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International Journal of Current Research
Vol. 9, Issue, 09, pp.57006-57009, September, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

PERFORMANCE AND EMISSION ANALYSIS OF DIESEL –BIODIESEL (KME) BLENDS AS FUEL IN D I DIESEL ENGINE

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ARTICLE INFO

Article History:
Received 12th June, 2017
Received in revised form
15th July, 2017
Accepted 23rd August, 2017
Published online 29th September, 2017

Key words:
Biodiesel, Karanja oil Methyl Ester,
Transesterification,
Engine Performance,
Blend Fuel.

ABSTRACT

To overcome the future energy crisis, vegetable oils can be used as a promising alternative energy source of fuel. Many vegetable oils have been studied with C I engine by modification of oil (Biodiesel) in case of density/viscosity. The blend fuels of diesel with Karanja oil methyl ester (KME) at 10%, 20%, 30% and 40% by volume were prepared to test the diesel engine performance. From the results, performance parameters were found to be very close to that of diesel fuel. The brake thermal efficiency and brake specific fuel consumption are better than diesel fuel for some blending ratios under certain loads. The emission characteristic levels of carbon dioxide, carbon monoxide, nitric oxide and hydrocarbons were found to be higher than pure diesel fuel.

Citation: Venkateswara Rao, P. 2017. "Performance and Emission Analysis of Diesel –Biodiesel (KME) blends as fuel in D I diesel Engine", *International Journal of Current Research*, 9, (09), 57006-57009.

INTRODUCTION

The fossil fuel is great concern due to increase in demand, fast depletion of available reserves and also a major source of enviornment pollution. So the efforts are being made towards finding alternative energy sources similar to the present day fuels which can be used as substitute of diesel fuel. Studies show that the vegetable oils can be used in diesel engines as they found to have properties very close to diesel fuel (Barnwal *et al*., 2005; Senthil Kumar, 2003). It is being considered a breakthrough because, availability of various types of oil seeds in huge quantities (Harrington, 1986). The trees planted for oil seeds will reduce enviornment pollution and protect soil erosion for longer duration of period. Vegetable oils are renewable in nature and may generate opportunities for rural employment when used in large scale for making of biodiesel (Babu, 2003). Vegetable oils from crops such as soya bean, peanut, sunflower, rape seed, coconut, karanja, neem, cotton, mustard, jatropha, linseed and castor have been evaluated in many parts of the world. Non edible oils have been preferred because they don't compete with food reserves. Karanja (pongamia) seed oil which is non-edible and does not find any other suitable application due to its odour and dark colour can be used to make biodiesel (Agarwal, 2007; Kesari *et al*., 2010). High viscosity and low volatility of vegetable oils causes poor cold starting, misfire and increases the ignition delay. This nature of oils causes gum formation on the surface of piston and rings which causes excessive wear due to the dilution of lubricating oil. In order to overcome these problems, vegetable oils need to be converted into compatible fuels (Biodiesels) to the existing C I engines without any modification (Agarwal, 2000; Hamasaki *et al*., 2001). Thus, vegetable oils need to be modified in order to bring their combustion related properties closer to that of diesel fuel. This is mainly aimed at reducing the viscosity of oil by transesterification process and increasing the volatility oil to enhance engine efficiency (Pramanik, 2003; Venkateswara Rao, 2015; Sahoo *et al*., 2009). The performance of engine with 10% Triacetin additive and COME biodiesel blends gives encouraging results in respect of engine efficiency and exhaust emissions when compared with neat diesel (Venkateswara Rao, 2012; Venkateswara Rao, 2013). In this work, different proportions of karanja oil methyl ester (KME) at 10%, 20%, 30% and 40% is mixed with 90%, 80%, 70% and 60% of diesel to prepare blend fuel on volume basis for conducting experiments on diedel engine.

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Making of biodiesel

Straight vegetable oils (SVO) can be used directly as a fossil diesel fuel substitute; however, using this fuel can lead serious engine problems. Due to high viscosity of SVO leads to poor atomization of fuel which leads to incomplete combustion and choking of fuel injectors (Guna Saketh, 2014). To overcome these problems transesterification process is used to produce biodiesel from SVO by transesterification process. Filtered karanja oil is heated at 105^0C and acid treated with methanol and sulfuric acid to remove part of glycerol.

In base treatment sodium mithoxide (mixture of NaOH and methanol) is added and the mixture is stirred by heating at temperature between 60^0C to 65^0C. After completion of reation (Fig. 1) glycerol is separated and the formed methyl ester is bubble washed with water and orthopashoric acid to remove soaps. The karanja oil methyl ester (KME) heated to remove water content from the biodiesel (Hassania *et al.*, 2013; Venkateswara Rao, 2013; Nikzad *et al.*, 2013).

