EXPERIMENTAL INVESTIGATION ON THE PERFORMANCE COMBUSTION AND EMISSION CHARACTERISTICS OF CI ENGINE FUELLED WITH DIESEL AND RICE BRAN OIL METHYL ESTER (ROME)

Arun Pattanashetti[1], Praveen A. Harari[2], Shambhuraje Jagatap[3], Shivasharanayya Hiremath[4]

[1, 2, 3, 4]*Assistant Professor, Department of Mechanical Engineering, SGOICOE, Belhe (Pune), Maharashtra, India*

ABSTRACT

The increased attention on alternative fuels in the recent years was mainly driven by increasing oil prices,strong emission norms and the concern on clean environment. The biodiesel has emerged as a potential substitute for diesel fuel on account of its renewable source and lesser emissions. Biodiesel is a renewable and environmental friendly alternative fuel which can be used as a substitute for diesel in compression engine without any modifications.In the present study, an experimental work had been carried out to analyze the performance, combustion and emission characteristics of diesel engine when fuelled with diesel (B0) and ROME (B100).

Keywords*: performance, combustion, emission, diesel, ROME.*

I. INTRODUCTION

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmental friendly. Increasing industrialization, growing energy demands, limited reserves of fossil fuel and increasing environmental pollution have joined necessitated exploring some alternative of conventional petroleum fuels. Biofuels are strongly emerging as partial substitutes for fossil fuel from the economic as well as environmental angle. Among the biofuels, vegetable oils like Jatropha oil, Rice bran oil, Karanja oil, Castor oil, Jojoba oil, Cotton seed oil, Neem oil, Mahua oil, Thumba oil, Palm oil, Soyabean oil, Sunflower oil etc. are being explored as promising alternative to hydrocarbon based fuels to full fill the future energy needs. Vegetable oils can be used as alternative fuels because they are biodegradable, non-toxic and significantly reduce pollution. Vegetable oils and their derivatives as diesel engine fuels lead to substantial reductions in carbon monoxide, smoke and particulate emissions. Vegetable oils have approximately 90% heating value of mineral diesel due to higher oxygen content. One of the main problems of vegetable oil use in diesel engines is high viscosity than that of mineral diesel due to which problems occur in pumping and atomization, ring-sticking, carbon deposits on the piston, cylinder head, ring grooves, etc. Therefore, a reduction in viscosity is of prime importance to make vegetable oils a suitable alternative fuel for diesel engines. The problem of high viscosity of vegetable oils can be resolved in several ways, such as preheating the oils, blending or dilution with other fuels, transesterification and thermal cracking or pyrolysis. One of the possible methods to overcome the problem of high viscosity is blending of vegetable oil in proper proportions with diesel. It is a fact that biodiesel is a safer, more economical and infinitely more environmentally friendly than the conventional petroleum diesel. Rice bran oil methyl ester (ROME) is a vegetable oil-based fuel that can be used to replace diesel oil.

II. METHODOLOGY

A. Transesterification reaction

It is most commonly used and important method to reduce the viscosity of vegetable oils. In this process triglyceride reacts with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acids, alkyl ester and glycerol. The process of removal of all the glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called esterification.

