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Performance And Emission Analysis Of Single Cylinder CI Engine With Using Crude Rice Bran Biodiesel

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ABSTRACT
The consumption of fuels in the world is increasing rapidly and it affects the global economyof all the countries so this factor forced all the countries to find the alternative fuel to reduceand even replace the usage of petroleum fuel. Thus use of biodiesel from non-edible oil sources serves asan alternative fuel to overcome this problem. The present study focuses on impact assessment of rice bran andcrude rice bran biodiesel and its blends with diesel on diesel engine performance and testing. The experimentalanalysis provides in study detail of the biodiesel production process, fuelproperties evaluation and impact on engine performance testing. The study also investigates the optimization of theCompression ratio (CR) of a compression ignition engine fueled with blends of biodiesel. In orderto find out the optimum CR of the engine, experiments were conducted at different CRs rangingfrom 12 to 18. Then the experiments were conducted using B10, B20 and B30 blends of crude ricebran bio-diesel and diesel at CR of 14 and 16 and these results were compared with the resultsobtained when the same engine was tested on conventional diesel fuel. Similarly the experimentalresults of B10, B20 and B30 blends of rice bran bio-diesel at CR 14 were investigated and analyzed.Based on the experimental investigation the blends of crude rice bran bio-diesel can be used as fuelin diesel engine without making any modification to the diesel engine

KeyWords:-Biodiesel; Transesterification; Crude rice bran oil; Rice bran oil; Diesel Engine

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I. INTRODUCTION

More than 90% world’s rice production comingfrom Asia. Rice production first among agriculturalcommodity of Indonesia. Rice bran is a brown layer presentbetween rice and the outer husk of the paddy. Rice bran oil isan important derivative of rice. Depending on variety of riceand degree of milling, the bran contains 16-32 wt% of oil.About 60-70% of the oil produced from this bran is non-edibleoil, due to the problems attributed to the stability and storageof the rice bran and the dispersed nature of rice milling. Ricebran oil (CRBO) is considered to be one of the most nutritiousoils due its favorable fatty acid composition and uniquecombination of naturally occurring biologically active andantioxidant compounds [1,2].Biodiesel can be produced from a greatvariety of feedstock’s which includes most common vegetableoils (e.g., soybean, cottonseed, palm, peanut, rapeseed/canola,sunflower, coconut) and animal fats (usually tallow) as well aswaste oils (e.g., used frying oils). The choice of feedstockdepends largely on availability. Biodiesel has a higher cetanenumber than diesel fuel, no aromatics, no sulfur, and contains10–11% oxygen by weight [3,4].Generally the direct useof vegetable oils in the diesel engine is not recommended dueto their high viscosity, which affects combustion. So in orderto reduce its viscosity so that it can be used in common dieselengines without making any modification in the engine thetransesterification method is used to reduce the high viscosityof oil [5–8].The resultsobtained show a 49% reduction in smoke, 35% reduction inHC and 37% reduction in CO emissions for the blendswhereas the brake power and BTE are reduced by 2.4% and3.2% respectively with 4.3% increase in the SFC . Therefore itis concluded from the present experimental study that theblends of RBO and Diesel fuel can successfully be used inDiesel engines as an alternative fuel without any modificationin the engine and it is also environment friendly by theemission standards. The present research is aimed toinvestigate experimentally the performance and exhaustemission characteristics of a direct injection (DI) diesel enginewhen fuelled with conventional diesel fuel, rice bran oilbiodiesel, a blend of diesel and rice bran oil biodiesel andthree blends of diesel-biodiesel-ethanol over the entire range of load on the engine [9-10].Rice bran oil ranks first among the non-conventional, inexpensive,low-grade vegetable oils. Furthermore, crude ricebran oil is a rich source of high value-added byproduct. Therefore,use of rice bran oil as raw material for the production ofbiodiesel not only makes the process economical but also generatesvalue added bio-active compounds. Isolation and purificationof these byproducts make the process attractive andremunerative. Thus, if the by-products are derived from cruderice bran oil and the resultant oil is used as feedstock for biodiesel,the resulting biodiesel could be quite economical andaffordable. In the present study, crude rice bran oil and refinedrice bran oil are chosen as potential alternatives for producingbiodiesel and use as fuel in four stroke compression ignition engines [11-13].The kinematic viscosity of crude rice bran oil and refinedrice bran oil is however several times higher than that of dieseloil [6] and this leads to problems in pumping and atomizationin the injection system of a diesel engine so their viscositymust be lowered. The combined effect of high viscosity andlow volatility causes poor cold engine start up, misfire andignition delay. Hence, it is necessary to bring their combustionrelated properties closer to those of diesel oil [4]. The freefatty acid (FFA) content of crude rice bran oil is high dependingon the quality of rice bran from which the oil has beenextracted. Because of the high FFA content for crude ricebran oil a 2-stage transesterification process is carried outwhich includes an acid catalyzed transesterification followedby a base catalyzed transesterification. For refined rice branoil a single stage base catalyzed transesterification was carriedout. The present study focuses on production and performanceevaluation of rice bran biodiesel as an alternativesource of fuel.

