Comprehensive analysis on performance and emission characteristics of C.I Engine by using Karanja (Pongamia Pinnata) Bio-Diesel

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Abstract—

On the face of the upcoming energy crisis, vegetable oils have come up as a promising source of fuel. They are being studied widely because of their abundant availability, renewable nature and better performance when used in engines. Many vegetable oils have been investigated in compression ignition engine by fuel modification or engine modification. The vegetable oils have very high density and viscosity, so we have used the methyl ester of the oil to overcome these problems. Their use in form of methyl esters in non modified engines has given encouraging results.

Karanja oil (Pongamia Pinnata) is non edible in nature is available abundantly in India. An experimental investigation was made to evaluate the performance, emission characteristics of a diesel engine using different blends of methyl ester of karanja with mineral diesel.

Karanja methyl ester was blended with diesel in proportions of 5%, 10%, 15%, & 20% by mass and studied under various speed conditions in a compression ignition (diesel) engine

Keywords—. Biodiesel, ***Karanja Biodiesel,***

I. INTRODUCTION

Fossil fuels are one of the major sources of energy in the world today. Their popularity can be accounted to easy usability, availability and cost effectiveness. But the limited reserves of fossil fuels are a great concern owing to fast depletion of the reserves due to increase in worldwide demand. Fossil fuels are the major source of atmospheric pollution in today's world. So efforts are on to find alternative sources for this depleting energy source. Even though new technologies have come up which have made solar, wind or tidal energy sources easily usable but still they are not so popular due to problems in integration with existing technology and processes. So, efforts are being directed towards finding energy sources which are similar to the present day fuels so that they can be used as direct substitutes.

Diesel fuel serves as a major source of energy, mainly in the transport sector. During the World Exhibition in Paris in 1900, Rudolf Diesel was running his engine on 100% peanut oil. In 1911 he stated ''the diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries, which use it''. Studies have shown that vegetable oils can be used in diesel engines as they are found to have properties close to diesel fuel.

1.1 Biodiesel:

Biodiesel is a liquid fuel made up of fatty acid alkyl esters, fatty acid methyl esters (FAME), or long-chain mono alkyl esters. It is produced from renewable sources such as new and used vegetable oils and animal fats and is a cleaner-burning replacement for petroleum-based diesel fuel. It is nontoxic and biodegradable. Biodiesel has physical properties similar to those of petroleum diesel. In simple terms, biodiesel is a renewable fuel manufactured from methanol and vegetable oil, animal fats, and recycled cooking fats (U.S. Department of Energy, 2006). The term "biodiesel" itself is often misrepresented and misused. Biodiesel only refers to 100% pure fuel (B100) that meets the definition above and specific standards given by the American Society of Testing and Materials (ASTM). However, it is often used to describe blends of biodiesel with petroleum diesel. Such blends are generally referred to as "B2," "B5," "B20," etc., where the number indicates the percent of biodiesel used.

2. THEORY

The engine performance tests were conducted with a Multi-cylinder 4-sroke Diesel Engine Setup. The parameters like fuel consumption, torque were measured at different speeds and constant loads for various blends of karanja methyl ester (PPME) with diesel. Performance parameters like break power, break thermal efficiency and brake specific fuel

Property	KME (B-5)	KME (B-10)	KME (B-15)	KME (B-20)	Diesel
Density (kg/m^3)	839	842	847	854	836
Viscosity (cst) At 40^0 C	4.7	4.9	5.1	5.6	2.87
Flash point(^{0}C)	55	62	70	78	46
Fire point(^{0}C)	61	73	85	98	52
Calorific value (MJ/Kg)	43.192	42.969	42.740	42.511	43.42
Cloud Point(^{0}C)	4.6	4.8	5	5.3	4
Pour Point(^{0}C)	2.3	2.5	2.8	3.1	2
Cetane number	44	45	46	48	45-50

consumption (bsfc), etc. were calculated using the collecting data at the same time the flue gas analysis using Flue Gas Analyser was done.
those of diesel. The higher pour point may cause problem in winter season or cold regions. The main source of instability in biodiesel fuel is unsaturation in the fatty acid chain. The metal and elastomers in contact with diesel during can also impact stability.

