Performance And Emissions Characteristics Of Diesel Engine Fuelled With Rice Bran Oil

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Abstract— **Due to the scarcity of conventional fuels and the crude oil, the price was going up day to day and there will be no more conventional fuels in future and also increasing the environmental pollution by the usage of crude oils, there is a need for the search of alternative fuel sources for the automobile applications. Therefore in the present investigation the oil taken is the rice bran oil which was obtained by the waste rice husk. The different proportions such as RB25, RB35, RB45, and RBE25,RBE35, RBE45, to find out the performance parameters and emissions. This work presents the experimental investigation carried on four stroke single cylinder diesel engine with Ethanol and Ethyl Hexyl Nitrate (EHN) as additives to the diesel-biodiesel blends. Ethanol was added as 10% by volume to the diesel-biodiesel blends. It was observed that the Brake Thermal Efficiency (BTE) increases in proportion to the blend percentage. The CO, HC and NOx emissions are decreased when compared to neat diesel.**

Keywords— **Rice bran oil, Ethanol, Ethyl Hexyl Nitrate (EHN), Emission characteristics.**

1. INTRODUCTION

More than 90% world's rice production coming from Asia. Rice production first among agricultural commodity of Indonesia. Rice bran is a brown layer present between rice and the outer husk of the paddy. Rice bran oil is an important derivative of rice. Depending on variety of rice and degree of milling, the bran contains 16-32 wt% of oil. About 60-70% of the oil produced from this bran is non edible oil, due to the problems attributed to the stability and storage of the rice bran and the dispersed nature of rice milling . Rice bran oil (RBO) is considered to be one of the most nutritious oils due its favourable fatty acid composition and unique combination of naturally occurring biologically active and antioxidant compounds [1]. RBO has been difficult to refine because of the its high content of free fatty acid (FFA), unsaponifiable matter and dark colour [2] . The results obtained show a 49% reduction in smoke, 35% reduction in HC and 37% reduction in CO emissions for the blends whereas the brake power and BTE are reduced by 2.4% and 3.2% respectively with 4.3% increase in the SFC . Therefore it is concluded from the present experimental study that the blends of RBO and Diesel fuel can successfully be used in Diesel engines as an alternative fuel without any modification in the engine and it is also environment friendly by the emission standards. The present research is aimed to investigate experimentally the performance and exhaust emission characteristics of a direct injection (DI) diesel engine when fuelled with conventional diesel fuel, rice bran oil biodiesel, a blend of diesel and rice bran oil biodiesel and three blends of diesel-biodiesel-ethanol over the entire range of load on the engine. The experimental results showed that the highest brake thermal efficiency was observed with 15% ethanol in diesel-biodiesel-ethanol blends. The exhaust gas temperature and the sound intensity from the engine reduced with the increase of ethanol percentage in diesel-biodiesel-ethanol blends. The Carbon monoxide and smoke emissions reduced significantly with higher percentage of ethanol in diesel-biodiesel-ethanol blends. The unused oxygen with 5% ethanol in diesel-biodiesel-ethanol blend was lower than that of diesel fuel [3]. .From the literature it is concluded that alternate fuels can be used as substitute for diesel by evaluating its properties and blending them with diesel in small proportions can improved performance parameters and reduce emissions without modifying the engine design.

2. EXPERIMENTAL PROCEDURE

2.1 Biodiesel Production by Transesterification Method

Rice bran oil and methanol were mixed and poured into the test reactor. Then base catalyst (CAO) in 1% w/w was added into the already present mixture in the reactor. The mixture inside the reactor was heated to a temperature of 65 ^{0}C and stirred continuously. The mixture in the reactor was allowed to remain at the same temperature for a period of 3 hrs and then it was allowed to settle under gravity. After settling two layers were formed, the upper layer was found to be Rice bran oil methyl esters (RBO) and the lower layer being glycerol.