In India, total consumption of crude oil was 103,44 million tonnnes (MT) in 2000-2001and 160.03MT in 2009-10,whereas production was 32.43MT in 200-01 and 33.69MT in 2009-10.Thus increment in production is only 3.7% as compared to increment in computation of 35.36%1.Transportation and agricultural sectors are major consumers of fossil fuel and biggest contributors to environmental pollution. Current price of vegetable oil worldwide is nearly competitive with petroleum based fuels.

II. BIODIESEL PRODUCTION BY TRANSESTERIFICATION METHOD

The idea of using plant-based oils, such as soybean oil or canola oil, to fuel an internal combustion engine is as old as the diesel engine itself. Rudolph Diesel, inventor of the diesel engine, used peanut oil to demonstrate his new invention at the Paris World's Exhibition in 1900. Throughout the 20th century, however, petroleum-based diesel fuel has been relatively cheap and convenient. As a result, diesel engines have been refined through the years to work well with this fuel source. Petroleum diesel flows more easily (i.e. is less viscous) than either plant or animal based fats and oils. As a result, using non-petroleum-based oils in today's diesel engines requires either modifying the vehicle's fuel system to accept these slower flowing oils or modifying the oil or fat itself so that it can be used directly in a diesel engine. The chemical process commonly used make bio-oils less viscous, turning them into "biodiesel" is called "transesterification".Rice bran oil and methanol were mixed and poured into thetest reactor. Then base catalyst (CAO) in 1% w/w was addedinto the already present mixture in the reactor. The mixtureinside the reactor was heated to a temperature of 65 ^{0}C andstirred continuously. The mixture in the reactor was allowedto remain at the same temperature for a period of 3 hrs andthen it was allowed to settle under gravity. After settling twolayers were formed, the upper layer was found to be Rice bran oil methyl esters (RBO) and the lower layer being glycerol.

- Biodiesel is made from the combination of a triglyceride with a monohydroxy alcohol (i.e. methanol, ethanol…).
- What is a triglyceride? Made from a combination of glycerol and three fatty acids:

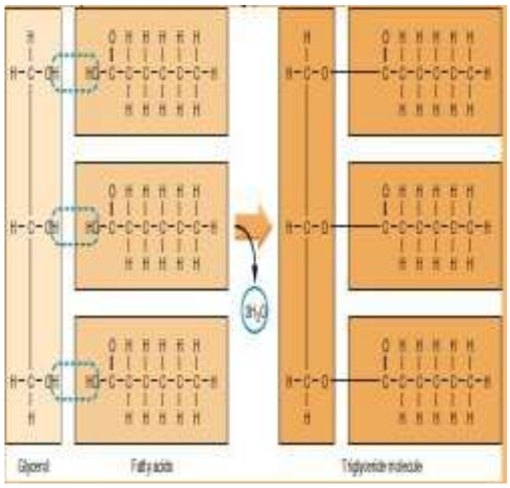

Fig.1 Chemistry of triglycerides

Tran'sesterification

While actually a multi-step process, the overall reaction looks like this:

