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AN EXPERIMENTAL STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF CI ENGINE FUELLED WITH HYBRID BLENDS OF BIODIESELS

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***Abstract*—Due to increase demand of energy, increasing price of petroleum fuels, depletion of petroleum fuels, and environmental pollution by these fuel emissions, it is very necessary to find the alternative fuels. This work focused on use of hybrid blends of Karanja and Cottonseed oil Biodiesels. In this work 20% and 25% blends are used and the performance and emission tests were conducted on single cylinder, 4-stroke, water cooled CI engine by running the engine at a speed of 1500rpm, at a compression ratio of 16.5:1 and at an injection pressure of 205bar and performance parameters like BP, BSFC, BTE and the emissions like CO, HC and NOx are compared. It was found that the blends gave comparatively good results in respect of performance and emissions.**

Index Terms—Petroleum fuel, Alternate fuels, Biodiesel, CI engine.

I. INTRODUCTION

Biodiesel, the most promising alternative diesel fuel, has been received considerable attention in recent years due to its following merits: biodegradable, renewable, non-toxic, less emission of gaseous and particulate pollutants with higher cetane number than normal diesel. In addition, it meets the currently increasing demands of world energy that, in a large degree, is dependent on petroleum based fuel resources, which will be depleted in the foreseeable future if the present pattern of energy consumption continues.

Biodiesel is derived from vegetable oils or animal fats through transesterification. Transesterification is also called alcoholysis, which uses alcohols in the presence of catalyst (e.g., base, acid or enzyme depending on the free fatty acid content of the raw material) that chemically breaks the molecules of triglycerides into alkyl esters as biodiesel fuels and glycerol as a by-product. The commonly used alcohols for the transesterification include methanol, ethanol, Methanol particularly due to its low cost.

Commonly used feed stocks (vegetable oil) for transesterification include pea nut oil, jatropha oil, soybean oil, rapeseed oil, cotton seed oil, honge oil etc. In recent years, there exist active researches on biodiesel production from cottonseed oil, of which the conversion between 72% and 94% was obtained by methanol catalyzed transesterification when the refined cottonseed oil reacted with short-chain primary and secondary alcohols. The results showed that the yield of methyl ester by alkali based transesterification was above 90% after 4 hours of reaction leaving a small amount of glycerine. No matter what kind of catalysts or approaches were applied, all those studies aimed to produce high yield of biodiesel by optimized reaction conditions based on optimized parameters in terms of alcohol/oil molar ratio, catalyst concentration, reaction temperature, and time. However, nearly in all studied cases, there existed complex interactions among the variables that remarkably affected the biodiesel yield. In this study the methanol process gave high yield of bio diesel as more than 90% i.e. for 1 litre of cotton seed oil we got more than 900 ml of biodiesel.

II. MATERIALS AND METHODOLOGY OF BIODIESEL PRODUCTION

Materials

Washed cotton seed oil has purchased from Farmer's Co-operative Society, Binkadakatte, Gadag. Honge oil has purchased from the Bio-diesel Plant, Tontadarya College of Engineering, Gadag. The chemicals like methanol (CH_3OH), sodium hydroxide (NaOH), sulphuric acid (H_2SO_4), phenolphthalein indicator and batch reactor for producing biodiesel in 1 liter batch and also the required chemical laboratory has been taken from TCE Gadag.

Methodology

Basically all vegetable oil are triglycerides having saturated and unsaturated fatty acids. These triglycerides break into glycerin and the corresponding alcoholic esters. The chemical reaction for the transesterification is given as shown in the figure1.

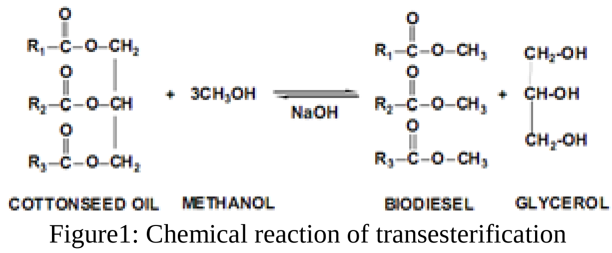

Figure1: Chemical reaction of transesterification

The vegetable oil reacts with methanol or ethanol in presence of sodium hydroxide (NaOH) as a catalyst it gives the bio-diesel with formation of glycerine as byproduct. Before the transesterification process, one has to know the FFA (free fatty acid) content in the raw oil. Depending on the FFA value the transesterification process involves into two viz. alkali base catalyst process or acid base and alkali based catalyst process. FFA will be determined by simple chemical titration and by using the following simple formula,

