Experimental Investigation on 4-Stroke Single Cylinder Diesel Engine by Using Roselle Seed Oil as Bio-Diesel

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Abstract— *As the petroleum based fuels are obtained from limited reserves it is an urgent need to promote use of alternative fuel. Biodiesel has been used as a renewable and potensial fuel in diesel engines. A t the same time, in order to reduce the green house gases net production research is analyzing alternative resources, such as bio-derived fuels. Review of literature suggests biodiesel as a good alternate to diesel suffering with a drawback of an increase in nitrous oxide (NO_X) emissions because biodiesel contains fuel nitrogen that leads to formation of NO, NO_2 during combustion. The use of vegetable oil as a fuel in diesel engines causes some problems due to their high viscosity compared with conventional diesel fuel. The present study covers the various aspects of biodiesels fuel derived from crude Roselle oil and performance emissions study on four stroke compression ignition engine.*

Keywords — *Bio fuel, Alternate fuel, Bio-Diesel, Roselle seed oil, IC Engine performance with bio-diesel, Blends with diesel, Oil's for bio diesel.*

I. INTRODUCTION (SIZE 10 & BOLD)

The Fuel which is produced from domestic, renewable resources is called as bio-diesel. In the last fifteen years the atmospheric pollution problem has become one of the most important topics of debate in the international milieu. role is played by the internal combustion engines, wide research efforts are being made aiming either to achieve higher engine efficiencies, or to better exploit alternative fuel sources.

Compression ignition engine are preferred prime movers due to excellent drivability and higher thermal efficiency. Despite their advantages they produce higher levels of NOx and smoke emissions which will more harmful to human health. Hence stringent emission norms have been imposed. In order to meet the emission norms and also the fast depletion of petroleum oil reserves lead to the research for alternative fuels for diesel engines. Biodiesel from vegetable oils are alternative to diesel fuel for diesel engines. The use of biodiesel in diesel engines does not require any engine modification. Biodiesel gives considerably lower emissions of PM, carbon monoxide (CO) and hydrocarbon (HC) without any fuel consumption or engine performance penalties. Many researchers have found that with biodiesel fueled engine produces higher NOx emissions compared to diesel. To achieve reductions in NOx emissions, exhaust gas recirculation (EGR) can be used with biodiesel in the diesel engines. EGR is an effective technique of reducing NOx emissions from the diesel engine exhaust [1-4]. Controlling the NOx emissions primarily requires reduction of in-cylinder temperatures.

Mostly all the diesel engines have high thermal efficiencies because of their high compression ratio and lean air-fuel operation. The high compression ratio produces the high temperatures required to achieve auto ignition and the resulting high expansion ratio makes the engine discharge less thermal energy in the exhaust. Due to lean air-fuel mixture, extra oxygen in the cylinders is present to facilitate complete combustion. Increasing diesel consumption increases the pollutant that pollutes the atmospheric air. Thus good efforts are being made to reduce the pollutants emitted from the exhaust system without loss of power and fuel consumption. Recent concern over development in automotive technology is the low environmental impact. In fact, partial recirculation of exhaust gas, which is not a new technique, has recently become essential, in combination with other techniques for attaining lower emission levels.

Several reasons can be used to explain for this interest.

- The proposal of the future Bharat Stages directive establishes separate and even more stringent limits for NOX emissions.
- The reductions in NOX emissions have probably become the most difficult target to attain, owing to the associated reverse effect of other recently used techniques, such as high supercharging, an improved mixing process by more efficient injection systems etc.
- The development of a new generation of exhaust gas recirculation (EGR) valves and

improvements in electronic controls allow a better EGR accuracy and shorter response time in transient conditions.

In order to meet future emission standards, EGR must be done over wider range of engine operation, and heavier EGR rate will be needed. Thus, using a specific device to expand EGR area is necessary. In this study, the venturi type EGR system was selected, because it is rather effective for expanding the EGR range. The present study covers the various aspects of biodiesels fuel derived from crude Roselle oil and performance emissions study on four stroke compression ignition engine. The seed contains 18% oil.