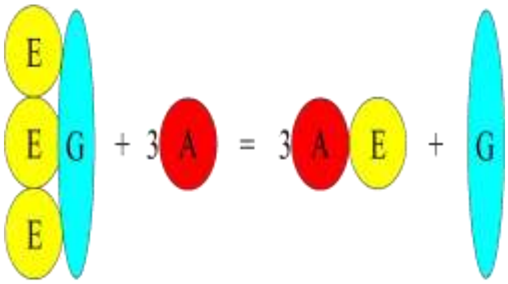

Fig.2 Trans esterification

III. PREPARATION OF BIODIESEL BLENDS

After production the RBO was blended with neat diesel fuel invarious volume concentrations to prepare biodiesel blends.These blends were subsequently used in the engine tests. Thelevel of blending for convenience is referred as RBXX. WhereXX indicates the percentage of biodiesel present in the blend. For example a CRB10 blend is prepared with 10% biodiesel and 90% diesel oil by volume. During the present engine experiments the blends prepared and used were CRB10,CRB20, and CRB30.

IV. PROPERTIES OF BIODIESEL COMPARISON WITH DIESEL

The specification of the engine used for experimentation isgiven in Table 1 The set-up enables the study of engine brakepower, fuel consumption, air consumption, heat balance, thermalefficiency, volumetric efficiency etc. The performance testswere carried out on the variable CR single cylinder four stroke diesel engine using various blends of crude rice bran oil biodieseland refined rice bran oil biodiesel and diesel as fuels. The tests were conducted at variable loads. The experimental datagenerated were documented and presented here using the biodiesel–diesel mixture for the engine test operation. In eachexperiment, engine performance parameters such as brakespecific fuel consumption (BSFC), brake thermal efficiency(BTE) and variation of cylinder pressure with crank angle weremeasured. Fig. 3 shows variable CR compression ignitionengine test Rig.CRB10, CRB20, CRB30.and Diesel oil.Before application on the engine, various physico-chemicalproperties is given in Table 2. of all the above test fuels were determined andcompared to each other

Table 1. Engine specification

Engine Make type	Kirloskar
Engine Type	Single cylinder four stroke water cooled
Bore	87.5mm
Stroke length	110mm
Loading Device	Eddy current dynamometer
Load indicator	Digital ,Range 0-50kg
Load sensor	Load cell, type strain gauge, range 0–50 kg
Speed indicator	Digital with non-contact type speed sensor
Rated power	3.5 Kw at 1500 RPM
Temperature sensor	Thermocouple
Rotameter	Engine cooling 40–400 LPH; calorimeter 25–250 LPH
Engine capacity	661cc
Variable CR range	12 to 18
Fuel used	Diesel, Biodiesel

Table 2.Fuel characterization.

Properties	Rice bran oil	Crude rice bran biodiesel	Pure diesel
Density, g/cc	0.876	0.897	0.82
Viscosity at 400c (Centi stokes)	6.29	3.59	5
Cloud point (^{0}C)	7	-1	-6
Pour point (^{0}C)	-3	-3	3
Carbon Residue(%)	0.48	0.251	0.1
Calorific value (KJ/kg)	37900.8	38000	42,500
Flash point, 0C	152	205	159
Fire point, 0C	159	210	150