2.1 ***Properties of Karanja Biodiesel:***

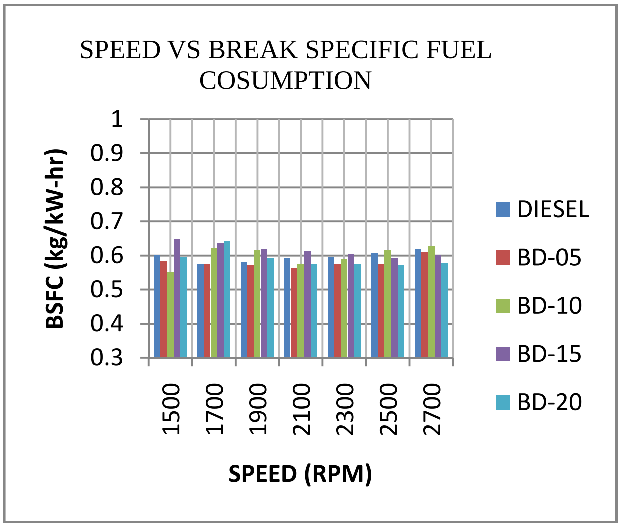
The important properties of biodiesel such as density, kinetic viscosity, flash point, fire point, boiling point, cetane number, etc. are determined as per ASTM standards before conducting performance tests. Karanja biodiesel is purchased from Indian Bio-Diesel Development Corporation Baramati, Pune and diesel is purchased from local diesel supplier at Baramati. The properties of biodiesel is tested in chemistry department of Indian Bio-Diesel Development Corporation Baramati, Pune and compared with diesel which is tabulated in table. It shows most of the properties are similar or closes to each other.

Chemical composition of vegetable oil esters is dependent upon the length and degree of unsaturation of fatty acid alkyl chains. The carbon or hydrogen ratio of biodiesel depends upon degree of unsaturation. Biodiesel contains 10 to 12 % by weight oxygen, which lowers energy density and lowers the particulate emission. Biodiesel is essentially no aromatic compound.

The calorific value biodiesel was less than diesel but blending with diesel gives optimum scale. It generally accepted that fuel consumption is proportional to the volumetric energy density of the fuel based upon lower or net heating value. Thus volumetric fuel economy is lower for biodiesel and its blends. Fuels having flash point above 90 ^{0}C are non-hazardous to store, biodiesel is safer to store as it has flash point at about 170 ^{0}C. The cloud point and flash point of biodiesel is higher than those of diesel. The higher pour point may cause problem in winter season or cold regions. The main source of instability in biodiesel fuel is unsaturation in the fatty acid chain. The metal and elastomers in contact with diesel during can also impact stability.

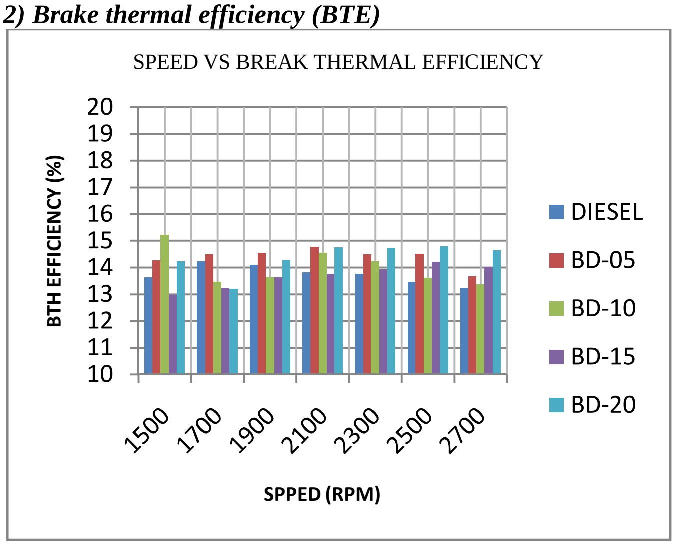
3. PERFORMANCE ANALYSIS GRAPHS:

3.1 Variation of BSFC with speed:



The variation of BSFC with speed for different blends and diesel are presented in Figure. It is observed from Figure that the BSFC for all the fuel blends and diesel tested decrease with increase in speed. This is due to higher percentage increase in Break power with speed as compared to increase in the fuel consumption. For B05 blend the BSFC is lower than diesel for all speeds. For B10, the BSFC is almost same as that of diesel. For blends with biodiesel grater than 15%, the BSFC was observed to be grater than that of diesel, the difference being maximum at 1700 rpm of speed.

2) Brake thermal efficiency (BTE)



Brake thermal efficiency (BTE) is one the main performance parameters which indicates the percentage of energy present in the fuel that is converted into useful work. The comparison of BTE of the various blends of karanja with diesel (BD-05, BD-10, BD-15 and BD-20) and lean diesel is as shown in Figure. Almost all blends show slightly better BTE than diesel at higher load conditions. The higher thermal efficiencies may be due to the additional lubricity provided by the fuel blends.

3.2 Graph for variation of The mechanical efficiency:

The mechanical efficiency of the fuel mixtures is plotted in figure. It can be seen that the mechanical efficiency for BD-05 is better than diesel fuel at lower speed conditions. The variation of mechanical efficiency with speed for Karanja biodiesel and its blends and diesel fuel are shown in

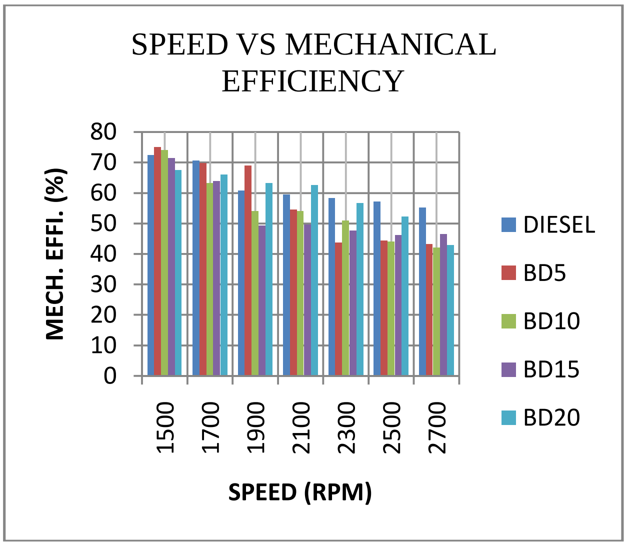
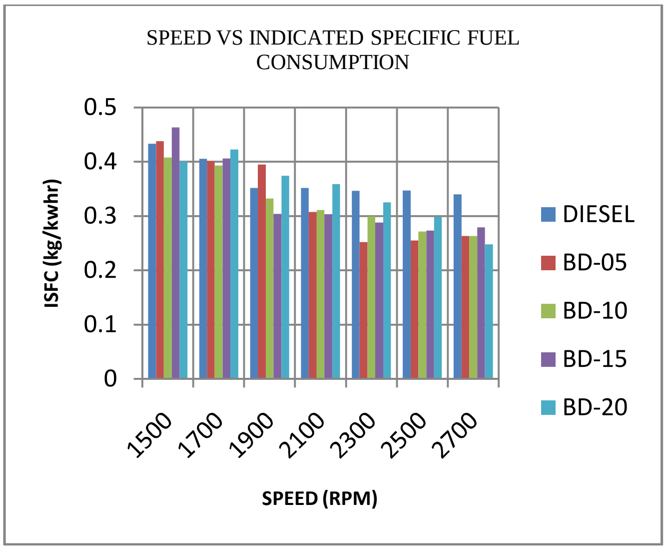


figure.It is seen from the figure that mechanical efficiency for the blends BD10, BD15 and BD20 is lower than diesel fuel at different speeds while it is lower for bio-diesel at higher speeds.