Fig.1 Roselle (Hibiscus sabdariffa L.) seeds and crop

II. STEPS IN THE PRODUCTION OF BIODIESEL

1. Purification
2. Neutralization of free fatty acids
3. Transesterification

A. *Specifications of Engine*

BP	: 5HP
SPEED	: 1500 RPM
BORE	: 80MM
STROKE	: 110MM
COMPRESSION RATIO	: 16.5:1
ORIFICE DIAMETER	: 20MM
METHOD OF START	: CRANK START
MAKE	: KIRLOSKAR
TYPE OF IGNITION	: COMPRESSION IGNITION
NO. OF CYLINDERS	: 01

DYNAMOMETER SPECIFICATIONS

TYPE	: ROPE BRAKE
Diameter of brake drum	: 300mm
Diameter of rope	: 12mm
Effective radius of brake drums	: 157.5mm

B. *Properties of Oil:*

Flash and Fire Point Test:

S.No	Oil		Flash Point ^oC	Fire Point ^oC
1	Diesel	D100	56	63
2	Biodiesel	R100	130	140

Table1. Flash and Fire points of Diesel and Bio-diesel

Oil	Diesel	Crude	B5	B10	B15	B20
Calorific Value (KJ/kg-k)	**42500**	**26900**	**41720**	**40940**	**40160**	**39380**

Specific Gravity:

Table2. Specific gravity of Crude oil and Diesel

CALORIFIC VALUE:

Table3. Calorific values of Crude oil and Diesel

Oil	Diesel	Crude	B5
Specific gravity	**0.83**	**0.91**	**0.7141**

III. TESTING PROCEDURE

The engine was a computerized single cylinder four stroke, naturally aspirated direct injection and water cooled diesel engine. The specifications of the test engine are given in below. In order to determine the engine torque, the shaft of the test engine was coupled to an electric dynamometer, which was loaded by an electric resistance. A strain load sensor was employed to determine the load on the dynamometer.

The engine speed was measured by an electromagnetic speed sensor installed on the dynamometer. The engine was equipped with an orifice meter connected to an inclined manometer to measure mass flow rate of the intake air. The temperatures of air inlet, cooling water engine inlet, cooling water engine outlet, water exchanger inlet, water exchanger outlet, exhaust gas engine outlet and exhaust gas exchanger outlet were measured by K type thermocouples. The engine and the dynamometer were interfaced to a control panel which is connected to a computer. This engine was used for evaluating the performance characteristics of diesel blends and exhaust gas analysis with EGR technique.

The first stage of experiments was performed with pure diesel at different loads from no-load to full load and at constant speed. After that, in the second stage of experiments was conducted diesel with Iso propyl alcohol (at different compositions) at different loads from no-load to full load and at constant speed. The third stage of experiments was conducted using blends of diesel (5% isopropyl) with exhaust gas recirculation (at different compositions) at different loads from no-load to full load and at constant speed. Engine Lab view Soft was 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 and volumetric efficiency. The ratio of experimental values of the engine performance parameters obtained compared with pure diesel values in graphic mode.

IV. RESULS AND DISCUSSIONS

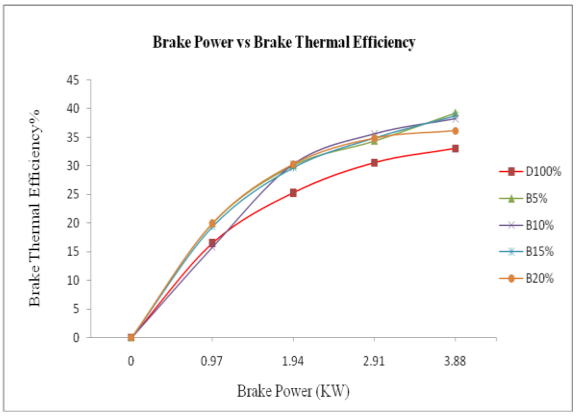

Fig.1. Brake power Vs. Brake thermal efficiency

The maximum brake thermal efficiency for B5 (39.25%) was higher than that of diesel. The brake thermal efficiency increased in 6.64% compared with diesel.

