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Research Article

Biodiesel as Alternative Fuel for Diesel Engine

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Abstract

Ability to do work is known as energy. The energy is of two types' i.e. Renewable and Non Renewable energy sources which have abundant storage but Non Renewable have limited storage, hence it is essential to use Renewable energy source and conserve energy. Growing importance regarding energy resources and environment safety motivates for study of alternative sources of energy. To meet energy demand we should search alternate source of energy which has large storage and which is of less emission also. The aim of this work is to compare emission and effects on environment. Hence from many researchers concluded that use Biodiesel is one of the favorable option as an Alternative fuel for Diesel because of the performance from Biodiesel is same that of diesel in Diesel Engine. With the use of Biodiesel we improve Brake Specific Fuel Consumption (BSFC) by 18-24%. Important advantage of use of Biodiesel is that there were no needs of change in arrangement of the Diesel engine. Hence, today focus on use of waste cooking oil as feed stocks for biodiesel production.

Keywords: *Abundant storage, BSFC, Conserve, Favorable Alternative, Waste cooking oil.*

1. Introduction

Alternative fuels are very important factor when we look from energy security and social economy point of view. As pollution caused by the fossil fuel like petroleum, coal, natural gas.etc the alternative fuels demand increases (Garlapati, *et al*, 2013). Increased demand of the energy leads to pollution; hence for control these demand and pollution we should acquire fuels of less emission. Increase use of petroleum tends to global warming (Ogunwole, 2012). Biofuels like alcohols and biodiesel have been proposed as an alternative because it has very important advantage that it contain almost no sulphur; non toxic and a natural lubricant, flash point is of 130°C (266°F), hence it not explode quickly and ignite under normal circumstance. Although it is readily available, renewable, biodegradable, cloud point, flash point and cold filter plugging point (Demirbas, 2007), (Agarwal, 2007). Biodiesel can form blends with petroleum diesel fuel at any ratio.

Biodiesel fuel affects engine performance, lot of research carried out on performance characteristics of diesel engine with biodiesel and diesel. Many researchers agreed that the fuel consumption of an engine fueled with biodiesel becomes high (Aydin, *et al*, 2010). As the increased content of biodiesel the fuel consumption also increases (Labecks, *et al*, 2009). Table 1 shows important properties of diesel and biodiesel.

Table 1 Diesel and Biodiesel fuel property

Sr. No	Property	Diesel	Biodiesel
1	Flash Point (°C)	61	150
2	Pour Point (°C)	0	-5
3	Cloud Point (°C)	3	-1
4	Kinematic Viscosity (mm^2/s)	4.15	4.3
5	Density (kg/mm^3)	830	875

Diesel engines mostly used in Industrial plants, transportation, agriculture etc. that produces smoke, particular matter, oxides of nitrogen (NO_x), un-burnt hydrocarbon. Several alternatives are studied to overcome these emissions from Diesel. Vegetable oil proposed as promising alternatives as they are produced in rural area (Mulmani, *et al*, 2012). Waste cooking oil is low cost and pollution free feedstock as an alternative fuel. These oils need to be treating before disposal to environment to prevent pollution. Biodiesel has higher oxygen content than petroleum diesel. They are produced from Transesterification process in which chemical reactions involves vegetable oil and alcohol to yield fatty acid alkyl ester and glycerol.

Agarwal (2008) Conducted an experiment had observed significant improvement in performance and decrement in emission when biodiesel is used as fuel in diesel engine. Thermal efficiency of the engine improved, Brake specific fuel consumption reduced and also reduction in exhaust smoke is observed. Altin

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et al. (2001) evaluated exhaust emission and performance of diesel engine with biodiesel as fuel and concluded that biodiesel given better performance characteristics than other alternative fuels. Goering *et al*, (1982) and Pramanik *et al*. (2003) also studied are results obtained that improved engine performance with reduction in exhaust gas temperature also controlled specific fuel consumption.

