Effects of Di Ethyl Ether And Exhaust Gas Recirculation on Engine Performance And Exhaust Emissions Using Rice Bran Biodiesel As Fuel In Diesel Engine

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Abstract- *Biodiesels are really a better substitute for depleting fossil fuels and to meet the present high energy demands. This fuel can be easily prepared from used or unused vegetables or animal fats are renewable, biodegradable and non-toxic. Despite many advantages there are also disadvantages which prevent its use to a greater extent, one which is higher NOx formation. Exhaust Gas Recirculation (EGR) is a better technique to reduce the NOx emission. In this present experiment, investigation is performed on using both EGR and Di ethyl ether (DEE) additive on Engine performance and exhaust emissions using rice bran biodiesel as fuel in single cylinder, four stroke, Compression ignition diesel engine. The influences of rice bran biodiesel blends using EGR & DEE studied on brake thermal efficiency, brake specific fuel consumption, smoke opacity and exhaust gas temperature and also emissions such as CO, HC & NOx. By using EGR technique the results showed it lowered Brake thermal efficiency and increased brake specific fuel consumption but on using DEE with EGR it had positive impact. Emissions HC & CO were increased on increasing EGR this was also reduced slightly by using additive EGR. But with usage of EGR NOx emissions were increased as it is an oxygenated additive.*

Keywords- Exhaust Gas Recirculation, Di Ethyl Ether, Rice bran biodiesel, Performance characteristics, Emission characteristics.

I. INTRODUCTION

Today liquid fuel is of high worth which is not cared by modern man. The primary source of liquid fuel today currently is fuel obtained from the fossil fuels which is depleting day by day and as its demand is increasing foreign suppliers increase the price for their declining reserves. The extensive jump in oil prices started the debate that made many governments to develop alternative energy sources.

The scientist are now agreeing that global warming is already well underway ,there are now more intense calls to replace crude oil as our liquid fuel source in order to reduce the growing of green house gases in the environment. Thus more attention is required for the development, production and the use of alternative fuel for being friendlier to the environment than fossil fuel. Generally, bio-sourced fuels are termed biofuel examples of which are biomethanol, bioethanol, biobutanol, biomethane, biohydrogen, biodiesel etc. This article centres on biodiesel not only because it has good chemical and physical properties to cope up the demands of engine application but because it is presently also used as a fuel on industrial scale. The biodiesel would be possible and suitable to replace fossil fuels as primary energy source for machineries and vehicles remains a driving force for scientists to research into the wide use of biodiesel. Today worldwide energy needs are currently full fill by using petro-chemical sources, coal and natural gases but these fossil fuels are depleting and are damaging environment. Energy consumption of world-wide is on increasing scale. Power generation in India is increased and upgraded but cannot meet the demands. For developing countries like India while installing a plant cost of generation of electricity is very high so to meet the demands usage of coal is made. Due to financial assets, struggling countries like India cannot jump directly to renewable source of energy. So, there is an approach towards Biodiesel. Biodiesel is a liquid bio fuel obtained by chemical processes from vegetable oils or animal fats and an alcohol that can be used in diesel engines, alone or blended with diesel oil. ASTM International (originally known as the American Society for Testing and Materials) defines biodiesel as a mixture of long-chain monoalkylic esters from fatty acids obtained from renewable resources, to be used in diesel engines. Blends with diesel fuel are indicated as ‘‘Bx’’, where ‘‘x’’ is the percentage of biodiesel in the blend. For instance, ‘‘B5’’ indicates a blend with 5% biodiesel and 95% diesel fuel; in consequence, B100 indicates pure biodiesel.

Rice (oryza sativa linn) is a byproduct obtained from outer layers of brown (husked) rice kernel during milling to produce polished rice. Due to the presence of an active lipase in the bran, free fatty acid (FFA) content in RBO is much higher than other edible oils. Because of this reason, about 60–70% of the RBO production is non-edible. In conclusion, rice bran oil (RBO) offers significant potential not only as a low-cost feedstock, but also as an alternative for BioDiesel. From previous studies, researchers have analyzed that the rice bran oil methyl ester i.e. 100-B produces higher smoke, HC and NO*x* emissions in addition to lower thermal efficiency as compared to diesel fuel. The NO_x emission values for the biodiesel blends are higher than the straight diesel at all loads. Thus it is necessary to use NOx reducing techniques such as Exhaust Gas Recirculation but due to use of EGR, brake thermal efficiency decreases and brake specific fuel consumption increases to counter this additive is used such as di ethyl ether.

