Performance & Emission Characteristics on Single Cylinder Diesel Engine using Calophyllum Inophyllum Biodiesel

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Abstract— Increasing usage of automobile vehicles has resulted in exponential demand of the fuel mainly the petroleum products like gasoline and diesel oil, which are depleting very fast. Also the cost of fuel is increasing continuously. This necessitates looking for the other sources of energy like renewable sources for all transport vehicles. Biodiesel is such promising alternative source of fuel energy which can be used in conventional Compression Ignition Internal Combustion engines with little or no modification of the engine design. Though edible vegetable oils can be used for the production of biodiesel, its usage jeopardizes food supplies and biodiversity. So the non-edible oils are also thought as alternative fuels for automobiles. One such oil is Calophyllum Inophyllum oil. In this project work, experiment al study has been carried out on Kirloskar single cylinder CI engine using diesel- Calophyllum Inophyllum blend to evaluate the Calophyllum Inophyllum biodiesel as an alternative fuel for CI engine. Blends with 20% (B20), 40% (B40), 60% (B60) and 80% (B80) of Calophyllum Inophyllum biodiesel are used to study the engine performance and emission characteristics of the CI engine. The results are compared with those obtained for pure 100% diesel (neat diesel).It is observed that the performance and emission characteristics of unheated of B20 Calophyllum Inophyllum biodiesel blend i.e. 20% of Calophyllum Inophyllum biodiesel and 80% diesel fuel by volume) are found to be close to neat diesel.

Key words: Calophyllum Inophyllum, CI engine, (B20) 20% of Calophyllum Inophyllum biodiesel and 80% diesel fuel, Compression Ignition Internal Combustion engines.

I. INTRODUCTION

Biodiesel is actually good for diesel engines. It lubricates better than petroleum-based diesel fuel and has excellent solvent properties. Conventional diesel fuel can leave deposits inside fuel lines, storage tanks, and fuel delivery systems overtime. Biodiesel dissolves this sediment while adding no deposits of its own, resulting in cleaner, more trouble-free fuel handling systems once fuel filters clogged with diesel sediments have been replaced after the switch to biodiesel has been made. Use of 100% biodiesel fuel does reduce the fuel economy and power of diesel engines by10%. This means that 1.1 gallons of biodiesel are equivalent to one gallon of conventional diesel fuel. Although both biodiesel and conventional diesel fuel tend to gel or freeze in cold weather, biodiesel switches from the liquid state at higher temperatures than petroleum based diesel fuel. Biodiesel is not a type of vegetable oil. Although diesel engines will run on various vegetable oils, prolonged use of these fuels can cause engine deposits that eventually lead to engine failures. These problems can be avoided however by modifying the oil based feed stock materials. A process called transesterification chemically alters organically derived oils in forming biodiesel fuel Biodiesel is safe to handle and transport because it is as biodegradable as sugar, tentesless toxic than table salt, and burns at are natively high temperature. Biodiesel actually degrades about four times faster than petroleum-based diesel fuel when accidentally released into the environment. Because it is physically similar to petroleum-based diesel fuel, biodiesel can be blended with diesel fuel in any proportion. Many federal and state fleet vehicles now use biodiesel blends in their diesel engines. The most common blend is a mixture consisting of 20% biodiesel and 80% petroleum diesel, called B20. The motive for blending the fuels is to gain some of the advantages of biodiesel while avoiding higher costs. Biodiesel is currently higher in price than conventional diesel fuel.

A. *Calophyllum Inophyllum*

Calophyllum inophyllum is a species of family Guisttifereae, native to India, East Africa, Southwest Asia, board leaved evergreen tree occurring as a littoral species along the beach crests. Although sometimes occurring inland and adjacent lowland forest. Although wilding occur, it can be moderately difficult to propagate. Its slow growth and large seeds make it unlikely that the tree will become an invasive weed if introduced into new areas. Tree grow to height of 8-20 m (25 -65ft), and also tree grows best in direct sunlight, but grows slowly. Annual yield of 20-100 Kg/tree of whole fruits have been reported. Trees begin to bear significantly after 4-5 years. The nut kernel contains 50-70% oil and the mature tree may produce 1-10 kg of oil per year depending upon the productivity of the tree and the efficiency of extraction processes. A use of the total calophyllum inophyllum tree has got excellent medicinal properties.