2.2 Preparation Of Biodiesel Blends

After production the RBO was blended with neat diesel fuel in various volume concentrations to prepare biodiesel blends. These blends were subsequently used in the engine tests. The level of blending for convenience is referred as RBXX. Where XX indicates the percentage of biodiesel present in the blend. For example a RB25 blend is prepared with 25% biodiesel and 75% diesel oil by volume.During the present engine

experiments the blends prepared and used were RB25, RB35, RB45, RBE25, RBE35 and RBE45..

2.3 Properties of biodiesel comparison with diesel

The test fuels used in the engine during the experiments were RB25,R B35, RB45, RBE25, RBE35, RBE45 and Diesel oil. Before application on the engine, various physico-chemical properties of all the above test fuels were determined and compared to each other.

Properties	Rice bran oil	Pure diesel
Density at15^{0}c (gm/cc)	0.92	0.82
Viscosity at 40^{0}c (Centi stokes)	6.29	5
Cloud point (^{0}C)	7	-6
Pour point (^{0}C)	-3	3
Carbon Residue (%)	0.48	0.1
Calorific value (KJ/kg)	37900.8	42,500

3. EXPERIMENTAL SETUP

The experimental setup shown in figure is a single cylinder four stroke naturally aspirated diesel engine.

Figure 4.1: Engine Test Rig

The setup is provided with necessary instruments like Rope brake dynamometer, Smoke meter(Netel's-NPM-DSM),Gas analyzer(Netel's-NPM-MGA-2),etc.,for performance and emission analysis. The Specifications of the test engine is shown in given below.

3.1. Specifications Of the Engine:

Type of Engine	Four stroke single cylinder vertical air cooled diesel engine
Rated power	**4.4kw**
Rated speed	**1500 rpm**
Bore dia	**87.5 mm**
Stroke length	**100 mm**
Compression ratio	**17.5**

4.RESULTS AND DISCUSSION

The performance and emission characteristics of a high speed diesel engine at various loads from no load to full load fueled with rice bran oil and its diesel blends with additives like ethanol and ethyl hexyl nitrate are discussed below as per the results obtained.

4.1 Specific Fuel Consumption (SFC):

The variation of brake specific fuel consumption with brake power is shown in fig.1.the plot it is reveals that as the the load increases the fuel consumption decreases. At full load condition the BSFC obtained are 0.34kg/kw-hr, 0.36 kg/kw-hr,0. 36kg/kw-hr ,0.36kg/kw-hr ,035kg/kw-hr,0.33kg/kw –hr and0.36kg/kw-hr of fuels of diesel RB25,RB35,RB45,RBE25, RBE35,RBE45 respectively. The BSFC of rice bran oil blend RBE45 decreased when compared to the diesel at full load condition.

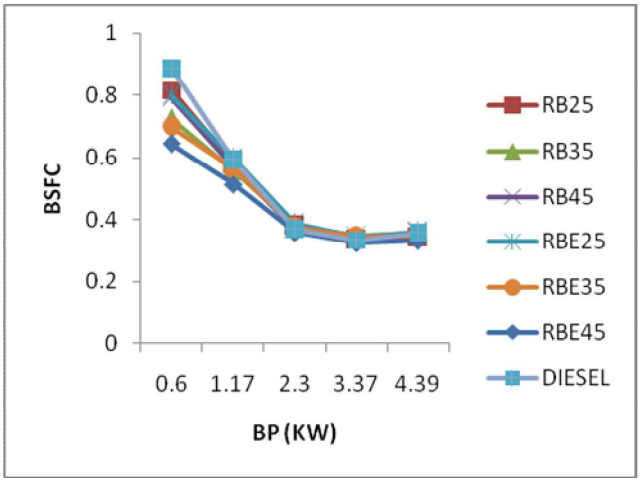
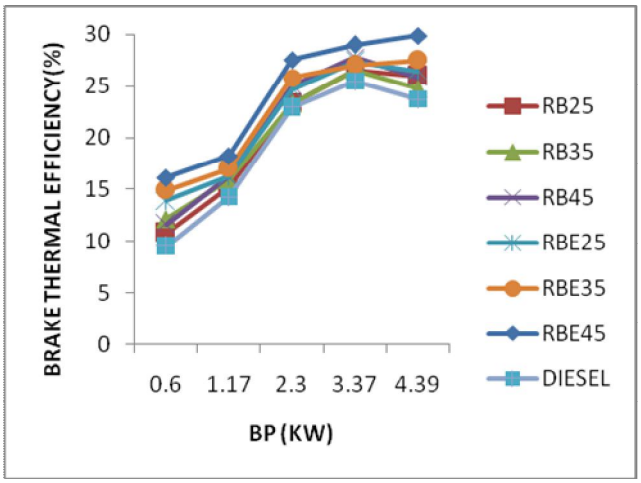