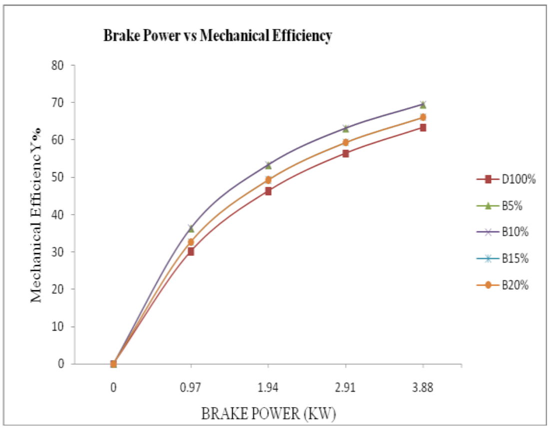

Fig:2. Brake power vs. Mechanical efficiency

Mechanical efficiency for the all the blends is greater then the Diesel as the Fictional power is less for the blends. Mechanical Efficiency for B5, B10 is more then other blends

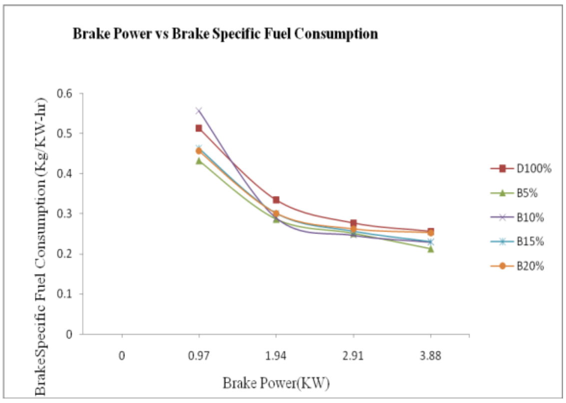

Fig:3. Brake power Vs. Brake specific fule consumption

Brake specific fuel consumption is decreases in blended fuels. In B5 fuel the BSFC is lower than the diesel by the percentage 17.5%.

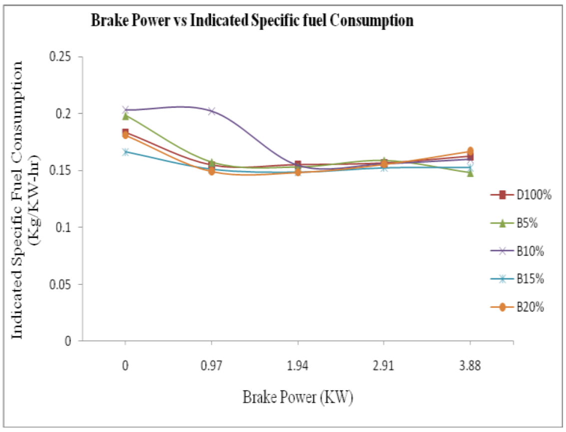

Fig:4. Brake power Vs ISFC

At full load ISFC of diesel is 0.162395kg/kW-hr and for B5 are 0.147971kg/kW-hr. The ISFC of biodiesel is increases up to 8.88% as compared with diesel at full load condition. ISFC for the B10 is slightly greater then the Diesel and other blends.

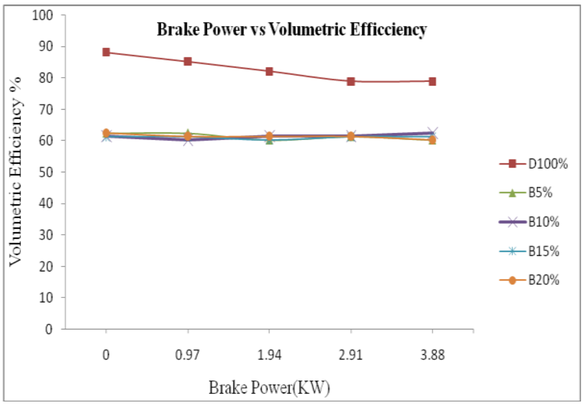

Fig:5. Brake power vs Volumetric efficiency.

It is observed diesel contains 78.94% at full load, in case of B5 at full load 60.35%.therfore the decreasing in volumetric efficiency by 23.54% while using B5. As the temperature of cylinder increases air intake will decreases.

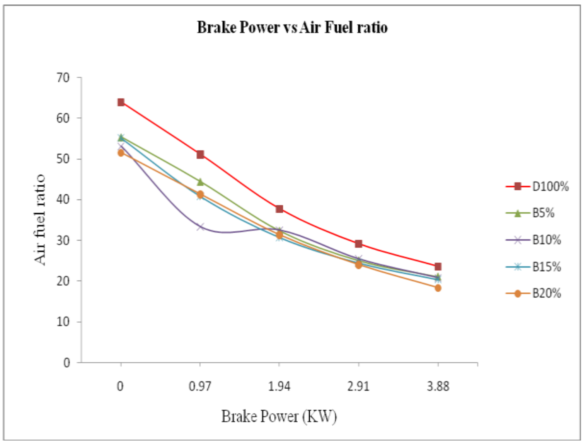

Fig:6. Brake power vs Air fuel ratio

A/F for diesel is 23.66, where as in case of B5 21.79 from that it is observed decrease in A/F was negligible 7.90% compare with diesel at full load condition. As the load increases Fuel required is more because of this A/F decreases.