II. PREPARATION OF CALOPHYLLUM INOPHYLLUM BIODIESEL

A. *Oil Extraction Process*

Calophyllum Inophyllum Oil is extracted from the seeds of Calophyllum Inophyllum tree commonly called in India as surahonne in kannada, Nag Champa in Sankrit, Sultan Champa/surpan in Hindi, Surangi in Marathi, Undi in Knokani, punnai in Tamil, Punna in Malayalam etc. Calophyllum Inophyllum is a good feed stock for biodiesel production. It has higher oil yield value than that for Jatropha curcas. Biodiesel obtained from Calophyllum Inophyllum Oil is compatible with diesel and has better lubrication capability.

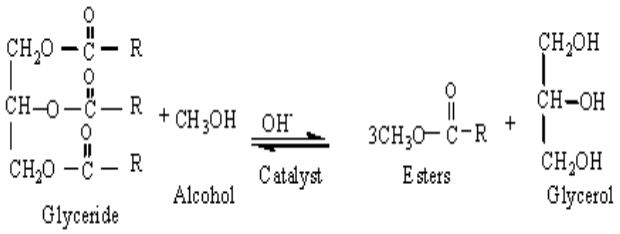
B. *Transesterification*

The Transesterification process is the action of a triglyceride (fat/oil) with an alcohol to form esters and glycerol. A triglyceride has a glycerine molecule a sits base with three long chain fatty acids attached. The characteristics of the fat are determined by the nature of the fatty acids attached to the glycerine. The nature of the fatty acid scan in turn

affects the characteristics of the biodiesel. During the transesterification process, the triglyceride is reacted with alcohol in the presence of a catalyst, usually a strong alkaline like sodium hydroxide. The alcohol reacts with the fatty acids to form the mono-alkyl ester, or biodiesel and crude glycerol. In most production methanol or ethanol is the alcohol used (methanol produces methyl esters, ethanol produces ethyl esters) and is base catalyst by either potassium or sodium hydroxide. Potassium hydroxide has been found to be more suitable for the ethyl ester biodiesel production, either base can be used for them ethyl ester. A common product of the transesterification process methyl Ester produced from oil reacted with methanol.

The figure below shows the chemical process form ethyl ester biodiesel. The reaction between the fat or oil and the alcohol is a reversible reaction and so the alcohol must be added in excess to drive the reaction towards the right and ensure complete conversion

Reactions showing Transesterification process



C. Production Process

An example of a simple production flow chart is proved below with a brief explanation of each steps like

(1) Mixing of alcohol and catalyst
(2) Separation
(3) Alcohol removal
(4) Glycerine neutralization
(5) Methyl ester wash

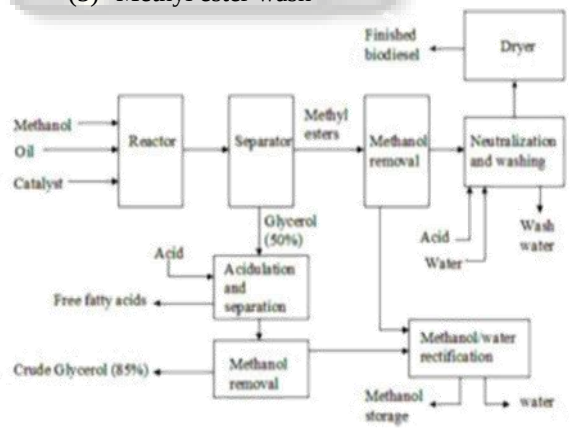


Fig. 1: Production Process of Biodiesel

D. Preparation of Blends and Properties of Calophyllum Inophyllum Biodiesel

Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in there tail diesel fuel market place. Much of the world uses as system known as the "B" factor to state the amount of biodiesel in any fuel mix.

- 20% biodiesel, 80% Diesel is labeled B20.
- 40% biodiesel, 60% Diesel is labeled B40.
- 60% biodiesel, 40% Diesel is labeled B60.
- 80% biodiesel, 20% Diesel is labeled B80.