2. Biodiesel Production

Schematic representation and picture of the system for production of Biodiesel from waste cooking oil is as shown in following figure

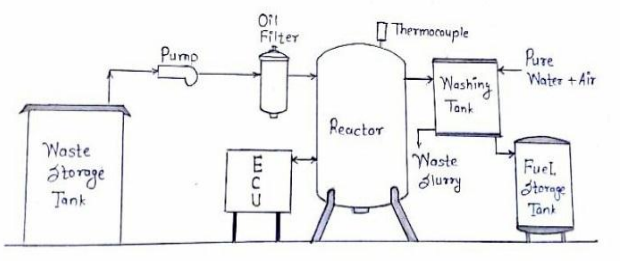

Fig.1 Biodiesel production from waste cooking oil

This recycling system consists of waste oil tank, fuel storage tank, pump, filter, reactor, condenser and control unit. Engine or cooking oil is stored in storage tank. Through the pump this oil is transferred to filter system where it get filtered and passed to reactor. Reactor is the most important part of this system. In reactor thermal treatment of the waste oil is takes place. Up to 20 liters of the fuel is produced in reactor system. It is then passed over Condenser section where is get purified by mixture of water and air. At the end in fuel storage tank Biodiesel is obtained. This volume is enough for test setup to calculate characteristics of the fuel, performance and emission. This Biodiesel also used as fuel for production of electricity purpose. Not only in Industrial purpose but also domestic use purpose they would be used, hence we can say that biodiesel are multipurpose fuel having less cost of production and pollution free fuel.

3. Experimental Work

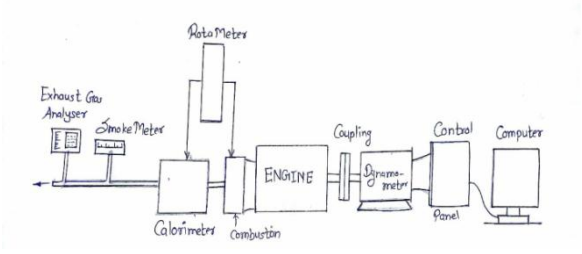

Fig.2 Schematic diagram of experimental setup

The experimental work is carried to calculate performance and emission characteristics at different load conditions with Biodiesel as fuel for diesel engine. In the test single cylinder, four stroke, water cooled diesel engine is used. This engine is coupled with Dynamometer (Eddy Current Dynamometer) of a rated output 5.2kW at average speed of 1500 rpm. Schematic representation is shown in Fig.2

Firstly engine is allowed to warm up to achieve steady state condition, after that experimental procedure is carried out to calculate readings. Dynamometer placed is used to calculate power output. Exhaust emission like HC, CO and NO_x are measured by exhaust gas analyzer. Exhaust temperature and smoke is also measured by AVL smoke meter. Dynamometer reading is given by the control panel and it is analyzed by computer. In the computer all the information regarding work setup has been stored and calculated readings like engine rate, flow rate, temperature, load etc. after test are also present. All the observations are taken five times to get reasonable value. Fuel property is shown in Table 2.

Table 2 Engine Specification

Type of Engine	Four Stroke, Single cylinder Diesel Engine
Bore	87.5 mm
Stroke	110 mm
Compression Ratio	17.5 : 1
Volume Displacement	661.5 cm^3
Rated Power	5.2 kW

4. Observations and results

The test was conducted on a direct injection diesel engine for different loads. Brake thermal efficiency, Carbon monoxide emission, Hydrocarbon emission, Oxide of nitrogen emission results are obtained with biodiesel as a fuel in diesel engine.

4.1 Brake Thermal Efficiency

Fig.3 shows variation of brake thermal efficiency with brake power for diesel and Soybean oil methyl ester (SOME), Pongamia methyl ester (PME) biodiesels at constant speed of engine. Brake thermal efficiency of diesel is always greater than Biodiesel but values of SOME and PME somewhat close to diesel. The lower calorific value and higher viscosity of biodiesel are responsible for lower brake thermal efficiency compared to diesel fuel.