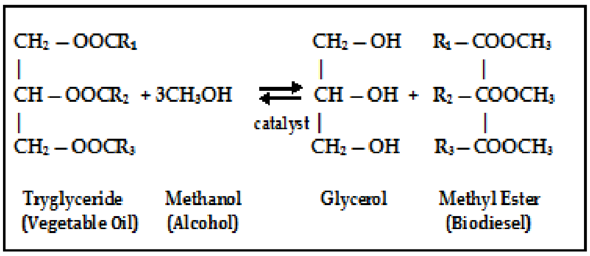

Fig.1. Biodiesel reaction

EXPERIMENTATION

Dynamometer was coupled to provide load on the engine. Sensors were connected near the flywheel and air box for speed and air flow measurement. A burette was used to measure fuel flow and a thermocouple with to a temperature indicator measures the exhaust gas temperature. Emissions such as unburnt hydrocarbon (HC), carbon monoxide (CO) and nitric oxide (NO) were measured by an AVL exhaust gas analyzer. Experiments were carried out by using various blends of karanja oil methyl ester (KME10, 20, 30, 40, 100) with diesel at different load conditions 0, 25, 50, 75 and 100 on the engine. Combustion parameters such as mechanical efficiency, brake thermal efficiency, brake specific fuel consumption, and emission parameters like exhaust gas concentrations were evaluated and compared the results with diesel fuel.

RESULTS AND DISCUSSION

Brake Thermal Efficiency (BTE): Figure 2 shows the variation of BTE and *BSFC* with respect to load on the engine. It is observed that biodiesel and blends with diesel shows higher efficiency at all load conditions compared to that of diesel fuel. The maximum BTE of 13.3% higher with biodiesel and 8.61% higher by KME30 at full load condition is obtained in comparison with diesel fuel. At higher load almost all blend fuels shows slightly better BTE than diesel, this may be due to additional fuel consumption and lubricity provided by biodiesel available in the blend fuel even at low calorific value. The BSFC of biodiesel and all blend fuels is lower as compared to diesel fuel at maximum load on the engine. The availability of oxygen in the blend fuel may be the reason for complete combustion, hence the BSFC is lower. At lower load conditions, additional fuel air mixture is required to produce the same power, so high viscosity of KME may lead to incomplete combustion that require additional blend fuel to produce the same power.

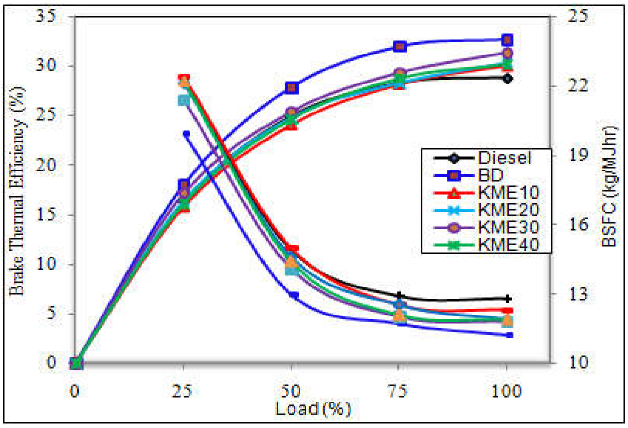

Fig.2. BTE and BSFC variation with load

Carbon Monoxide (CO): The variation of CO emission with load is shown in figure 3. The emissions are slightly higher for almost all blends; this is due to higher viscosity of the fuel, which results in poor atomization and incomplete combustion. At higher load, more fuel is consumed that results in relatively low availability of oxygen for combustion of fuel, which results in slightly higher carbon monoxide.

Carbon Dioxide (CO_2): Figure 4 shows the variation of CO_2 emission with loads. The CO_2 emission for the blends is higher than diesel for all loads. Complete combustion of fuel with oxygen forms into CO_2. As the calorific value of the fuel is low, more fuel needs to be burnt to get same output power and also excess amount oxygen available in biodiesel that leads to complete combustion; hence carbon dioxide emission is higher.