Fig:4.1. Variation of specific Fuel Consumption with brake power

4.2Brake Thermal Efficiency(BTE):

The variation of brake thermal efficiency with brake power is shown in fig. 2.from the the plot it is observed that as the the load increases the brake thermal efficiency increases. At full

load condition the brake thermal efficiency obtained are 25.96%,24.72%, 25.83%,26.45%,27.47%,29.87%,and 23.7% for fuels of RB25,RB35,RB45,RBE25,RBE35,RBE45and diesel respectively. The brake thermal efficiency of rice bran oil blend RBE35 increased when compared to the diesel at full load condition.



4.3. Indicated Power(IP):

The variation of indicated power with brake power is shown in fig.3.the plot it is reveals that as the the load increases the indicated power decreases. At full load condition the indicated power obtained are 6.3kw,6.2kw 6.6 klw,4.7 kw 4.6 kw,4.3 kw, and 7.7 kw for fuels of RB25,RB35,RB45,RBE25,RBE35,RBE45 and diesel respectively. The indicated power of rice bran oil blend RB25 decreased when compared to the diesel at full load condition.

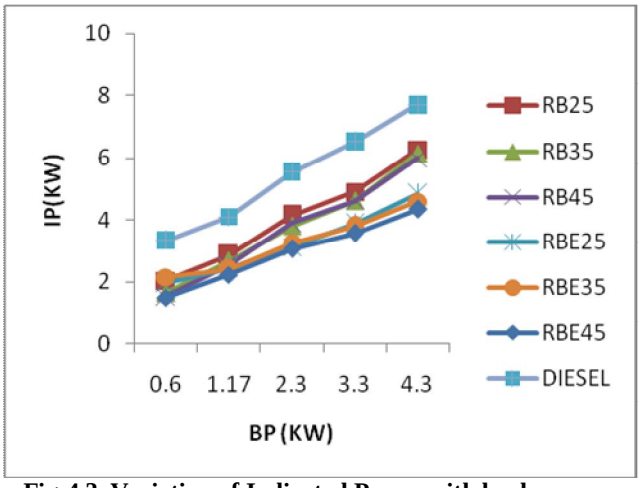


Fig:4.3. Variation of Indicated Power with brake power

4.4. Mechanical Efficiency:

The variation of mechanical efficiency with brake power is shown in fig.4.the plot it is reveals that as the the load increases the mechanical efficiency increases. At full load condition the mechanical efficiency obtained are 70.11%,71.48%,73.34%,69.66%,67.43%,79.76%and 57.09%. For fuels of RB25,RB35,RB45,RBE25,RBE35,RBE45and diesel, respectively. The mechanical efficiency of rice bran oil blend RBE35 increased when compared to the diesel at full load condition.