The experiment is carried on rice bran biodiesel and its blends with increasing percentage of EGR from 0% to 5% and to 10% on volume basis. 2% of Di ethyl ether is used for the same blend i.e., first tests are conducted on biodiesel blends without additive with EGR and further on with additive with EGR. The biodiesel blends here prepared are RBB10 (RBB10+90D), RBB20 (RBB20+80D) and RBB30(RBB30+70D) with additive are RBB10 + 2%DEE (RBB10+ 2%DEE +88D), RBB20+ 2%DEE (RBB20+ 2%DEE +78D) and RBB30+ 2%DEE (RBB30+ 2%DEE +68D).

II. EXPERIMENTAL SET UP & PROCEDURE

Pure Rice bran biodiesel is purchased from nearby market and blends are prepared by mixing it with conventional diesel. The properties such as density, viscosity, calorific value, flash point and fire point are determined which are given below in
the table 1.

Table 1. Properties of Rice Bran Biodiesel & its Blends

Sl No	Properties	Diesel	B100	RBB10	RBB20	RBB30
1	Density (Kg/m^3)	840	880	850	860	870
2	Kinematic Viscosity at 40°C (cSt)	3	5.3	4	4.2	4.5
3	Flash point (°C)	75	172	85	94	104
4	Fire point (°C)	80	184	95	102	112
5	Calorific Value (KJ/Kg-K)	43,000	38,950	40,730	40,500	40,100

Sl No	Properties	RBB10 + 2% DEE	RBB20 + 2% DEE	RBB 30 + 2% DEE
1	Density (Kg/m^3)	856	865	875
2	Kinematic Viscosity at 40°C (cSt)	3.8	4.2	4.6
3	Flash point (°C)	82	92	102
4	Fire point (°C)	91	100	110
5	Calorific Value (KJ/Kg-K)	39,800	39,700	39,650

Table 1. Properties of Rice Bran Biodiesel & its Blends with DEE

The Experimental setup is as shown in the fig.1 which is a single cylinder 4 stroke, compression ignition, direct injection and water cooled diesel engine.

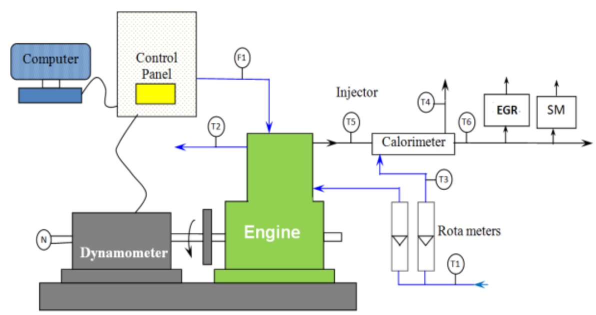

Fig 1. Test Engine

The engine is loaded with an eddy current dynamometer. Delta 1600S gas analyzer is used for measuring the CO, UHC, NOx, CO2 and an Hartridge Smoke Meter 4 smoke meter is used for measuring the smoke opacity. For circulation of exhaust gases into the intake manifold, an EGR set-up was provided which consists of a control valve and a manometer. This engine is used for evaluation of performance and emission characteristics of diesel and biodiesel blends.

The specifications of Test Engine are given below in Tabe3

Table 3. Specifications of Engine

Make and Model	Kirloskar, TV1
No of Cylinders	One
Orientation	Vertical
Cycle	4 stroke
Ignition	Compression Ignition
Bore x Stroke	87.5 mm x 110 mm
displacement	661 cc
Compression Ratio	17.5 : 1
Rated Speed	1500 rpm
Rated Power	5.2 Kw (7HP)

This engine is used for evaluation of performance and emission characteristics of diesel and biodiesel blends.

