Experimental Investigation of Castrol oil Methyl Esters as Biodiesel on Compression Ignition Engine

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Abstract

The methyl esters of vegetable oils, known as biodiesel are becoming increasingly popular because of their low environmental impact and potential as a green alternative fuel for diesel engine and they would not require significant modification of existing engine hardware. Methyl ester of castor (CME) derived through transesterification process. Experimental investigations have been carried out to examine properties, performance and emissions of different blends (B10, B20, and B40) of castor in comparison to diesel. The use of alternatives for the fossil fuels, such as castor, jatropha, pongamia, etc. is very essential. It has been found that biodiesel plays an important role in the automobile industry now a day. This work aims at reducing the cost of the fuel consumed by blending the biodiesel from castor oil with diesel with different proportions and testing the performance of blended diesel. Initially the engine has to run by diesel and the following characteristics of Brake Power, Total Fuel Consumption, Indicated Power, Mechanical Efficiency, Brake Thermal Efficiency, and Volumetric Efficiency are calculated. Then same procedure is followed for biodiesel blend with varying the proportion by 20%, 40%, 70%, and then by 100% biodiesel. The Characteristics are obtained and compared with diesel in a graph. Based on the performance analysis the efficiency of B-40 just decreases by 2.62% then of pure diesel, which gives an inference that the biodiesel is an acceptable alternative fuel.

Keywords

Bio-diesel, Transesterification, Methyl Esters, Transesterification, Emission

1. Introduction

Energy is an important input in all sectors of any country's economy. World is facing energy crisis now, it is because Increase in population and standard of living .The demand for energy increases day by day. The world mostly depends on fossil fuels. The present crisis demands the need of an alternative fuel. The need of an alternative fuel can be fulfilled by a processed fuel derived from biological sources called biodiesel.

2. Biodiesel

Biodiesel refers to a diesel-equivalent, processed fuel derived from biological sources. Though derived from biological sources, it is a processed fuel that can be readily used in diesel-engine vehicles, which distinguishes biodiesel from the straight vegetable oils or waste vegetable oils used as fuels in some modified diesel vehicles. Biodiesel refers to alkyl esters made from the transesterification of both vegetable oils and/or animal fats. Biodiesel is a biodegradable and non-toxic, and has significantly fewer emissions than petroleum based diesel when burned. Biodiesel functions in diesel engines, and is a possible candidate to replace fossil fuels as the world's primary transport energy source. Biodiesel can be distributed using today's infrastructure and its use and production is increasing rapidly. Fuel stations are beginning to make biodiesel available to consumers, and a growing number of transport fleets use it as an additive in their fuel. Biodiesel is generally more expensive to purchase than petroleum diesel, but can be made at home for much cheaper than either. This differential may diminish due to economies of scale, the rising cost of petroleum and government tax subsidies. Biodiesel is a light to dark yellow liquid. It is practically immiscible with water, has high boiling point and low vapour pressure. Typical methyl ester biodiesel has a flash point of approximately 150º C (302ºF), making it rather non-flammable. Biodiesel has a density of approximately 0.8gm/cm^3, less than that of water. Biodiesel uncontaminated with starting material can be regarded as non-toxic.

Biodiesel can be used in diesel engines either as a standalone or blended with Petro diesel much of the world uses a system known as the 'B' factor to state the amount of biodiesel in any fuel mix. For example, fuel containing 20% biodiesel is labeled B-20 pure biodiesel is referred as B-100.

3.Castor Oil

Castor oil is one of hard oils, where the oil content in the seed is relatively high. In the caseof castor seed, the oil content is close to 50% of the total by weight – the castor bean contains 50-55% oil. The oil itself contains a number of fatty acids similar to those in cooking oils, such as oleic acid, linoleic acid, stearic acid and palmitic acid. However, among vegetable oils, castor oil is distinguished by its high content (over 85%) of icinoleic acid. No other vegetable oil contains so high a proportion of fatty hydroxyl acids. Castor oils unsaturated bond, high molecular weight (298), low melting point (5ºC) and very low solidification point (-12ºC to -18ºC) make it industrially useful, most of all for the highest and most stable viscosity of any vegetable oil

4.Production of Biodiesel from Castor Oil

Castor oil is converted into methyl ester by the transesterification process. This involves making the triglycerides of castor oil to react with methyl alcohol in the presence of catalyst (KOH) to produce glycerol and fatty acid ester. Specified amount (1000ml) of castor oil (300ml) methanol and (5kg) KOH are taken in a tank. The contents are stirred till ester formation began. The mixture is heated to in the range of 60 to 65 ºC and held at a temperature and stirred for 1hour time. Then it is allowed to cool overnight without stirring. Two layers are formed. The bottom layer consists of glycerol and top layer is ester.