If the FFA is less than 4% alkali based process is carried. And if FFA is more than 4% then acid + alkali based process is carried

$$FFA = \frac{28.2 \, X \, 0.1 \, X \, \text{Titration value}}{\text{Weight of the oil}}$$

TRANSESTERIFICATION

Transesterification is carried in a 3-neck flask with reflex condenser, take 1litre of cottonseed oil into a 3-neck flask. Heat the oil to 60°C with magnetic stirrer and reflex condenser fixed. Take 300 ml of methanol and required quantity of sodium hydroxide (NaOH) and mix these properly. This solution is called methoxide mixture. When the temperature of the oil reaches 63^0 C add the methoxide mixture to the 3-neck flask. Allow the mixture to heat and stir for $1\frac{1}{2}$ to 2 hours to mix properly.

Figure2: batch reactor (3-neck flask)

Figure3: separating funnel

Then transfer the mixture into a separating funnel and allow to settle for 2-3 hours so that the glycerin is settled at the bottom and is drained off carefully. Again allow the same for ½ hour and observe if any glycerin settles. These processes are shown in figure2 and figure3.

Once the glycerine is removed, the biodiesel is to be washed i.e. transfer the prepared bio-diesel into washing funnel, spray 300-500 ml of warm water slowly into bio-diesel and allow to settle for diesel 10-15 minutes so that soap water starts to form, drain the soap water slowly and again spray warm water and remove soap content, repeat the procedure 4-5 times. The last step is drying of bio-diesel i.e. transfer the washed bio-diesel to a beaker and heat the beaker to 100^0 C with magnetic stirrer. Allow the bio-diesel to cool gradually. Store it in a clean and dry container.

III. PROPERTIES OF BIODIESEL

Some of the properties needed for using the bio-diesel as vehicular fuel like flash point, viscosity, density, specific gravity and calorific value are determined as follows. The flash & fire point were determined by closed cup apparatus, the kinematic viscosity was determined by cannon-fenske viscometer with tube number 100, and the calorific value was determined by bomb calorimeter. We determined the density at 25°C and the kinematic viscosity at 40°C

Bio-diesel can be used in diesel engines either as a standalone or blended with diesel. H100 stands for neat honge biodiesel, C100 for neat cotton seed oil bio diesel. We used two blends in the proportion of 5H+15C+80D and 5H+20C+75D. After finding the properties of each fuel they are tabulated as shown in the Table1.

Table1: Properties of biodiesels and their blends.

Fuel type	Flash point (°C)	Kinematic viscosity (cst)	Specific. gravity	Calorific value (kJ/kg)
D100	38	2.42	0.823	43033
H100	206	5.89	0.852	34902
C100	170	5.79	0.840	36565
5H+15C+80D	43	3.182	0.827	41657
5H+20C+75D	42	3.353	0.828	41333

IV. EXPERIMENTAL PROCEDURE

The engine tests were conducted on a computerized single cylinder four-stroke, water-cooled diesel engine test Rig. It was directly coupled to an eddy current dynamometer that permitted engine motoring either fully or partially. The engine and the dynamometer were interfaced to a control panel, which is connected to a digital computer, used for recording the test parameters such as fuel flow rate, temperatures, air-flow rate, load etc and for calculating the engine performance characteristics such as brake thermal efficiency, brake specific fuel consumption, volumetric efficiency etc. computerized CI engine is used. The calorific value and the density of the particular fuel is fed to the software for calculating the above said performance parameters. The photographic view of the engine used is shown in figure4 and the engine specifications are given in Table2.

The components of the experimental setup of the present work as detailed below**.** A four stroke, single cylinder, water cooled diesel engine is used for the experiment and the engine specifications are provided below. The engine speed runs up to 1500 rpm. The engine is attached at one end to the eddy current type dynamometer with a drive shaft coupling flange for loading. A throttle is used to control and increase the speed of the engine as the control variable. The dynamometer and engine is cooled by continuous supply of water to dissipate the generated heat. The other end of the dynamometer is hooked up to the digital readout system which contains the digital RPM meter, flow meter, oil sump temperature and so that experimental readings can be obtained.

Figure4: Single cylinder 4-stroke CI engine with computerized control panel

The engine was started by hand cranking with diesel fuel supply, and it is allowed to get its steady state (for about 10 minutes). Water to engine cooling jacket is maintained about 80lph and water flow pressure to Eddy current dynamometer is maintained between 1 to 1.5 bar throughout the experiments, this water flow pressure is maintained by means of ¼ HP external water pump.