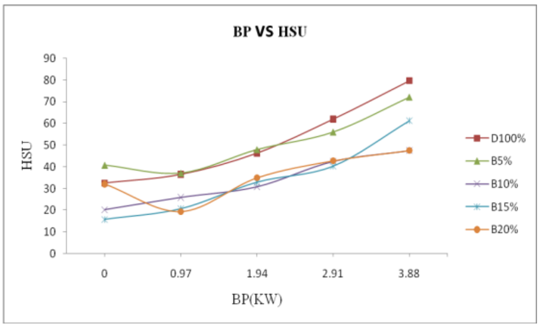

Fig:7. Brake power Vs. HSU

The maximum smoke density recorded for the diesel was 79.6HSU, 72.104HSU for B5, 47.53HSU for 10, 61.17HSU for B15 and 47.53HSU for B20 at maximum load.

A. Performance by using Ignition Improver Iso Propyl Alchohol:

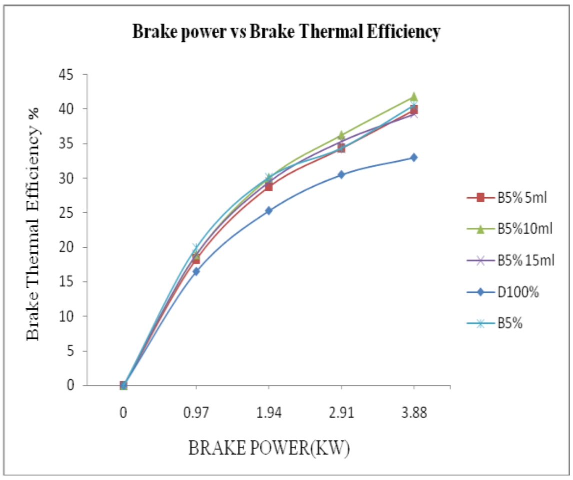

Fig:8. Brakepower vs Brake Thermal Efficiency

The maximum brake thermal efficiency for B5D93IP2 (41.86%) was higher than that of B5 and diesel. The brake thermal efficiency increased in 6.64%, 26.75% compared with B5 and diesel. By using Ignition Improver Viscosity of the fuel decreases and there is an increasing in Oxygen.

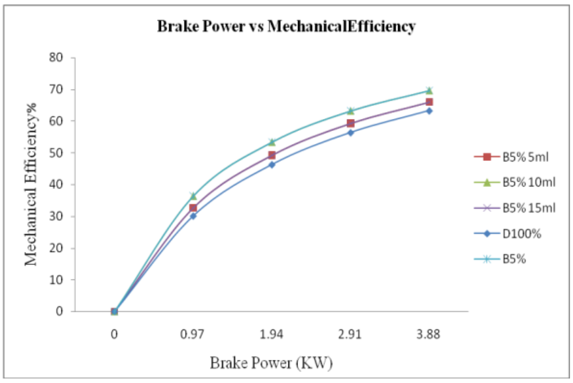

Fig:9. Brakepower vs Mechanical efficiency

At full load diesel contains 63.31%, 66.00% for B5D94IP1, 69.55% for B5D93IP2 and 66.00% for B5D92IP3.As the friction power is less Mechanical power is increased.

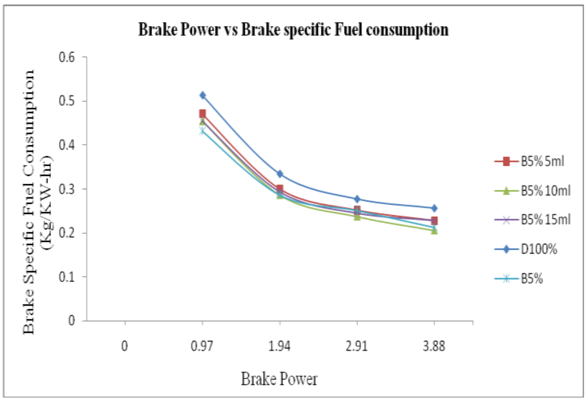

Fig:10. Brake power Vs BSFC

Brake specific fuel consumption is decreases in blended fuels with added ignition improver. In B5D93IP2 fuel the BSFC is lower than the B5 and diesel .The decreased in BSFC in 6.23% and 19.61%.