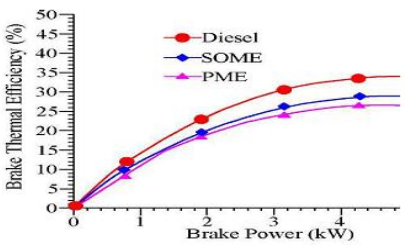

Fig.3 Graph of Brake power Vs Brake thermal efficiency

4.2 Hydrocarbon Emission (HC)

Fig.4 shows variation of hydrocarbon emission with brake power for diesel and biodiesels at constant speed of the engine. At full load condition HC level of biodiesel and diesel is shown in fig. HC level of biodiesel is higher than diesel fuel respectively. At full load condition due to high viscosity that leads to bigger fuel droplets and hence non-uniform mixing with air.

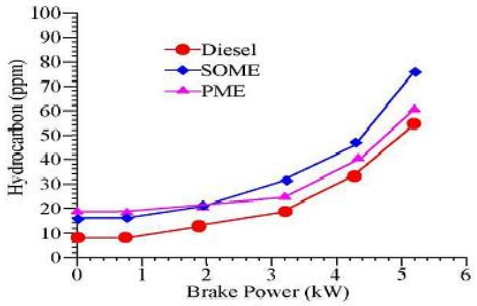

Fig.4 Graph of Brake power Vs Hydrocarbon

4.3 Carbon Monoxide Emission (CO)

Fig.5 shows variation of carbon monoxide emission with brake power for diesel, biodiesel at constant speed of the engine. Up to 4 kW of brake power carbon monoxide emission rate of Palm oil Methyl Ester (PME) biodiesel is linear with diesel but after 4kW power emission rate of PME is higher than diesel.

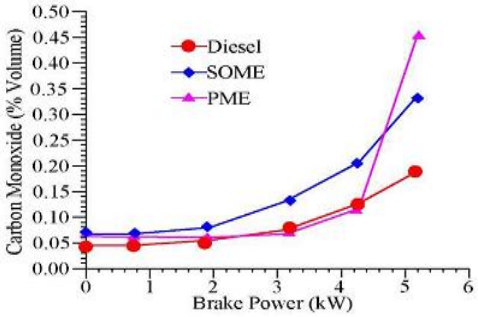

Fig.5 Graph of Brake power Vs Carbon Monoxide

4.4 Oxides of Nitrogen Emission (NO_x)

Fig.6 shows oxides of nitrogen emission with brake power for diesel, biodiesel at constant speed of the engine. It is observed that NO_x emission increase with the increase in brake power for all fuels at constant speed of the engine. At part load condition NO_x emission of both biodiesel are higher than diesel fuel. At medium load condition NO_x emission of biodiesel and diesel fuel is same. At full load condition NO_x emission of biodiesel and diesel is shown in figure NO_x emission for biodiesel is higher at all load condition due to presence of higher oxygen content and complete combustion of the biodiesel.

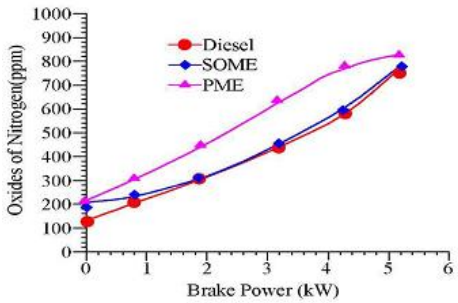

Fig.6 Graph of Brake power Vs Oxides of Nitrogen

Conclusions

At four stroke water cooled single cylinder direct injection diesel engine was run successfully using biodiesel and diesel as fuel. The performance and emission characteristics have been analyzed and compared to baseline diesel fuel. Followings of the conclusions are made,

1) Brake thermal efficiency of Biodiesel is somewhat lower than Diesel at full load condition.
2) HC level of Biodiesel little bit greater i.e. 2-3ppm than Diesel at full load condition.
3) NO_x is also higher of Biodiesel at full load condition than Diesel.

From above point we conclude that biodiesel can be a good alternative for diesel engine if there is no presence of diesel in future.

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