3.3 Graph for variation of Indicated Specific Fuel Consumption:

The variation of ISFC with speed for different blends and diesel are presented in Figure. It is observed from Figure that the ISFC for all the fuel blends and diesel tested decrease with increase in speed. This is due to higher percentage increase in Break power with speed as compared to increase in the fuel consumption.

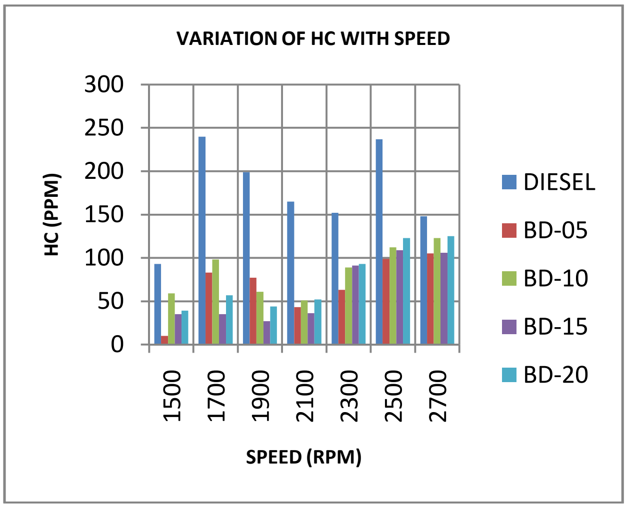
For B05 blend the ISFC is lower than diesel for all speeds. For B10, the ISFC is almost same as that of diesel. For blends with biodiesel grater than 15%, the BSFC was observed to be less than that of diesel, the difference being maximum at 2300 rpm of speed.



4. Graphs for Exhaust Gas Analysis:

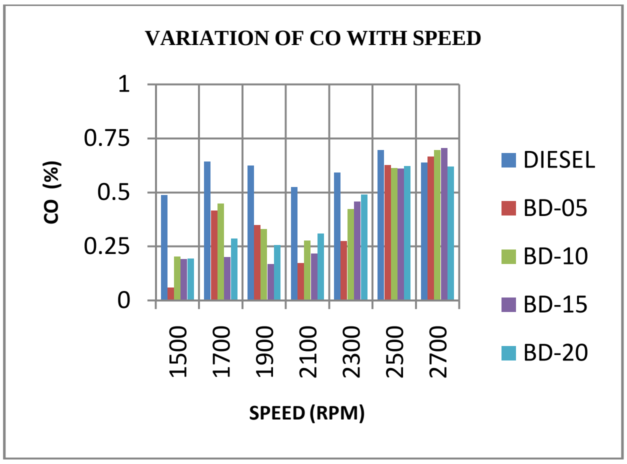
4.1 Graph for variation of HC:

Unburned HC is also an important parameter for determining emission behaviour of the engines. Figure shows the variation of HC emission with speed for different fuels. It is observed that HC emission of the various blends was lower at lower speed as compared to diesel, but increased at higher engine speed. This is due to the availability of less oxygen for the reaction when more fuel is injected into the engine cylinder at higher engine speed.