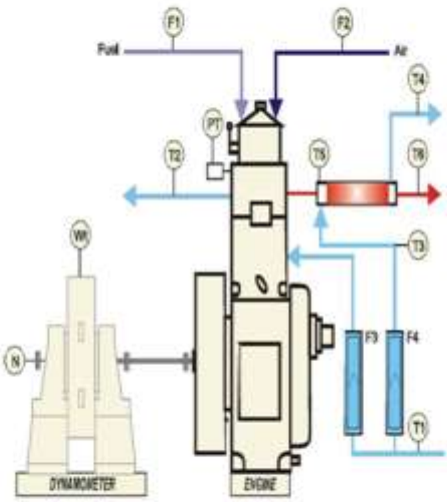

Fig.3 Schematic arraignment

V. RESULT AND DISCUSSION

A. Performance Analysis

1.Brake thermal efficiency analysis: - The variation of thermal performance parameters at different values of CRs at 14 and 16 with a load of 2 kg, 4kg, 6kg and 8 kg and IP of 200 bar it represented in figure 4 to 5. It can be observed that BTHE increases continuously with increase in Load. The increasing trend is due to higher air temperature achieved at diesel due to better combustion of fuel. From above two results clearly indicates at full load condition only Brake thermal efficiency increases continuously in pure Diesel at C.R 14 CRB30 gives less thermal efficiency compare to CRB. The nearest result obtained at CRB20 at same like as pure Diesel as shown in figures 4 to 5. It depicts the variation of brake thermal efficiency with variation of engine load at CR of 16 for the good one in X-axis load and Y-axis BTHE at load 8 higher thermal efficiency occurs at pure diesel.

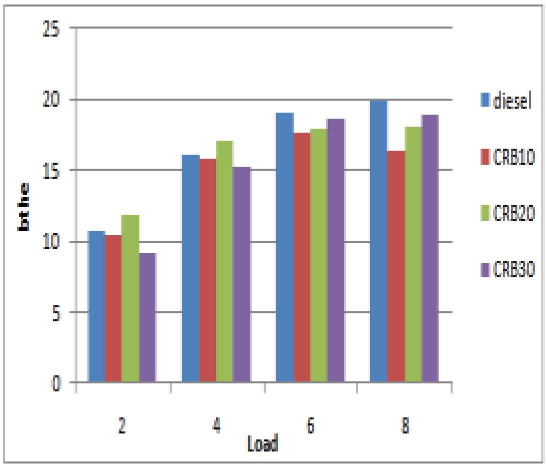

Fig.4 at C.R 14 (Load vs BTHE)

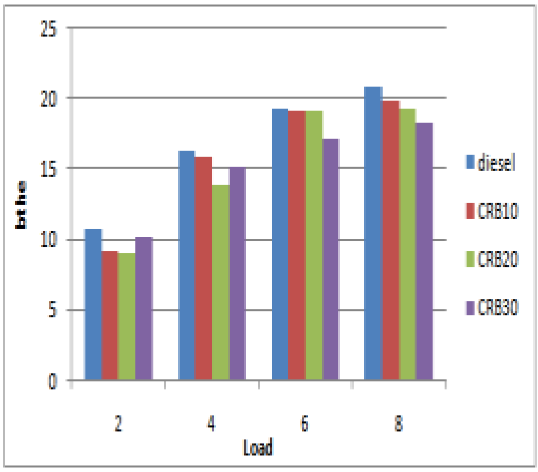

Fig.5 at C.R 16(Load vs BTHE)

2. Brake specific fuel consumption analysis: - It can be observed (Fig 6 and 7) that as the CR of the engine increases, then BSFC of decreases when load increases and result will obtained bsfc is also reduces continues at CRB10 and Pure diesel it will almost same

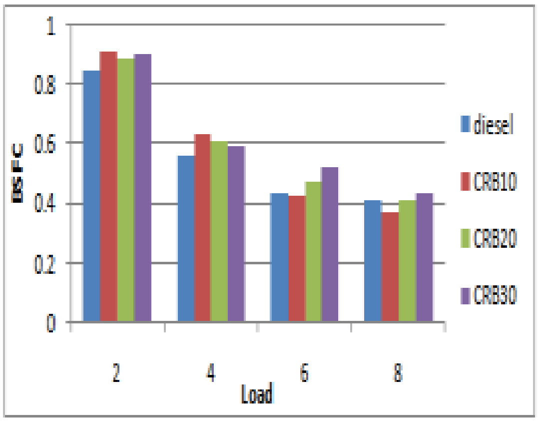

Fig.6 at C.R 14 (Load vs BSFC)