The engine is run at a constant speed of 1500 rpm. The first stage of experiment is performed with pure diesel at different loads from no-load to full load with EGR rates such as 0%, 5% and10% at constant speed. The engine loads are adjusted by using an eddy current dynamometer. The exhaust gases are tapped from the exhaust pipe and connected to the inlet airflow passage. The rate of EGR is varied with the help of an EGR control valve which is fixed in the pipe control. The second stage of the experiment is conducted using various blends of diesel-biodiesel with additive Di ethyl ether 2% by volume (designated as RBB10 + 2%DEE, RBB20+ 2%DEE , RBB30+ 2%DEE).

III. RESULTS AND DISCUSSION

A. Performance Analysis

The performance parameters such as Brake thermal efficiency, Brake specific fuel consumption and Exhaust gas temperature are analysed using rice bran biodiesel and its blends using di ethyl ether and its results are plotted in graphical form.

Fig 2(a) illustrates that with increase in load the Brake thermal efficiency (BTE)also increases. The BTE for all fuel increases as the load increases. For 80% load all fuels show maximum BTE, but at full load the BTE decreases. Fig 2(b) illustrates for fixed 100% load that with increase in the percentage of EGR, BTE decreases on further usage of di ethyl ether the BTE increases slightly for the same blend. As EGR increases BTE decreases this is due to the fact that on increasing EGR the oxygen content present in the combustion chamber reduces which leads to incomplete combustion. Fig 3(a) illustrates that with increase in load the brake specific fuel consumption (BSFC) decreases. For pure rice bran biodiesel BSFC is higher than diesel and also higher than rice bran biodiesel blend at lower loads. At full loads the BSFC remains nearly constant for all the fuels. But with increase in the amounts of biodiesel blends, BSFC also increases because the blends have less energy content.

Fig 3(b) illustrates that with increase in the percentage of EGR, BSFC increases. With use of Di ethyl ether, BSFC decreases slightly. As EGR increases, BSFC increases due to the replacing of fresh oxygen molecules from suction and as density of air reduces there is less amount of oxygen available in combustion chamber thereby increasing BSFC. Fig 4(a) illustrates that with increase in load the Exhaust gas temperature (EGT) increases. 4(b) illustrates that with increase in the percentage of EGR, EGT decreases. With use of Di ethyl ether, EGT further decreases .As EGR increases, EGT decreases the reason behind decreasing EGT may be due to higher specific heat of intake air as diluents and reducing the combustion temperature.

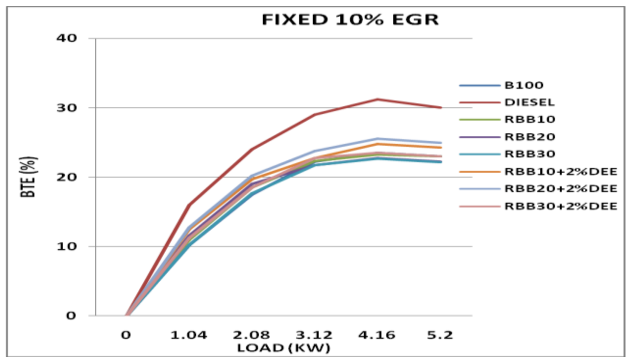

Fig 2(a)

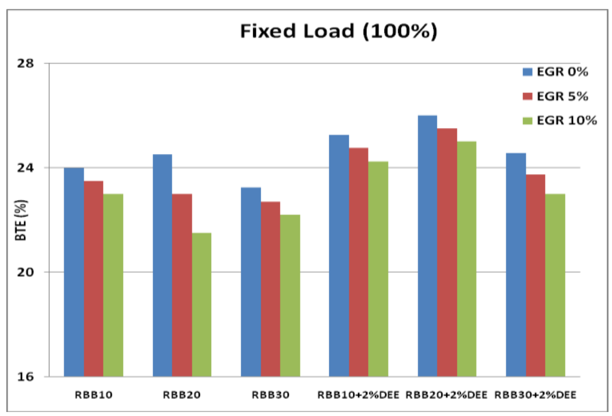

Fig 2 (b)