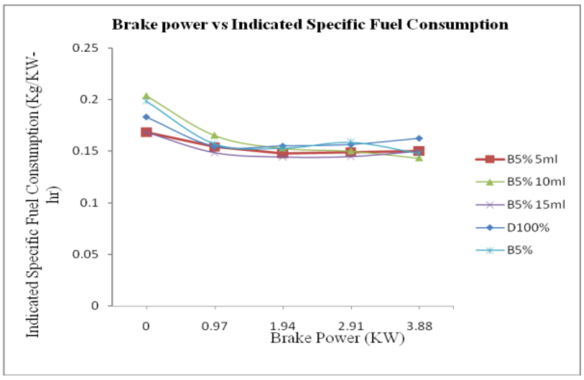

Fig:11. Brake power Vs ISFC

The ISFC of B5D93IP2 is decreased up to 12.08% as compared with diesel at full load condition.

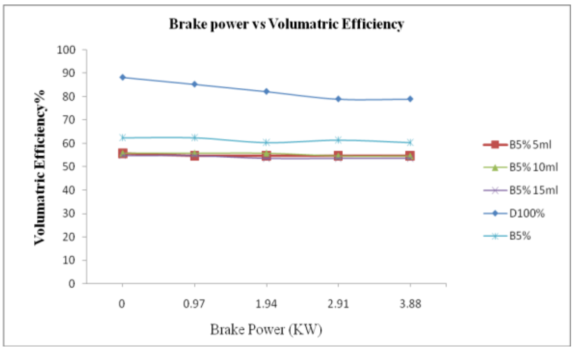

Fig:12. Brake power Vs Volumetric Efficiency

Volumetric efficiency decrease because of increasing in temperature of the cylinder. As ignition improver is added combustion process is increase because of this the temperature of the cylinder is increased this leads to decrease in Volumetric efficiency then the optimal blend.

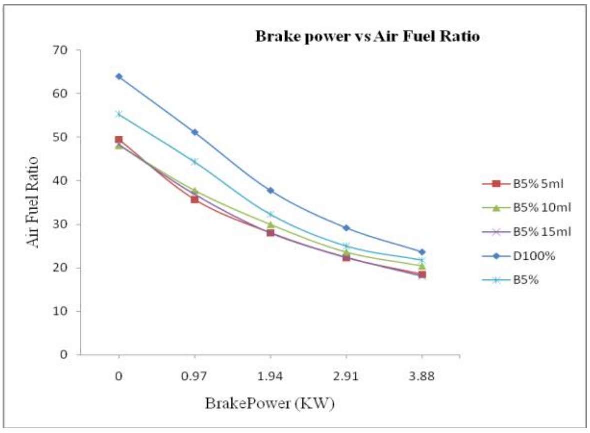

Fig:13. Brake Power Vs Air Fuel Ratio

A/F for diesel contains 23.66, B5 contains 21.79, and B5D94IP1contains 19.43, B5D93IP2 contains 20.39 and B5D92IP3 contains 18.07 at full load. From the graphs observed that decreasing up to 13.82% compare with optimum blend B5.

V. CONCLUSION

- The maximum brake thermal efficiency for B5 (39.25%) was higher than that of diesel.
- The brake thermal efficiency increased in 6.64% compared with diesel.
- Brake specific fuel consumption is decreases in blended fuels. In B5 fuel the BSFC is lower than the diesel by the percentage 17.5%.
- Significant reductions were obtained in smoke level. Smoke level was decreased by 9.37%, with B5 compared to diesel at maximum load of the engine.
- The maximum brake thermal efficiency for B5D93IP2 (41.86%) was higher than that of B5 and diesel. The brake thermal efficiency increased in 6.64%, 26.75% compared with B5 and diesel.
- Brake specific fuel consumption is decreases in blended fuels with added ignition improver. In B5D93IP2 fuel the BSFC is lower than the B5 and diesel .The decreased in BSFC in 6.23% and 19.61%.
- The marginal increases in smoke densities compared with B5 and diesel .The increment was in the order of 0% and 9.413% respectively.
- B5 is the optimal Blend when compared to Diesel .By using the Ignition Improver B5D93IP2 is the best Blend for our project which have less BSFC and more BTE.

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