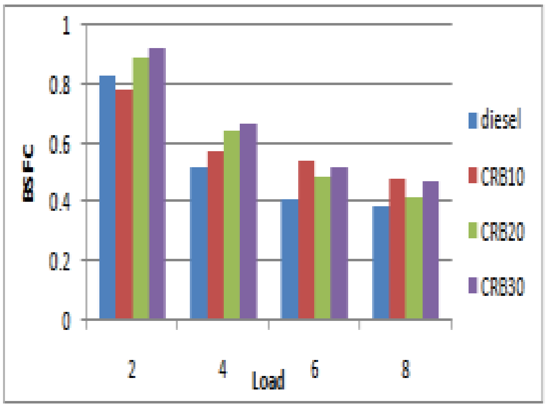

Fig.7 at C.R 16 (Load vs BSFC)

B. Emission Analysis

1. CO Emission Analysis:-Figure 8 to 9 shows the effect of engine load, CR, on blends of CO emissions because oxygen promotes complete combustion. It is found that the CO emissions increases at 6 kg load condition for all fuel tested. When the load increases diesel produce high CO at CR 14 but at CR 16 when load 2 kg CRB20 produce high CO.

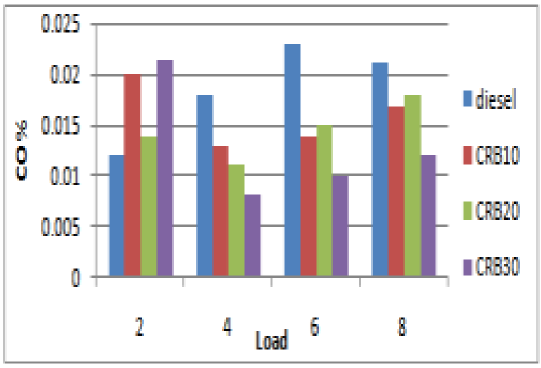

Fig.8 at C.R 14 (Load vs Co in %)

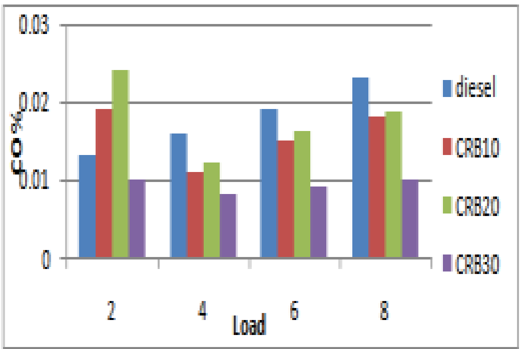

Fig.9 at C.R 16 (Load vs CO in %)

2 CO Emission Analysis:-The Figure 10 and 11. Presents the variation of CO2 emissions in the exhaust gases of tested blends andstraight diesel. The straight diesel has almost same emission as that of the biodiesel at various loadswith little variations. This indicates that the combustion pattern of the biodiesel blends is similar tothat of the straight diesel. At No load condition the CO2 emission is less for the biodiesel blend CRB10 gives better results.

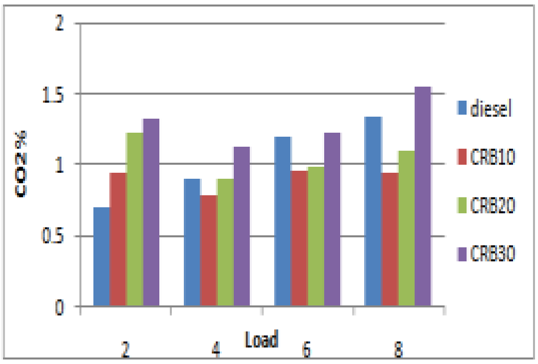

Fig.10 at C.R 14 (Load vs CO2 in %)