5.Engine Specification

The biodiesel produced is made to run on an IC engine and its performance is recorded.

1. Type of engine : Vertical, C.I. four stroke cycle
2. Speed: high speed.
3. Number of Cylinders: One
4. Brake Power: 3.7 KW
5. Speed: 1500 rpm
6. Bore: 80mm
7. Stroke: 110mm
8. Compression Ratio: 16:1
9. Cooling: Water cooling
10. Orifice diameter: 0.02m
11. Coefficient discharge: 0.62m
12. Type of loading: brake drum dynameters.
13. Radius of brake drum: 0.1524m

6. General Procedure Before Starting

1. Check cooling water supply and fuel supply to engine before starting.
2. Then change the position of the de-composition lever.
3. Shaft the engine of rotating the constant manually and change the position of the de-combustion lever to normal position

7. Set of observation

1. Speed of camshaft (to calculate the speed of crank shaft.).
2. Manometer difference (to calculate the amount of air blow)
3. Time taken for 10cc of fuel consumption in the burette.

8. Experiment Procedure

1.

Initially engine is run using diesel and characteristics has to found such as Brake power, Total Fuel Consumption, Isothermal efficiency, Mechanical efficiency, Brake thermal efficiency and volumetric efficiency are to be calculated. Then test has to be carried out in diesel engine using diesel- castor biodiesel blend with varying proportion 20%, 40%, 70% and 100% and characteristics are to be calculated. The characteristics of biodiesel has to be compared with diesel characteristics in a figure

9.Results and Discussion

The variation of brake thermal efficiency with brake output is shown in the figure-1.

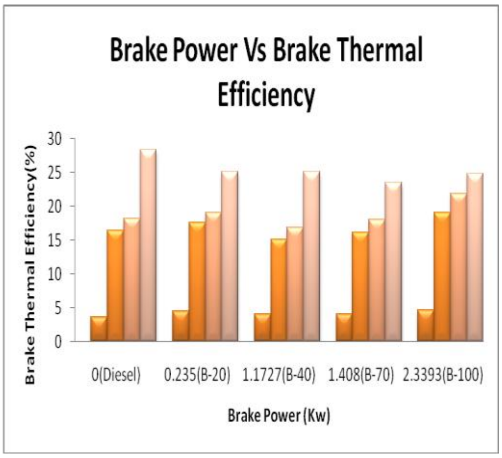

Fig-1. Brake Power Vs Brake Thermal Efficiency

Owing to the poor formation as a result of low volatility and high viscosity the thermal efficiency is lower with blend fuel as compared with diesel. The maximum brake thermal efficiency with blend fuel is about 26.89%. Where as it is 28.37% with diesel at maximum power output. The brake thermal efficiency is higher with B-40 blend fuel. The brake thermal efficiency for other blends is 25.07%, 23.50% and for B-100 is 24.80%.The reduction in viscosity loads to improved atomization, fuel vaporization and combustion due to faster burning of methanol in the blend the thermal efficiency is improved.

The variation of volumetric efficiency with power output is shown in figure-2.

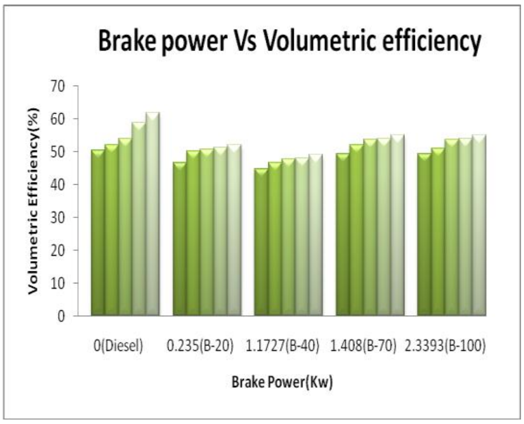

Fig-2. . Brake Power Vs Volumetric Efficiency

The volumetric efficiency with the blend fuel was slightly lower than diesel. For diesel efficiency is 61.91% and for the blend fuel are 52.04%, 49.19%, 55.04% respectively for B-20, B-40 and for B-70. The volumetric efficiency for B-100 is 55%. B-70 is the blend fuel with highest volumetric efficiency. This is due to the highest temperature of retained exhaust, which will preheat the incoming fresh air and lower the volumetric efficiency.

The variation of mechanical efficiency with power output is shown in figure-3.