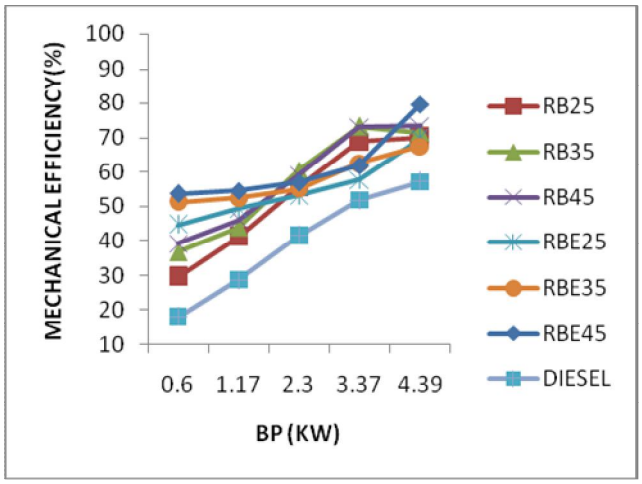


Fig:4.4. Variation of Mechanical Efficiency with brake power

4.5. Carbon Monoxide (CO):

The variation of CO emission with brake power is shown in fig.5.the plot it is reveals that as the the load increases the CO emission decreases. At full load condition the CO emissions obtained are 0.45%,0.61%,0.77%,0.67%, 0.59%,and 0.07% for fuels of RB25,RB35,RB45,RBE25,RBE 35,RBE45 and diesel respectively. The Co emission of rice bran oil blend RBE35 decreased when compared to the other diesel at full load condition.

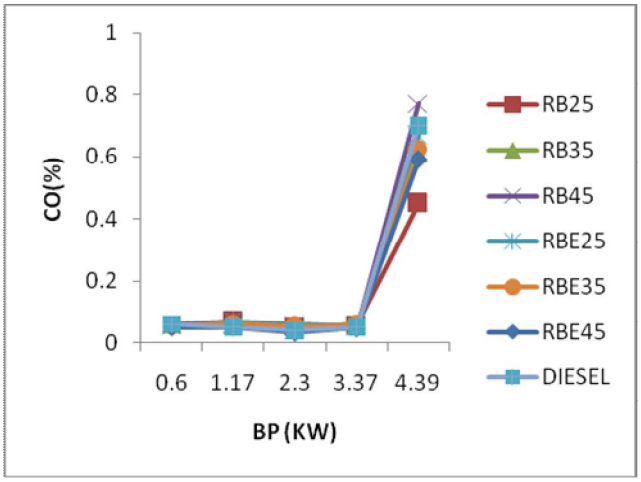


Fig:4.5. Variation of Carbon Monoxide with brake power

4.6.Unburned Hydrocarbon (HC):

The variation of HC emission with brake power is shown in fig.6.the plot it is reveals that as the the load increases the HC emission decreases. At full load condition the HC emissions obtained are 40,42,38,39,37,19 and 47ppm for fuels of RB25,RB35,RB45,RBE25,RBE35,RBE45 and diesel respectively. The HC emission of rice bran oil blend RB20 decreased when compared to the other diesel at full load condition.

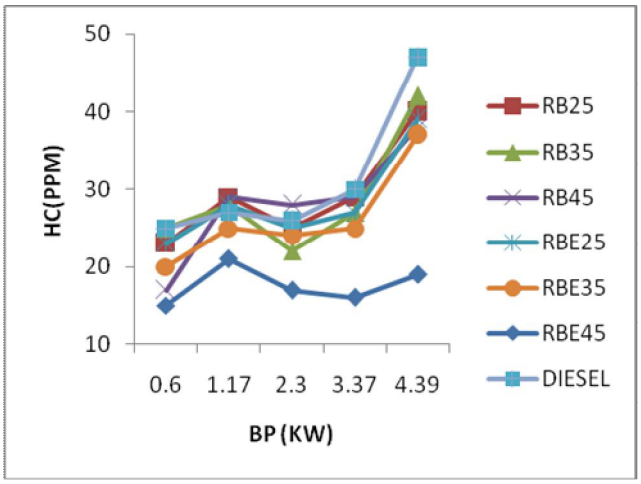


Fig:4.6. Variation of Unburned Hydrocarbon withbrake power

4.7. Co2 Emission(CO2):

The variation of CO2 emission with brake power is shown in fig.6.the plot it is reveals that as the the load increases theCO2 emission decreases. At full load condition theCO2emissionsobtainedare:7.8%,7.7%,7.5%,7.2%,6.9%,5.3%,and7.9%,forfuelsofRB25,RB35,RB45,RBE25,RBE35,RBE45 and diesel respectively. The CO2 emission of rice bran oil blend RBE35decreased when compared to the diesel at full load condition.