Particulars	Data
Make	Kirloskar, AV1
Number of Cylinders	One
Bore	80 mm
Stroke	110mm
Displacement Volume	553 cc
Power	3.7 kW
speed	1500 RPM
CR	16.5:1
Dynamometer	Eddy current Dynamometer
Injection Pressure	205 bar

Table 2: Engine specifications

The software is run and operated in ONLINE mode with a specific filename. To record the data online, software is logged every time and data will be stored in the computer hard disk, which can be retrieved as and when required. The set of experiments were conducted at the designed speed of 1500 RPM and compression ratios of 16.5:1. The experiments were conducted at no-load, 10% of full load, 30% of full load, 50% of full load and 70% of full load, with neat diesel and blends of Methyl ester of Cotton seed oil and honge oil with Diesel as fuel. Data such as fuel flow, cylinder pressure, indicated power, brake power, air flow, exhaust temperature, specific fuel consumption, break thermal efficiency, volumetric efficiency, PV-diagram, pressure v/s crank angle diagrams were recorded at this condition.

V. RESULTS AND DISCUSSIONS

The results from the experiments performed on the four stroke, single cylinder, diesel engine at an engine speed of 1500 rpm and compression ratio of 16.5:1 for various load operating conditions (likewise no load, 10%, 30%, 50%, and 70% and 100%). Initially the experiments are performed for diesel, H100, and C100 fuels. Then for different blends like 5H+15C+80D, and 5H+20C+75D was carried. The engine performance, like brake power, indicated power, brake specific fuel consumption, brake thermal efficiency, volumetric efficiency are obtained and then compared the performance of blends with those of D100, H100 and C100.

The comparison graphs are shown in figure from figure5 to figure9.