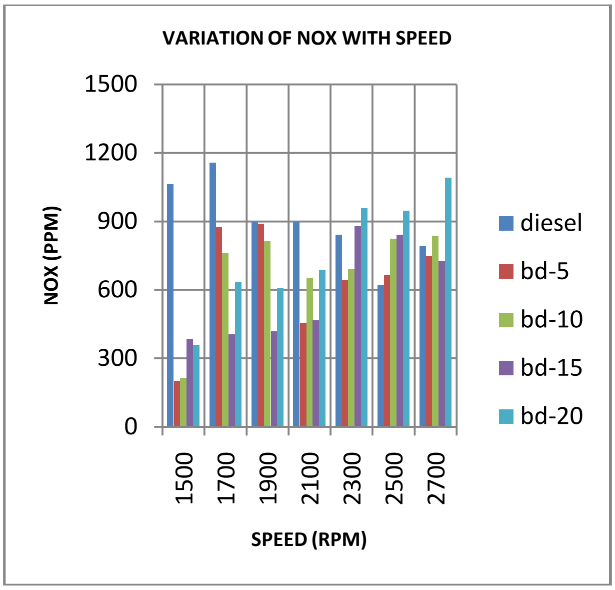


4.2 Graph for variation of CO:

Carbon monoxide emissions occur due to the incomplete combustion of fuel. The emissions of carbon monoxide are toxic. The comparative analysis is as shown in Figure. Biodiesel blends give less carbon monoxide as compared to diesel due to complete combustion.



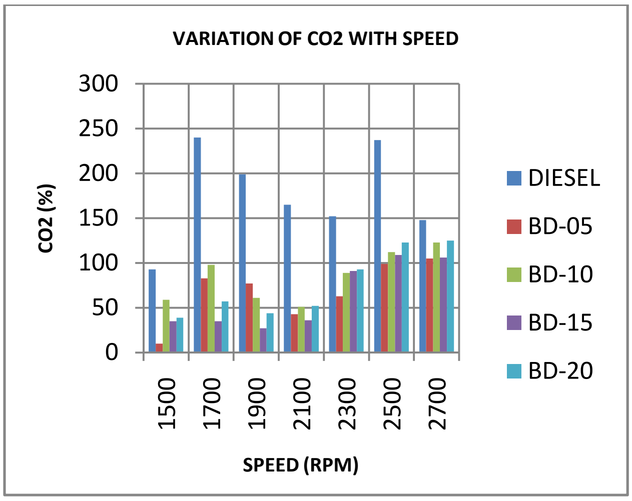
4.3 Graph for variation of NO_X :



NOx emissions are extremely undesirable. NOx is one of the main emissions in diesel engine. NOx is more likely to cause respiratory problems such as asthma, coughing, etc. Three conditions which favor NOx formation are higher combustion temperature, more oxygen content and faster reaction rate. The above conditions are attained in biodiesel combustion very rapidly as compared to neat diesel

4.4 Graph for variation of CO_2

Graph depicts the CO2 emission of various fuels used. The CO2 emission increased with increase in speed for all blends. The lower percentage of biodiesel blends emits



less amount of CO2 in comparison with diesel. Blends B05 and B10 emit very low emissions. This is due to the fact that biodiesel is a low carbon fuel and has a lower elemental carbon to hydrogen ratio than diesel fuel

5. CONCLUSION:

Biodiesel production is a modern and technological area for researchers due to constant increase in the prices of petroleum diesel and environmental advantages. Biodiesel from Karanja oil was produced by alkali catalysed transesterification process. The engine performance studies were conducted with a M&M make multi-cylinder diesel engine setup with hydraulic dynamometer and exhaust gas analyser.

It is observed that the biodiesel has good lubricity when used in diesel engines. The biodiesel with 05%, 10%, 15% and 20% blends are used in the conventional diesel engine without any modification in engine design or fuel system the biodiesel performance evaluation is done. No other trouble was found during entire running period of the engine

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6. FUTURE WORK:

- To study the efficiency of biodiesel with different blends of biodiesel.
- To find the various constituents responsible for effective use.
- To find the proper utilization of by-product.
- To improve the quality of biodiesel.
- To produce biodiesel from different non-edible oil.
- To investigate different blends of esters with diesel to determine better performing blends.
- To investigate combustion characteristics and emission characteristics.

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