Fig. 2: Different type of blends

Properties	Diesel	Calophyullum inophyllum
Calorific Value (KJ/k)	42200	34200
Kinematic Viscosity (Centistokes) at 50^0C	1.9	6
Density (Kg/m^3)	0.82	0.88
Flash Point (^{0}C)	56	165
Fire Point(^{0}C)	58	179

Table 1: Properties Of Calophyullum Inophyllum And Diesel.

III. EXPERIMENTAL SETUP

The experimental setup is shown in figure. The engine used is Parry's engine whose specifications are also given below.

Fig. 3: Engine Setup

SLNO	PARAMETERS	SPECIFICATION
1	Type	TV 1 (kirloskar made)
2	Nozzle opening pressure	200 to 225 bar
3	Governor type	Mechanical centrifugal type
4	Number of cylinders	Single cylinder
5	Number of strokes	Four stroke
6	Fuel	Diesel
7	Compression ratio	16.5:1

8	Cylinder diameter (Bore)	80mm
9	Stroke length	110mm
10	Type	Foot mounted, continuous rating
11	Alternator rating	3KVA
12	Speed	2800-3000RPM
13	Voltage	220 V AC

Table 2: Engine and Dynamometer Specification

A. AVL DIGAS 444 Exhaust Analyzer

Emission from the diesel engine can be classified into some categories as those from the gasoline. But the level of emission in these categories varies considerably. A sample of diesel exhaust may be free from smoke, smog and have no unburnt hydrocarbons or they may be heavy smoke led and heavy concentration of unburned hydrocarbons.

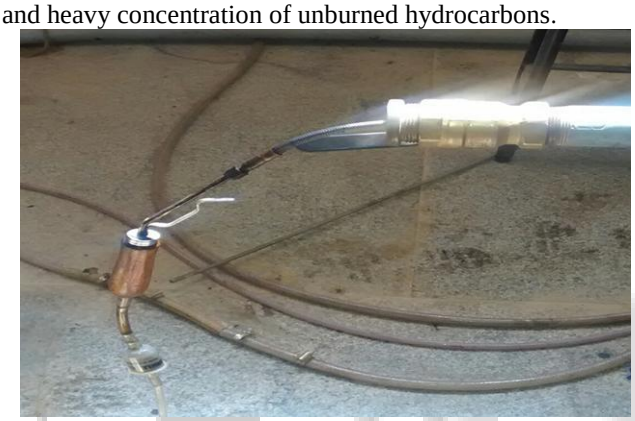
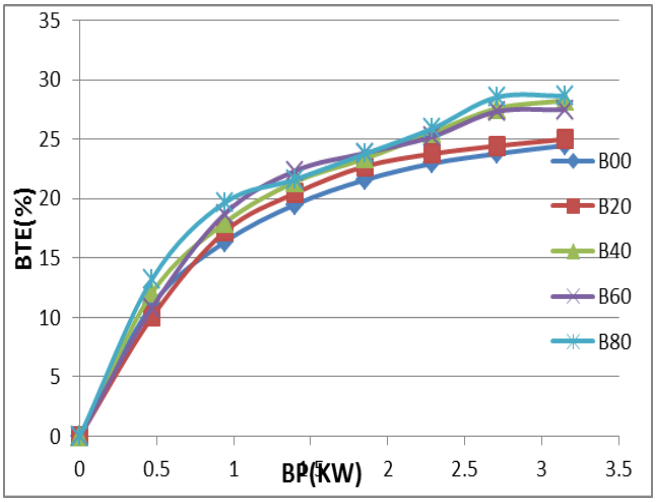


