pollutant are being released to the atmosphere due to the excessive consumption of fossil fuels in automobiles, process industries, and power plants. The environmental degradation caused due to the consumption of fossil fuels can be declined by the use of biomass-based fuels. The renewable energy technologies have gained international recognition for research, development, and dissemination because of its environment and eco-friendly nature. However, due to the complexity of renewable energy extraction process, inadequate technology, and diminutive quantity production drags its growth. The replacement of fossil fuels by alternative renewable liquid and gaseous fuels in the transportation sector could be a significant contributor to the sustainable development. The application of biomass-based gaseous fuels in automotive and power sector is considered to be superior, in comparison with that of liquid biofuels, due to their easy mixing characteristics with intake air before combustion.

Gaseous fuels such as compressed natural gas (CNG), methane (CH_4), producer gas, furnace gas, pyrolysis gas, and biogas are emerged as potential alternative fuels and can be used in a diesel engine in dual fuel mode. The use of CNG in diesel and gasoline engine is extensive in the present decade [1]. However, the CNG reservoirs have decreased drastically in the past few years and may result crisis of CNG availability in future by 2030 [2,3]. Among gaseous fuels the use of biogas in the diesel engine offers certain advantage on waste to energy, waste minimization and waste to bio-fertilizer. Biogas is environmental friendly and can be produced from easily available waste by-products of biomass, by-products of agricultural industries, food processing industries, municipal solid waste and waste water [4–7]. Biogas is a carbon neutral fuel and it offers zero addition of greenhouse gas to the atmosphere. Biogas is a colorless gas, which is lighter than air. The concentration of CH_4 in biogas signifies its energy content. The main constituents in biogas are methane (CH_4), carbon dioxide (CO_2), traces of hydrogen sulfide (H_2S), and nitrogen (N_2) [8,9]. The presence of CO_2 in biogas decreases its combustion quality, when used in engines. The CO_2 from the biogas can be separated by purifying biogas in a scrubber. The purified biogas property is almost similar to CNG, and can be used in CNG operated vehicles without any modification to the engine. Also the purified biogas can be used for decentralized power generation

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