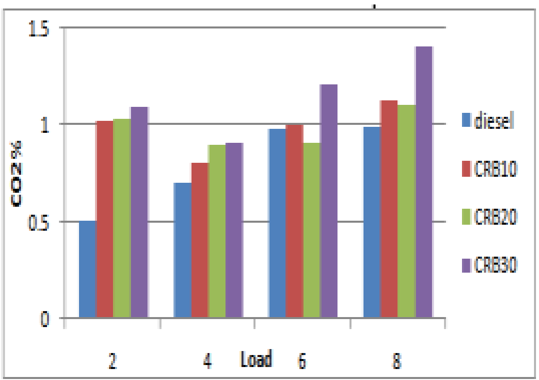

Fig.11 at C.R 16 (Load vs CO2 in %)

3.HC Emission Analysis:-The emission of unburnt hydro carbons in the exhaust gasses has many adverse effects on theatmosphere which leads to global warming. The Figure 12 and 13. Illustrate the HC emission at different loadsfor diesel and biodiesel in conventional engines. Diesel records the highest HC emission at all loads.The other blends have fluctuation values at different loads.

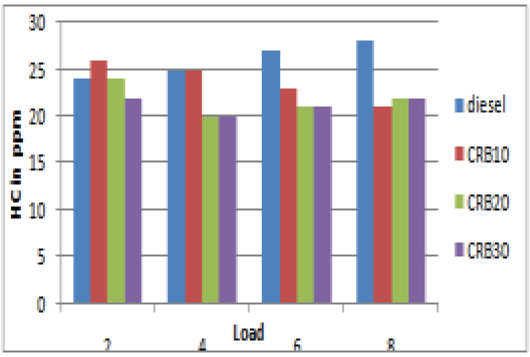

Fig.12 at C.R 14 (Load vs HC in ppm)

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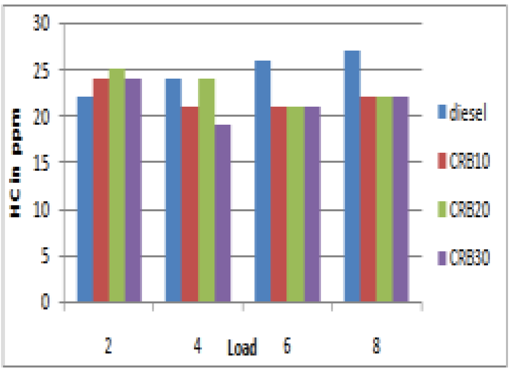

Fig.13 at C.R 16 (Load vs HC in ppm)

REFERNCES

[1]. SinghSP,SinghD.Biodieselproductionthroughtheuseofdifferentsourcesandcharacterizationofoilsandtheirestersasthesubstituteofdiesel: a review.RenewSustainEnergyRev2010;14:200–16.

[2]. Karim, G A (1991): An examination of some measures for improving the performance of gas fuelled diesel engines at light load. SAEPaper No. 912366.

[3]. Karim, G A and Burn, K S (1980): The combustion of gaseous fuels in a dual fuel engine of compression ignition type with particular.

[4]. Pahl G.; McKibben B., 2008, "Biodiesel: Growing a New Energy Economy", Ed.Chelsea Green Publishing, 368 p.

[5]. Bhandari, K et al. (2005): Performance and emissions of natural gas fueled internal combustion engine, A review, JSIR Volume 64333-338.

[6]. Youtonge, Z et.al The effect of palm biodiesel fuel on the Performance and Emissionof the automotive diesel engine" International, the CIGR Ejournal, Manuscript EE 07 005.

[7]. Karim, G A (1983): The dual fuel engine of the compression ignition type –prospects, problems and solutions –a review. SAE PaperNo. 831073

[8]. T.V. Rao, K.H.C. Reddy, G. Rao, Jordan J. Mech. Ind. Eng. 2(2008) 117–122.

[9]. G. Knothe, J.V. Gerpen, J. Krahl, The Biodiesel Handbook,AOCS Press Champaign, Illinois, 2005.

[10]. M. Balat, H. Balat, Energy Convers. Manage. 49 (2008) 2727–2741.

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