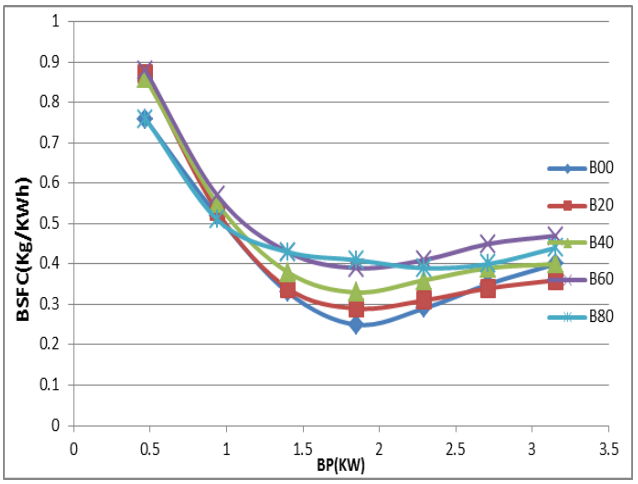
Fig. 4: Exhaust Analyzer

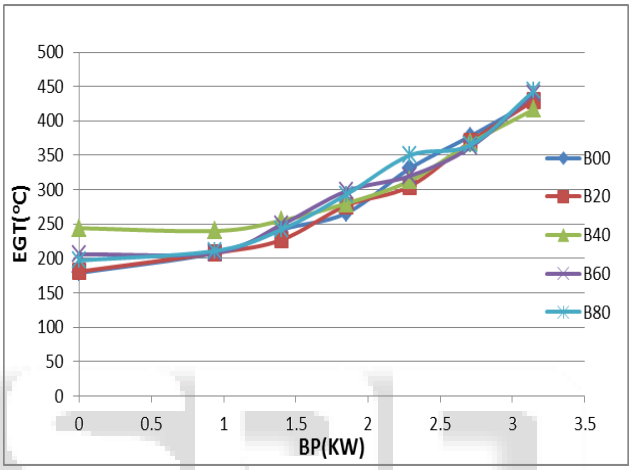
IV. RESULTS AND DISCUSSION

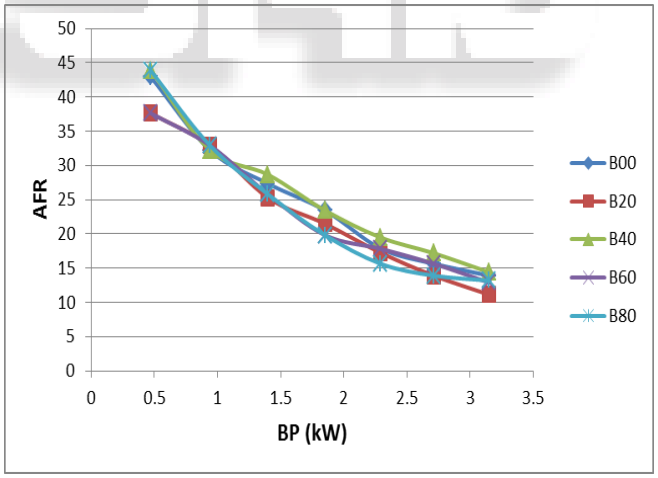
A. Performance Characteristics:

The performance characteristics of the engine are the very important criterion for selection and suitability of alternate fuels. This study evaluates BSFC, BTE, AF Ratio and EGT of diesel blends.

