Investigation of Performance and Combustion Characteristics of Biofuel in Compression Ignition Engine

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Abstract—The main aim of this investigation is to find out the performance and combustion characteristics of a CI Engine using cottonseed oil biodiesel blends and compare it with petroleum diesel. The tests were conducted on a single cylinder, four stroke, TV1 Diesel engine connected to eddy current type dynamometer for loading developing power 3.5 kW at 1500 rpm. The tests were conducted at various loading conditions. The experimental results revels that the performance and combustion characteristics of CSO biodiesel blends were very slightly differ than that of diesel fuel. . The experimental result illustrates that the CSOME Biodiesel Blend can be used successfully as a sustainable fuel for diesel engine without any major modifications.

Key words: CI Engine, CSOME, Performance, Combustion

I. INTRODUCTION

Biodiesel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean-burning fuel and can be a fuel component for use in existing, unmodified diesel engines. This means that no retrofits are necessary when using biodiesel fuel in any diesel powered combustion engine. It is the only alternative fuel that offers such convenience. Biodiesel acts like petroleum diesel, but produces less air pollution, comes from renewable sources, is biodegradable and is safer for the environment. Producing biodiesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of biodiesel already exist at the local, state and national level.

Biodiesel is designed for complete compatibility with petroleum diesel and can be blended in any ratio, from additive levels to 100 percent biodiesel.

India is a second largest country in the world in production of cotton seed. In India, Maharashtra especially the Vidarbha region is the region where the main yield for farmers is cotton on which their economy is depend. This is also the side by side aim for research that to provide another income source to that farmers. The limited (and fast diminishing) resources of fossil fuels, increasing prices of crude oil, and environmental concerns have been the diverse reasons for exploring the use of vegetable oils as alternative to diesel oil [1-4]. Vegetable oils offer almost the same output with slightly lower thermal efficiency when used in diesel engines [5-7].

The Cotton seed oil is transesterified to get biodiesel and then Biodiesel blends were prepared by mixing the proportionate biodiesel in the diesel such as Blend B-10 is prepared by mixing 10% of transesterified cotton seed oil in diesel. Similarly the other blends B-20, B-40, B-60, & B-80 are prepared in a laboratory (Figure 1). These blends were then tested simultaneously on a 1 cylinder, 4 stroke, computerized VCR Diesel Engine test set up (Figure 2).

II. ENGINE SPECIFICATIONS

- Make : Kirloskar,
- Type :1 cylinder, 4 stroke Diesel, water cooled,
- Power :3.5 kW,
- Stroke :110 mm,
- Bore : 87.5 mm. 661 cc,
- Dynamometer : eddy current, water cooled, with loading unit

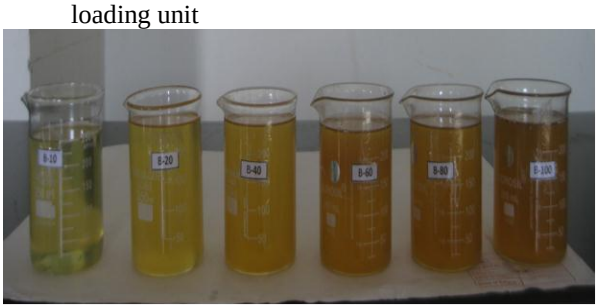

Fig. 1: CSOME Biodiesel Blends

III. ENGINE DESCRIPTION

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement.

The setup enables study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance.

Fuel Property	**Diesel**	**CSO Biodiesel**				
		B-10	***B-20***	***B-30***	***B-40***	***B-50***
Kinematic viscosity at 40^{O}C	2.5	2.58	2.68	2.77	2.77	3.22
Specific Gravity	0.85	0.83	0.8333	0.8336	0.847	0.85
Pour Point (^{O}C)	15	0	-3	-3	-3	-3
Flash point (^{O}C)	66	130	140	145	148	152

Fire Point (^{O}C)	62	57	59	61	65	70
Cetane Number	51	49	50	50	51	52
Calorific Value (kJ/Kg)	42500	41900	41460	40870	40240	39580
Density (g/cm^2)	830	822.5	826	829	832.5	840