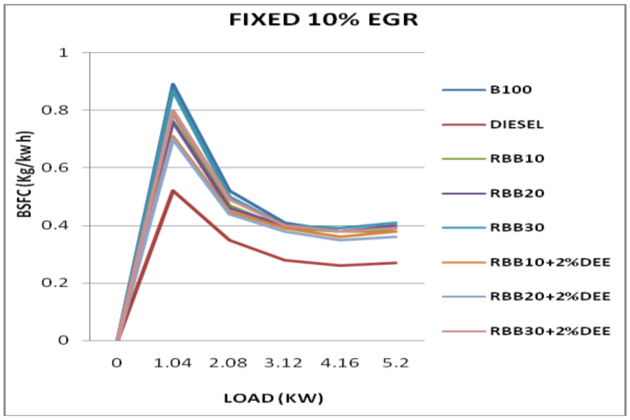

Fig 3(a)

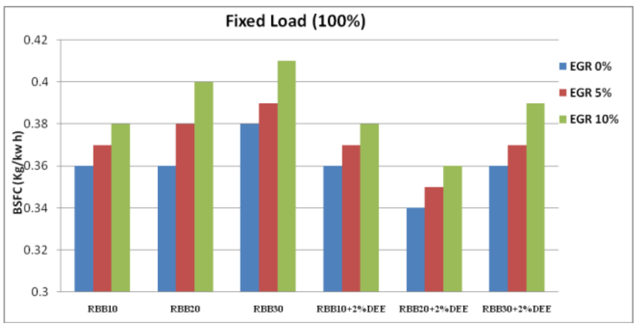

Fig 3(b)

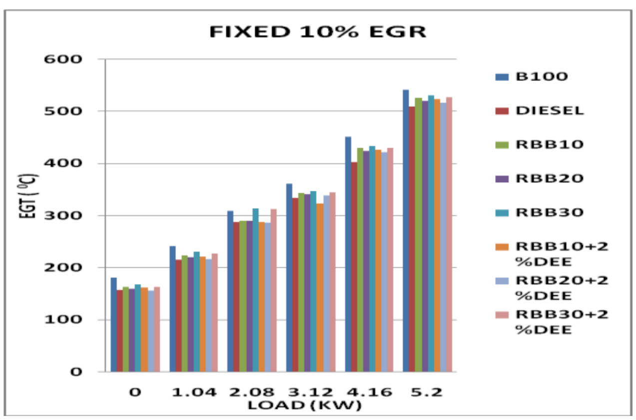

Fig 4(a)

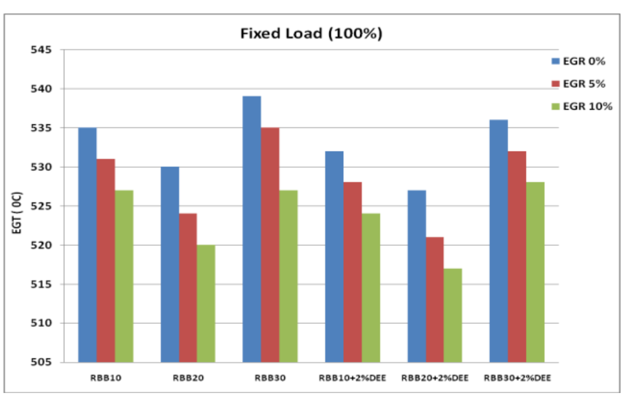

Fig 4(b)

B. Emission Analysis

Exhaust Emissions such as CO,HC, NOx are measured using DELTA 1600 S exhaust gas analyser and smoke opacity is measured using Hartridge smoke meter. Fig 5(a) illustrates that with increase in load the CO Emissions increases. Up to 80% of engine load the entire test fuels with and without EGR indicates almost similar amount of CO emissions. But at full load conditions, CO emissions increases. 5(b) for fixed 100% load it shows that as the percentage of EGR increases CO Emissions also increases. With use of Diethyl ether, CO Emissions decreases slightly. As EGR increases CO Emissions increases. Reason behind this is due to use of CO_2 to displace oxygen (O_2) in inlet air which results in less amount of O_2 supplied to combustion chamber, preventing oxidation process thereby increasing CO emissions. Fig 6(a) illustrates that with increase in load the HC Emissions increases. CI engines have lower HC emissions using Diesel fuel. Fig 6(b) for fixed 100% load it shows that as the percentage of EGR increases HC Emissions also increases. With use of Diethyl ether, HC Emissions decreases slightly. As EGR increases HC Emissions increases this is due to low oxygen content in combustion process. This low oxygen results in rich air fuel mixture in different locations of combustion chamber increasing HC Emissions. Fig 7(a) illustrates that with increase in load the NOx Emissions increases. Fig 7(b) for fixed 100% load it shows that with increase in the percentage of EGR the NOx emissions reduces this is due to the fact that as the exhaust gases gets recycled into the combustion chamber they tend to reduce the oxygen content diluting the intake charge which decreases the combustion temperature as inert gases present in EGR absorbs the energy released during combustion replacing oxygen and thus finally inhibits NOx formation. With use of Di ethyl ether, NOx Emissions increases as it is an oxygenated additive. Thus with increase in percentage of EGR, NOx can be reduced. As we go on increasing the EGR rate, NOx emissions reduces but this decreases Brake thermal efficiency and increases HC and CO emissions. Fig 8(a) illustrates that with increase in load the Smoke Opacity increases. Fig 8(b) for fixed 100% load it shows that as the percentage of EGR increases Smoke Opacity also increases. With use of Diethyl ether, Smoke Opacity decreases slightly. As EGR increases Smoke Opacity increases, because as the recirculated exhaust gases has already soot particles present in it do not take part in combustion process .