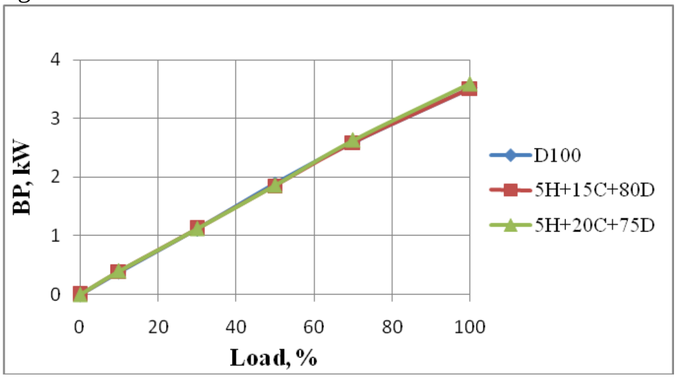

Figure5: Comparison of BP of blends with Diesel

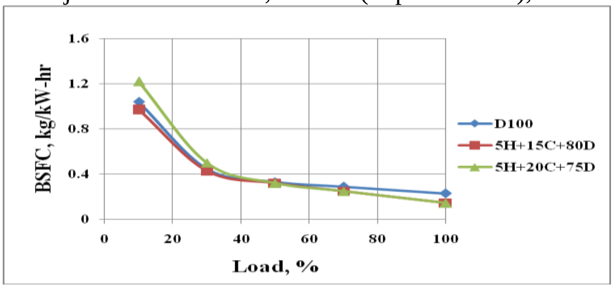

Figure6: Comparison of BSFC of blends with Diesel

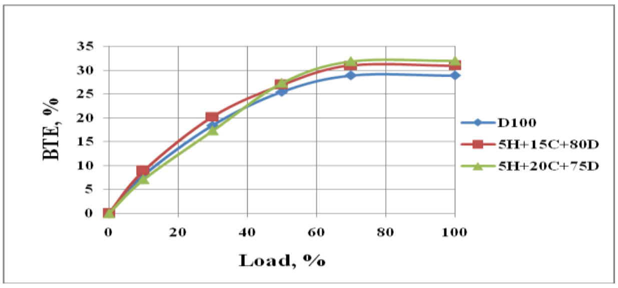

Figure7: Comparison of BTE of blends with Diesel

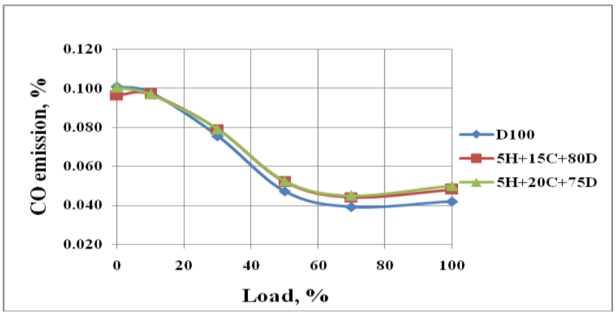

Figure8: Comparison of CO emission of blends with Diesel

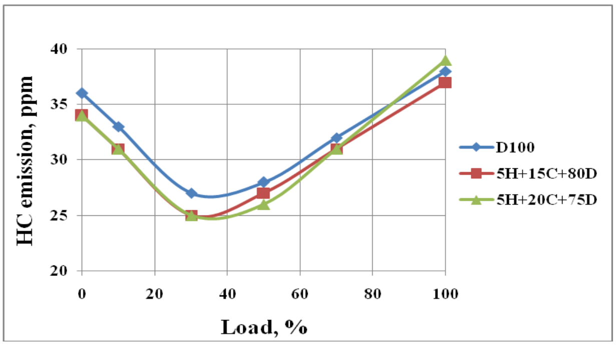

Figure9: Comparison of HC emission of blends with Diesel

VI. CONCLUSION

From this study it is found that the performance characteristics like break power (BP), break specific consumption (BSFC), break thermal efficiency (BTE) and emissions characteristics for the hybrid blends are better than the D100. Hence these two blend blends of Karanja oil biodiesel and Cotton seed oil biodiesels can be used as a vehicular fuel in CI engines.

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REFERENCES

[1] A Shivkumar, D Maheshwar, K Vijaya Kumar Reddy (2009) “Comparison of Diesel engine performance And emissions from neat and transesterified cotton seed oil”, JJMIE, Vol. 3, Sept 2009, pp. 190-197.

[2] A Haiter Lenin, K Thyagarajan (2012) “Performance evaluation of disel engine fuelled with methyl ester of pongamia oil”, International Journal of Energy and Environment, Vol. 3, issue 6, 2012, pp.939-948

[3] Hanumanth Mulimani, Dr.O D Hebbal, M C Navindgi,(2012) “Extraction of biodiesel from vegetable oils and their comparisons”Intarnational Journal of Advanced Scientific Research and Technology. Vol.2. Issue 2. April 2012.

[4] Xiahu Fan, Xi Wang, Feng Chen, Daniel P Geller, Peter J Wan.(2008) “Engine Performance Test of Cottonseed Oil Biodiesel”The Open Energy and Fuels Journals. Vol 1, pp.40-45

[5] Lohith.N, Dr .R Suresh , Yathish K V (2012) “Experimental Investigation of CI Engine using Karanja oil Methyl Ester as Alternative Fuel.” IJERA, Vol.2 Issue 4, August 2012, pp. 1172-1180.

[6] S Kirankumar, Prof. K Apparao, Prof. R Nagendra Babu. “Experimental Investigation on Performance, Combustion Characteristics of Diesel Engine by using Fish Oil” IJERA, Vol.2, December 2012, pp. 1258-1263

[7] Sanjay Patil,” Theoretical Analysis of CI Engine Performance Fuelled with Honge Oil and its Blends with Ethanol”. IJMET, vol.4, August 2013, pp. 366-372

[8] Jinlin Xue, Tony E grift, Alan C Hansen (2011). “Effect of Biodiesel on Engine Performance and Emissions”. Renewable and Sustainable Energy Reviews, ELSEVIER, vol.15, pp. 1098-1116.

[9] J M Marchetti, V U Miguel, A F Errazu,(2007). “Possible Methods for Biodiesel Production” Science Direct, vol.11, pp.1300-1311.

[10] S P Singh, Dipti Singh.(2010) “Biodiesel Production through the use of different sources and characterization of oils and their esters as the substitute of diesel” ELSEVIER (rser), vol.14, pp.200-216

[11] T Elango, T Shenthilkumar (2011), "Performance and Emission Characteristics of CI Engine Fuelled with Non Edible vegetable oil and Diesel blends". JEST, vol. 6, No.2,(2011), pp.240-250.

[12] Lokesh Adhappa Chandrashekar, N S Mahesh, Balakrishna Gowda, Willium Hall, (2012). "Life Cycle assessment of bio diesel production from pongamia oil in rural Karnataka". CIGR Journal, vol.13 No.3 pp 67.

[13] S V A R Sastry, Ch.V Ramachandra Murthy (2012). "Prospectus of biodiesel for future energy security". Elexir,Chemical Engg., 53 (2012) 12029-12034.