Table: 1 Comparison of diesel, biodiesel and blend properties

IV. EXPERIMENTAL RESULTS

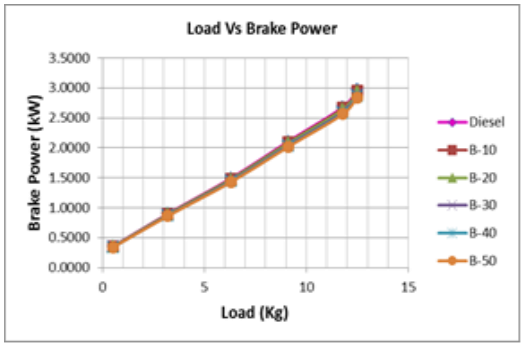

Fig. 2: Load Vs Brake Power

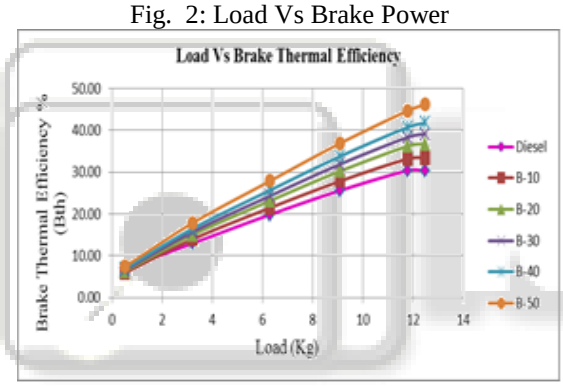

Fig. 3: Load Vs Brake Thermal Efficiency

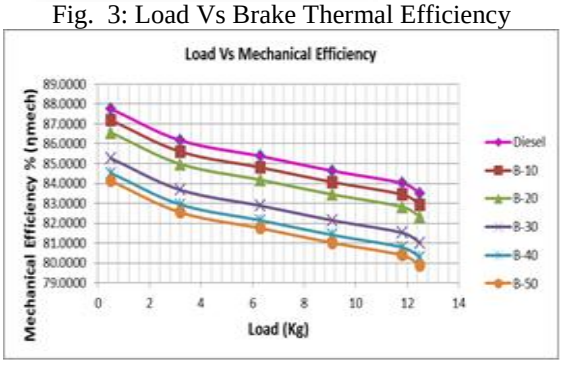

Fig. 4: Load Vs Mechanical Efficiency

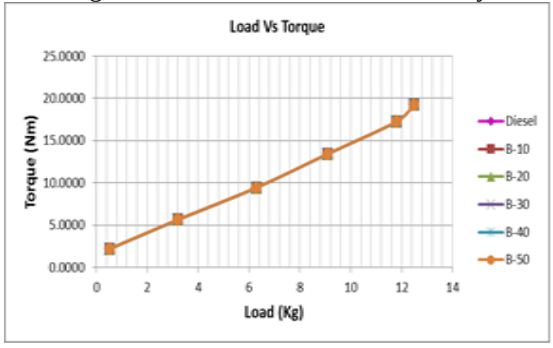

Fig. 5: Load Vs Torque

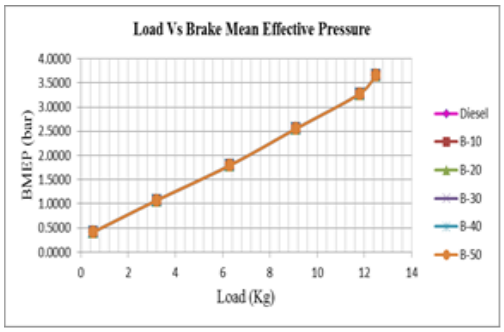

Fig. 6: Load Vs Brake Mean Effective Pressure

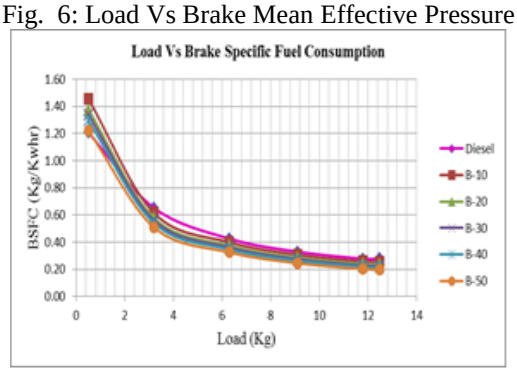

Fig. 7: Load Vs Brake Specific Fuel Consumption

V. CONCLUSION

This experimentation was performed without any major modification in existing setup. The measurement parameters are kept constant for both the fuel.

The brake power for all the blends of Cotton Seed Oil Methyl Ester Biodiesel blends is less as compared to pure diesel. Brake power for B-20 Blend is 1.7245 kW which is 1.40 % less than pure diesel, similarly 2.94% less for B-30, 3.81% less for B-40,and 4.28% less for B-50 Cotton Seed Oil Methyl Ester Biodiesel blend. It can also be seen that as we increase the load, the torque increases and thus there is an increase in brake power with load.

Brake thermal efficiency for pure diesel is 21.0315 % whereas for B-10 blend it is 22.6409 % which is 7.65% more; likewise the brake thermal efficiency for B-20 Blend is 24.6297% i.e.17.10 % greater than that of Pure Diesel. It may be due to reduction in heat loss and increase in power. It is also observed that diesel exhibits slightly higher thermal efficiency at most of the loads than blends of cotton seed biodiesel blends. BMEP increases with increase in the load applied on the engine. This may be related to the increase in the brake power developed by the engine for the same load conditions.

In case of biodiesel mixtures, the BSFC values were determined to be higher than that of neat diesel fuel. This trend was observed owing to the fact that biodiesel mixtures have a lower heating value than neat diesel fuel, and thus more biodiesel mixtures were required for the maintenance of a constant power output.

The Torque increased as the load on the engine increases. This could be as a result of reduction in the viscosity and the lubricity. However, the torque of the engine with standard diesel was higher than for biodiesel and its blends. This may be attributed to low calorific value of biodiesel.

Mechanical efficiency of the diesel is greater than the biodiesel blends at all the loads. Pure diesel have

mechanical efficiency 85.24% whereas B10 biodiesel blend have the mechanical efficiency of 84.67% and B-20 have 84.051%, which is 0.66% and 1.396 % less respectively as compared with pure diesel .

Cottonseed oil promising as the best alternative fuel source of diesel engine because of its high heat content. It can be directly used as diesel fuel but having a major problem was cottonseed oil having high viscosity. From this investigation, test results reveals that B-20% cottonseed oil Biodiesel for suitable it to be used as diesel fuel without any modification of engine.

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