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Experimental investigation on the behavior of a direct injection diesel engine fueled with Karanja methyl ester-biogas dual fuel at different injection timings

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ABSTRACT

The present investigation explores the possibility of using Karanja methyl ester (KME) as a pilot fuel in a biogas run direct injection (DI) diesel engine of rated power 4.4 kW at 1500 rpm, with compression ratio of 17.5:1. The biogas was inducted with the intake air, and KME was injected directly into the combustion chamber. The injection timing of the pilot fuel, in the biodiesel dual fuel mode (BDFM) was varied from 21.5 °CA bTDC to 27.5 °CA bTDC in steps of 1.5 °CA. The BDFM with injection timing was denoted as BDFMX, where X indicates the injection timing. BDFM24.5 (biodiesel dual fuel mode of 24.5 °CA) gave better performance and lower emissions than those of other injection timings. The results showed that, the brake specific fuel consumption (BSFC) for BDFM24.5 was found to be higher by about 23.9% than that of KME, at full load. About 6.6% increase in the brake thermal efficiency was observed for BDFM24.5 in comparison with BDFM23.0, at full load. BDFM24.5 gave a reduction in the CO, HC and smoke emissions of 17.1%, 18.2% and 2.1%, in comparison with the BDFM23.0, at full load, respectively. But, the NO emission for BDFM24.5 was higher by about 5.5% than that of BDFM23.0, at full load.

1. Introduction

Currently, the world is very keen to search the alternative energy sources, because of the steep increase in fuel cost, overcome the crisis of fossil fuel depletion, and reduce the environmental pollution. Although harnessing energy from solar and wind energy are focused by several researchers, utilization of biofuels which can be derived from variety of biomass sources, is also of great interest today. This is because of renewable nature, abundant availability and low CO_2 generation of biomass sources. Three biomass based biofuels are mainly focused as alternative fuels today for IC engines, which are (i) alcohols (ii) biodiesel and (iii) biogas. Many developed countries and some of the developing countries use ethanol in the range of 10–15% in blended form with gasoline, while biodiesel was used by 5–10% with diesel fuel in vehicles for transport applications. In this context, production of biodiesel from different edible and non-edible oils has been investigated and reported by several researchers [1–4]. Biodiesel is biodegradable, nontoxic, environment friendly and non-explosive [2]. Biodiesel can be used in pure form or blended with diesel, without any major modification to the engine and its components [3,4].

Due to the increasing demand of biodiesel, many commercial biodiesel plants are being installed and in operation worldwide. In biodiesel plants, after extraction of oil from the oil seed, the de-oiled seed cake remains as a solid organic waste. The edible de-oiled cakes are used for manure preparation and cattle feed. The non-edible de-oiled cakes cannot be used as cattle feed, or can be used in agrarian farms directly, because of its toxic nature (i.e., existence of crucin and saponins). Hence, the non-edible de-oiled cakes are basically dumped in open land, which emit various anthropogenic gases, such as methane (CH_4), nitrous oxide (N_2O), hydrogen sulfide (H_2S), ammonia (NH_3), carbon dioxide (CO_2) and volatile organic compounds (VOCs), which cause increase in the global warming potential (GWP) [5]. Recently, extraction of energy from such non edible oil cakes through pyrolysis [6–8] and anaerobic digestion [5,9–11] have been documented. Pyrolysis oil, gas and char are produced from the pyrolysis process, while biogas

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