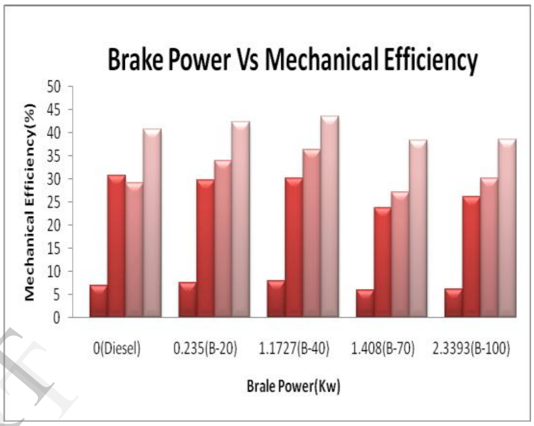

Fig-3. . Brake Power Vs Mechanical Efficiency

The mechanical efficiency with the blend fuel is slightly lower than the diesel. For diesel the mechanical efficiency is 46.14% and for blend fuel are 42.30%, 43.52%, 38.35% respectively for B-20, B-40 and B-70. The mechanical efficiency for B-100 was 38.60%. B-40 is the blend with maximum mechanical efficiency.

The indicated thermal efficiency for diesel and various blend fuels has been found out and shown in the figure-4.

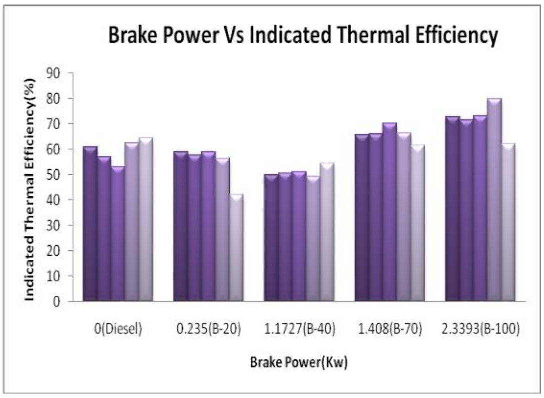

Fig-4. . Brake Power Vs Indicated Thermal Efficiency

The indicated thermal efficiency for diesel is 64.25% the indicated thermal efficiencies for various blends are 57.48%, 54.35% and 61.5% respectively for B-20, B-40 and B-70.The highest indicated thermal efficiency is 62.02%

The variation of Brake Specific Fuel Consumption (B.S.F.C) with power output is shown in the gfigure-5.

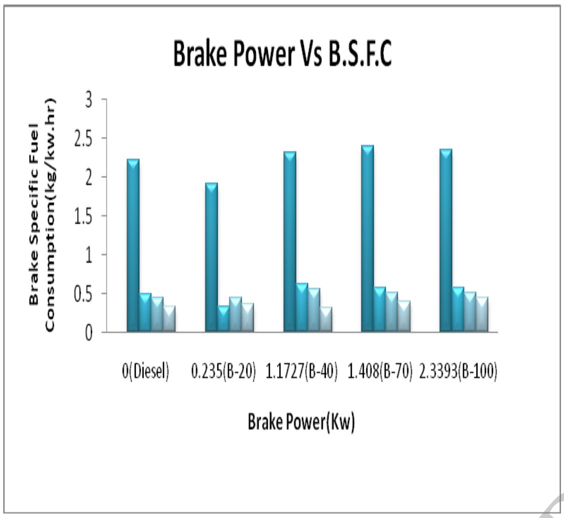

Fig-5. . Brake Power Vs B.S.F.C

The B.S.F.C of the blend fuel was higher than diesel. For diesel the B.S.F.C for maximum power output is 0.0326. The B.S.F.C of the blend fuels are 0.37, 0.32, 0.39 for B-20, B-40, B-70 respectively. The B.S.F.C for B-100 is 0.39.

Conclusion

Blended fuel resulted in a slightly reduced Thermal Efficiency as compared to diesel. The blended fuel, the Brake Thermal Efficiency, is little lower as compared to diesel. The Brake Thermal efficiency is 26.89 % for B-40 blend as compared to diesel 46.06%. The Indicated Thermal Efficiency is 62.02% for B-100 as compared to diesel value of 64.25%. The Mechanical Efficiency is 43.52% for B-40 blend as compared to diesel value of 46.14%. The Volumetric efficiency is 55.04% for B-70 when compared to diesel values of 61.91%.Based on the performance analysis the efficiency of B-40 are decreases by just 2.62%than of the pure diesel, which gives an inference that the biodiesel is acceptable as alternative fuel.

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Mr.V.Veeraragavan has received the Master of Engineering from Anna University in 2004. Currently he is working as a Lecturer in Mechanical Engineering, Eritrea Institute of Technology, Ministry of Education, Eritrea. He has blended his wide experience of 12 years in teaching and research in the field of Mechanical Engineering. He has published a number of international journal papers. His areas of research interest include Heat and Mass Transfer, I.C.Engines and Power Plant Engineering.