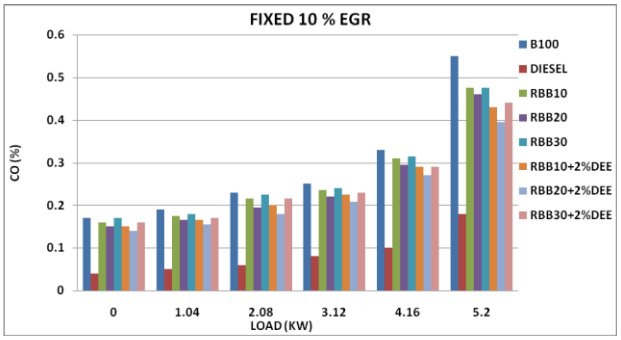

Fig 5(a)

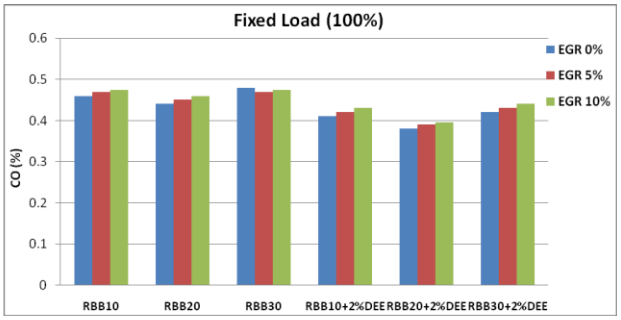

Fig 5(b)

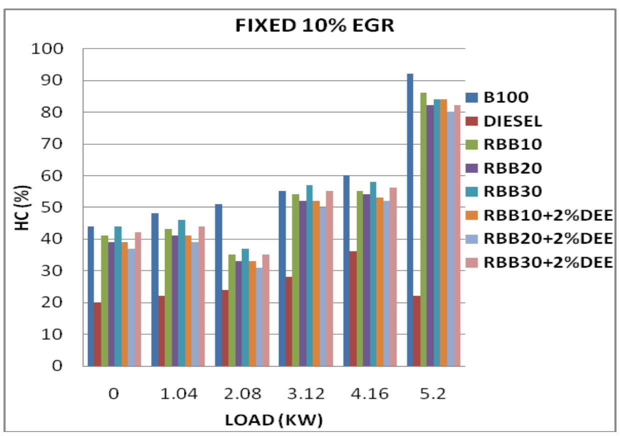

Fig 6(a)

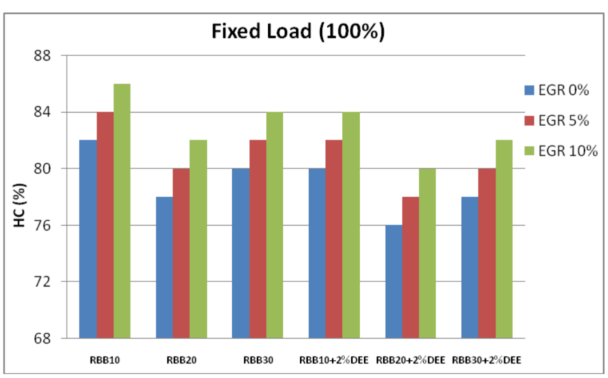

Fig 6(b)