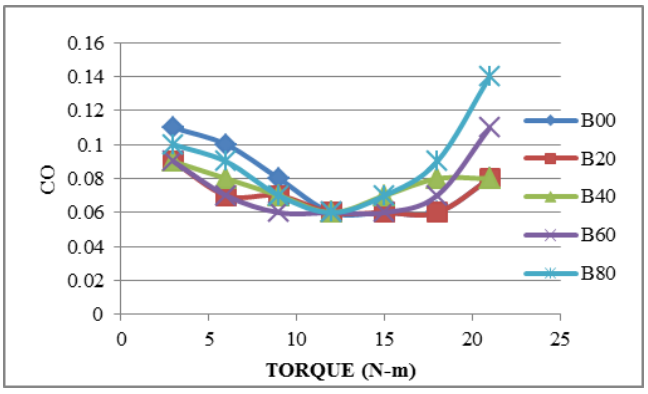


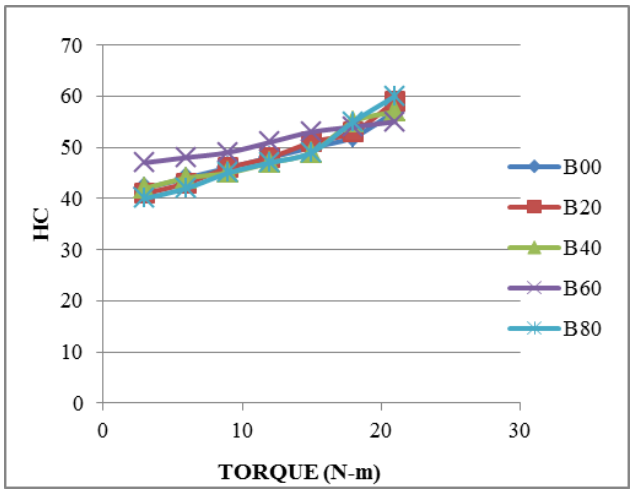


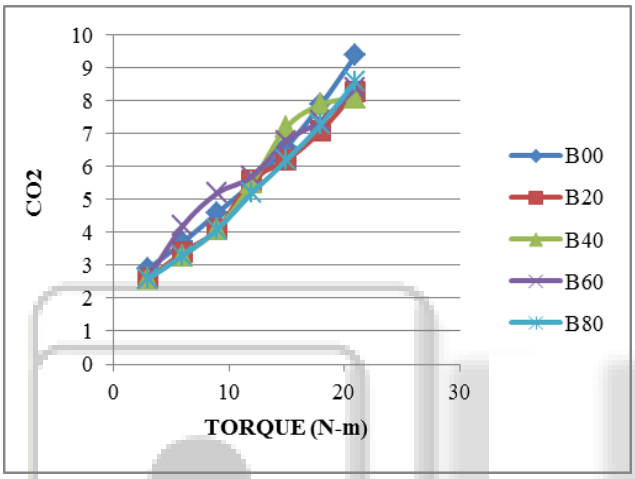


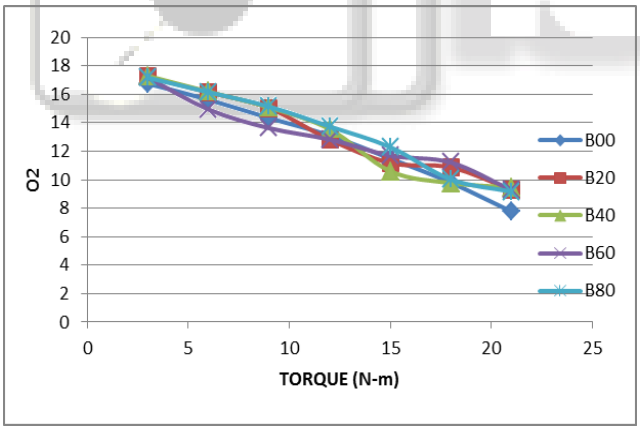


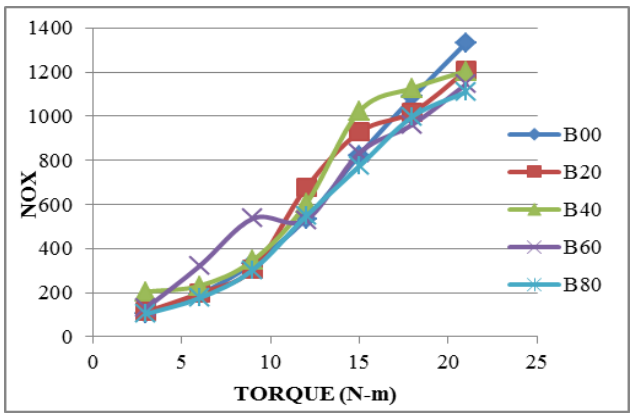
B. Emission characteristics











V. Conclusion

Based on the results of this study, the following specific conclusions were draw:

1) Brake specific fuel consumption for B20 is lower than the diesel fuel and it is increased as blend ratio increase.
2) The maximum thermal efficiency for B20 (25.38%) was higher than that of diesel. The brake thermal efficiency obtained for B40, B60, and B80 were less than that of diesel.
3) The exhaust temperature increased as a function of the concentration of biodiesel blend i.e. higher the percentage of Calophyllum Inophyllum biodiesel.
4) The fuel properties of fish oil biodiesel except calorific value, all other properties of Calophyllum Inophyllum biodiesel found to be higher compared to diesel.
5) From engine performance it is found that the "B20" is optimum blend as it shows higher BTE and lower BSFC than any other blend.

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