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ORIGINAL ARTICLE

Experimental investigations on mixing of two biodiesels blended with diesel as alternative fuel for diesel engines

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Abstract The world faces the crises of energy demand, rising petroleum prices and depletion of fossil fuel resources. Biodiesel has obtained from vegetable oils that have been considered as a promising alternate fuel. The researches regarding blend of diesel and single biodiesel have been done already. Very few works have been done with the combination of two different biodiesel blends with diesel and left a lot of scope in this area. The present study brings out an experiment of two biodiesels from pongamia pinnata oil and mustard oil and they are blended with diesel at various mixing ratios. The effects of dual biodiesel works in engine and exhaust emissions were examined in a single cylinder, direct injection, air cooled and high speed diesel engine at various engine loads with constant engine speed of 3000 rpm. The influences of blends on CO, CO_2, HC, NOx and smoke opacity were investigated by emission tests. The brake thermal efficiency of blend A was found higher than diesel. The emissions of smoke, hydro carbon and nitrogen oxides of dual biodiesel blends were higher than that of diesel. But the exhaust gas temperature for dual biodiesel blends was lower than diesel.

1. Introduction

The preservation of energy is decreasing now a days and it alleged that it leads to energy demand. In the last two decades, alternative fuels have obtained and identified as essential. A potential biodiesel substitutes diesel oil, consisting of ethyl ester of fatty acids produced by the transesterification reaction of triglycerides of vegetable oils and ethanol with the help of a catalyst. In addition, biodiesel is better than diesel fuel in terms of very low sulfur content and it is also having higher flash and fire point temperatures than in diesel fuel.

A lot of research work pointed out that biodiesel has received a significant attention and it is a possible alternative fuel. Biodiesel and its blends with diesel were employed as a fuel for diesel engine without any modifications in the existing engine.

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Nomenclature

PPEE	pongamia pinnata ethyl ester	PB10	10% of PB + 90% diesel
MEE	mustard ethyl ester	PB20	20% of PB + 80% diesel
PPO	pongamia pinnata oil	PB30	30% of PB + 70% diesel
MO	mustard oil	PB40	40% of PB + 60% diesel
SFC	specific fuel consumption	PB60	60% of PB + 40% Diesel
BSEC	brake specific energy consumption	PB80	80% of PB + 20% diesel
TFC	total fuel consumption	MB	mustard biodiesel
HC	hydro carbon	MB10	10% of MB + 90% Diesel
NOx	nitrogen oxides	MB20	20% of MB + 80% diesel
CO	carbon monoxide	MB30	30% of MB + 70% diesel
CO_2	carbon dioxide	MB40	40% of MB + 60% Diesel
PO	pongamia pinnata oil	MB60	60% of MB + 40% diesel
MO	mustard oil	MB80	80% of MB + 20% diesel
PB	pongamia pinnata biodiesel		

Ghaly et al. (2010) reported that the research on the production of biodiesel has increased significantly in recent years because of the need for an alternative fuel which endows with biodegradability, low toxicity and renewability.

Theansuwan and Triratanasirichai (2011) concluded that the biodiesel produced by transesterification showed similar properties to the standard biodiesel. Agarwal et al. (2008) investigated that the process of transesterification is found to be an effective method of reducing viscosity of vegetable oil.

Lawrence et al. (2011) revealed that prickly poppy methyl ester (PPME) blended with diesel could be conveniently used as a diesel substitute in a diesel engine. The test further showed that there was an increase in break thermal efficiency, brake power and reduction of specific fuel consumption for PPME and its blends with diesel.

Deepanraj et al. (2011) described that the lower blends of biodiesel increased the brake thermal efficiency and reduced the fuel consumption. In addition to this, biodiesel blends produce lower engine emissions than diesel.

Rahimi et al. (2009) used Diesterol (combination of diesel fuel, bioethanol and sunflower methyl ester) as a fuel for diesel engines. The authors revealed that, as the percentage of bioethanol in the blends is increased, the percentage of CO concentration in the emission is reduced. This trend is due to the fact that bioethanol has less carbon than diesel. Mani et al. (2009) investigated the diesel engine runs with waste plastic oil as fuel. The authors concluded that, the smoke was reduced by 40% than diesel.

Muralidharan and Govindarajan (2011) prepared biodiesel from non-edible pongamia pinnata oil by transesterification and used as a fuel in C.I engine. The authors reported that blend B5 exhibits lower engine emissions of unburnt hydrocarbon, carbon monoxide, oxides of nitrogen and carbon dioxide at full load.

Venkatraman and Devaradjane (2011) performed the experiments in a single cylinder DI diesel engine fueled with a blend of pungam methyl ester for the proportion of PME10, PME20 and PME30 by volume with diesel fuel for validation of simulated results. The authors observed that there is a good agreement between simulated and experimental results.

Kumar et al. (2003) conducted the experiments using pure jatropha oil, jatropha methyl ester, blends of jatropha and methanol and dual fuel operation (0–80% methanol by volume is inducted and jatropha acts as pilot fuel). The authors reported that, brake thermal efficiency for jatropha esters, dual fuel operation and diesel was 29%, 28.7% and 30.2% respectively.

Srivastava and Verma (2008) carried out the experiments using methyl ester of karanja oil. The authors reported that, the maximum thermal efficiency with methyl ester of karanja oil was about 24.9%, whereas that of the diesel was 30.6% at maximum power output. The authors concluded that, the methyl ester of karanja oil is a suitable substitute of diesel.

Ramadhas et al. (2008) studied the dual fuel mode operation using coir-pith derived producer gas and rubber seed oil as pilot fuel. The authors reported that, non-edible oils can be used as pilot fuel, which eliminates the use of petroleum diesel.

Nwafor (2004) studied the potential of rapeseed methyl ester and its blends with diesel fuel as alternative substitute for diesel fuel. The author described that, the fuel consumption of rapeseed methyl ester was little higher than diesel fuel operation. Forson et al. (2004) found that, jatropha oil could be conveniently used as a diesel substitute, in a diesel engine. Wang et al. (2006) confirmed that, the vegetable oils possess almost the same heat values as that of diesel fuel. The engine power output and the fuel consumption of the vegetable oil and its blends are almost the same when the engine is fueled with diesel.

From the review of literatures, numerous works in the utilization of biodiesel as well as its blends in engines have been done. However, most of the literatures focused on single biodiesel and its blends. From previous studies, it is evident that single biodiesel offers acceptable engine performance and emissions for diesel engine operation.

Very few experiments have been conducted with the combination of dual biodiesel and diesel as a fuel (Prabhakar et al. 2012). Most of the literatures suggested that pongamia pinnata oil (also called as karanja oil) is a suitable substitute of diesel and a few research works have also been carried out with mustard oil. So, the pongamia pinnata oil and mustard oil were selected for this current study which is easily and locally available. As a first level of experimentation, the properties of above said fuels in various combinations were found out in this work. This proved that the calorific value of the dual biodiesels and its blends with diesel fuel is more than the single biodiesel