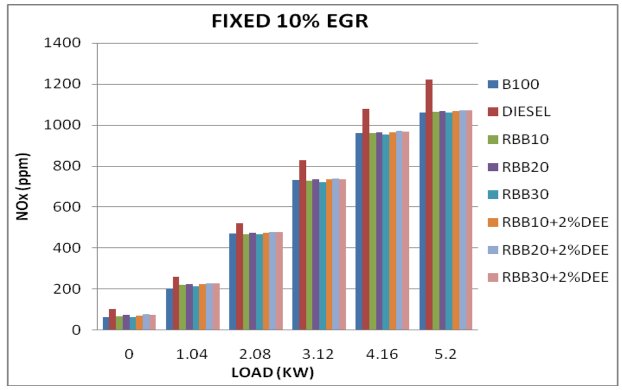

Fig 7(a)

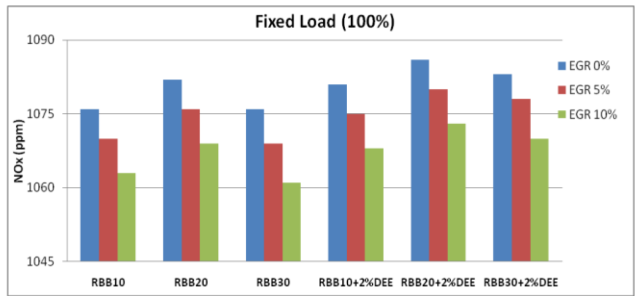

Fig 7(b)

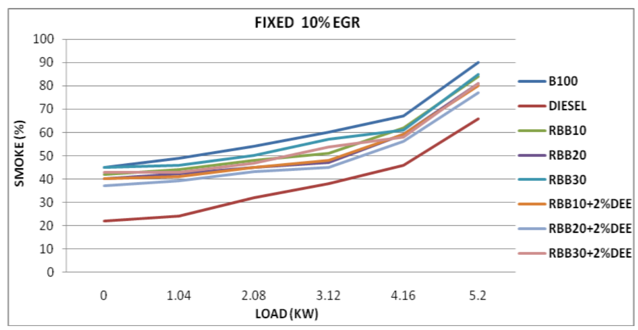

Fig 8(a)

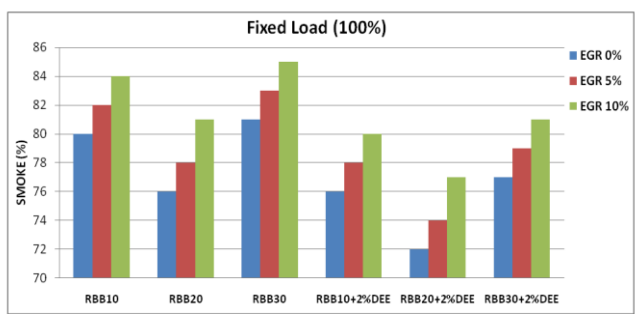

Fig 8 (b)

IV. CONCLUSION

This experimental investigation may be summarized as follows :

- With increase in load, Brake thermal efficiency increases. With use of additive DEE, BTE further increases. But at full load, BTE decreases slightly. On using EGR technique, with increasing percentage of EGR, BTE decreases.

- With increase in load, Brake specific fuel consumption decreases. With use of additive DEE, BSFC further decreases. At full loads the BSFC remains nearly constant for all the fuels. On using EGR technique, with increasing percentage of EGR, BSFC also increases.
- With increase in load, Exhaust gas temperature increases. With use of additive DEE, EGT decreases slightly. With increasing percentage of EGR, EGT decreases.
- With increase in load, HC & CO Emissions increases. With use of additive DEE, HC & CO emissions decrease slightly. With increasing percentage of EGR, HC & CO emissions also increases.
- With increase in load NOx Emissions increases. With use of additive DEE, NOx emissions further increases. With increasing percentage of EGR, NOx emissions decrease. As we go on increasing the percentage of EGR, NOx emissions reduces but this decreases Brake thermal efficiency and increases HC and CO emissions.
- With increase in load, Smoke opacity increases. With use of additive DEE, Smoke opacity decreases slightly. With increasing percentage of EGR, Smoke opacity also increases.

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