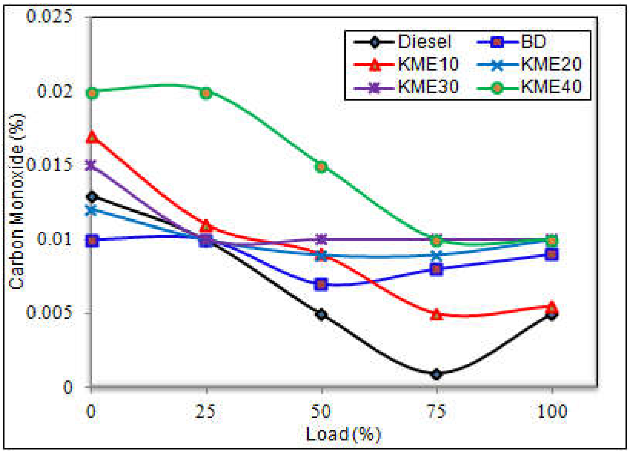

Fig.3. Carbon Monoxide variation with Load

Hydrocarbons (HC): The variation in HC emission with load for blend fuels is shown in figure 5. Incomplete burning of carbon compounds in the fuel is a result of HC emission. Initially all blends have lower values of HC than diesel fuel but at higher temperatures of combustion chamber which helps in cracking and faster burning. But when load increases, fuel consumption also increases which results in relative reduction of oxygen in the fuel air mixture that leads to higher exhaust as compared to diesel. Due to oxygen availability in biodiesel, reduction in HC emission is observed with biodiesel operation.

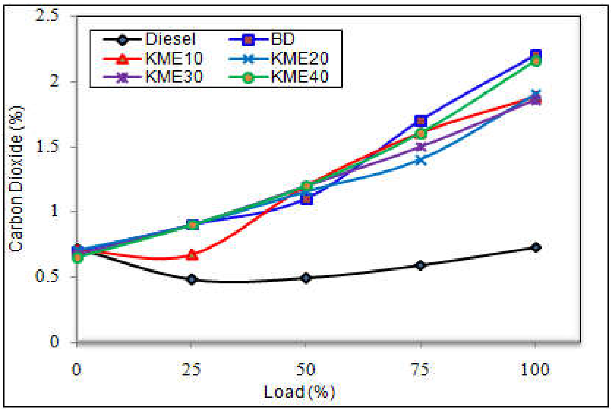

Fig.4. Carbon Dioxide variation with Load

Nitric Oxide (NO): Figure 6 shows the nitric oxide emission trend for different blend fuels at various loads. High temperature and availability of oxygen are the two important factors to form nitric oxide. Majority of nitrogen in the exhaust forms into nitric oxide. Higher quantity of nitric oxide emission was observed with biodiesel and the trend decreases with blend fuels as compared to diesel fuel.

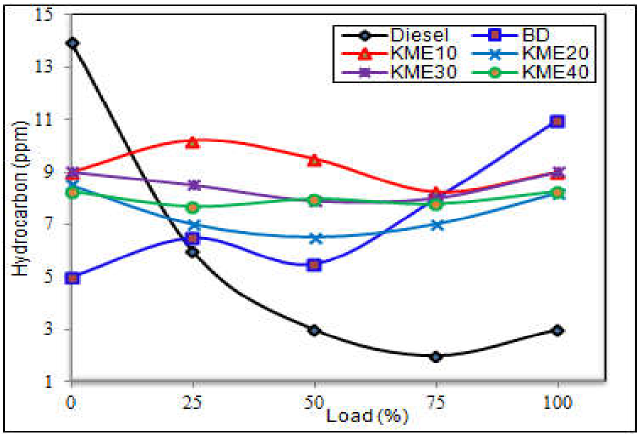

Fig.5. Hydrocarbon variation with Load

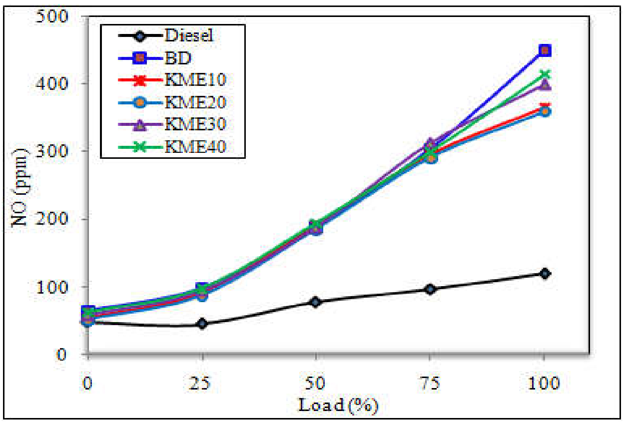

Fig.6. NO variation with Load

CONCLUSION

Karanja oil methyl ester blends with diesel have a potential to use as alternative fuel in diesel engines and the following conclusions are made from the experimental study.

- Brake thermal efficiency of the engine with karanja oil methyl ester-diesel blend was marginally better and BSFC is lower at all loads.
- The emission characteristics are higher than pure diesel but the KME30 is relatively better in performance with respect to other blend fuels.

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