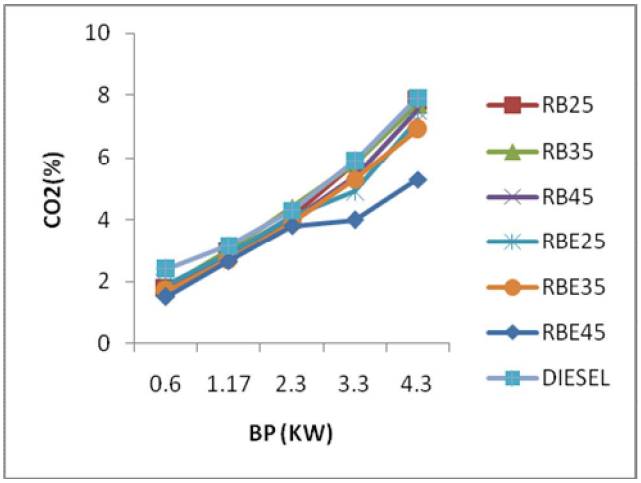


Fig:4.7. Variation of carbon dioxide with brake power

4.8. OXIDES OF NITROGEN(NOx):

The variation of NOx emission with brake power is shown in fig.6.the plot it is reveals that as the the load increases theNOx emission decreases. At full load condition the NOx emissions obtainedare:592ppm,579ppm,541ppm,875ppm,783ppm,530ppm,and971ppm, for fuels of RB25,RB35,RB45,RBE25,RBE35, RBE45 and diesel respectively.The NOx emission of tyre oil blend RBE35 decreased when compared to the other blends at full load condition.

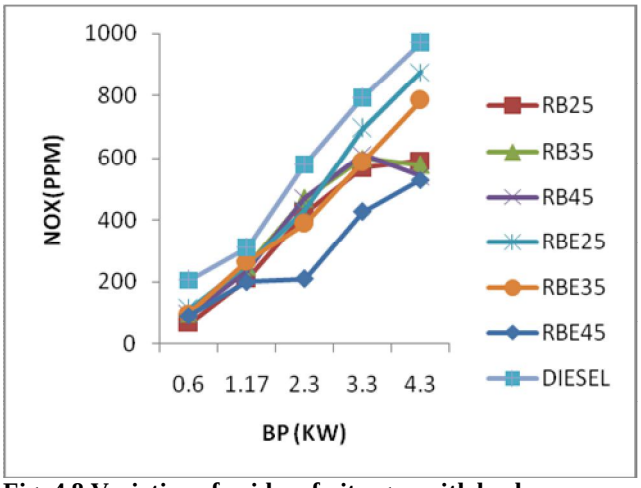


Fig: 4.8.Variation of oxides of nitrogen with brake power

5 CONCLUSIONS

The conclusions derived from present experimental investigations to evaluate performance and emission

characteristics on four stroke single cylinder diesel engine fueled with diesel RBOblends with Ethanol and EHN as additives are summarized as follows.

1. Brake thermal efficiency increased with all blends when compared to the conventional diesel fuel.
2. The Brake specific fuel consumption is decreased with the blends when compared to diesel.
3. CO,CO2 and HC emissions are decreased significantly with the blends when compared with diesel.

From the above analysis the blend RBE35 shows the better performance compared to other blends(RB25,RB35, RB45, RBE25,RBE45) and diesel

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