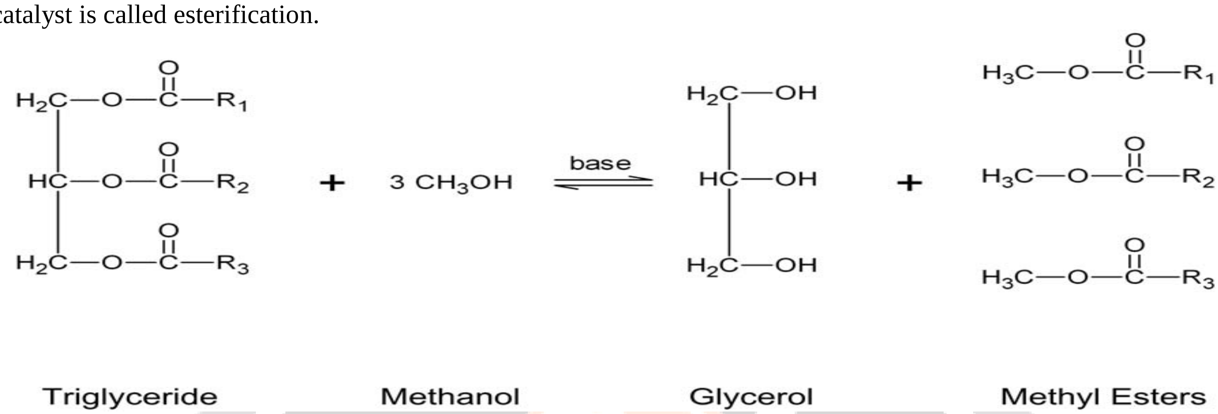

Fig-1: Transesterification reaction

B. Properties of fuels

Properties	Diesel (B0)	ROME (B100)
Viscosity @ 40˚C (cSt)	4.59	5.16
Flash point (˚C)	56	176
Calorific Value (kJ/kg)	44146	39345
Density (kg/m³)	827	860

Table-1: Properties of fuels

C. Experimental setup

Fig-2: Computerized diesel engine setup

D. Engine specifications

Engine Parameters	**Specifications**
Type	TV1 (Kirloskar make)
No of cylinders	Single cylinder
No of strokes	Four stroke
Rated power	5.2 kW at 1500 RPM
Bore x Stroke	87.5 mm x 110 mm
Compression ratio	17.5 : 1
Injection timing	27° bTDC
Dynamometer	Eddy current

Table-2: Engine specifications

The experiment was carried out to investigate theperformance combustion and emission parameters of diesel engine fuelled with diesel (B0) and rice bran oil methyl ester (B100). Technical specifications of the engine are given above. The engine was coupled with eddy current dynamometer. The performance, combustion and emission parameters were analyzed from the graphs regarding brake thermal efficiency (BTE), brake specific fuel consumption (BSFC), Peak pressure rise, HC, CO, NO_X, smoke opacity. Exhaust gas analyzer and smoke meter are used for measuring emissions.

III. RESULTS AND DISCUSSIONS

1. **Brake Thermal Efficiency (BTE)**

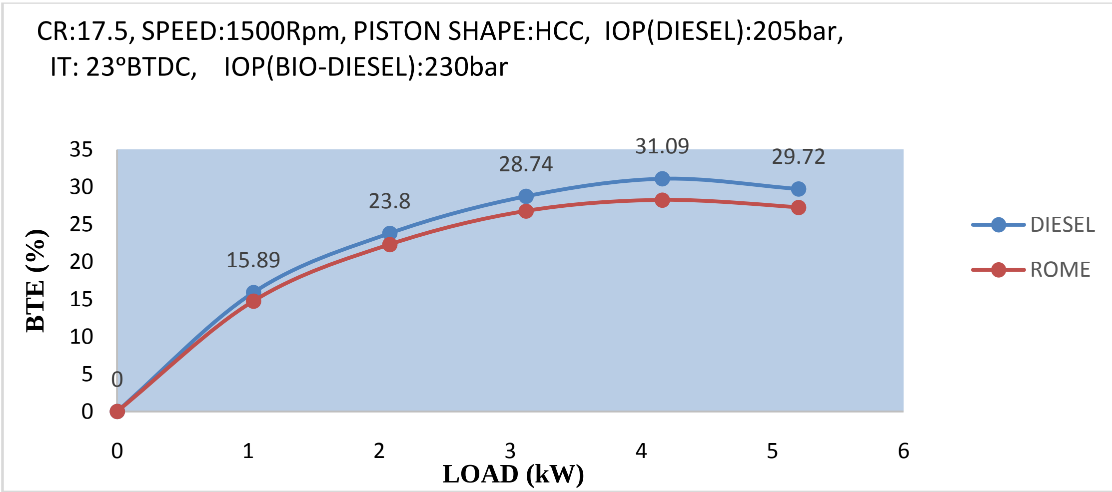

Fig: Variation of BTE with Load

Figure gives the information about variation of brake thermal efficiency for entire load. Since the brake thermal efficiency for diesel is higher than Rice bran oil methyl ester (ROME), because of high viscosity and density of vegetable oil that leads to low volatility which results in poor mixture formation. The maximum values are found to be 31.09% and 28.27% for diesel and ROME respectively at 80% load.

2. **Brake specific fuel consumption (BSFC)**

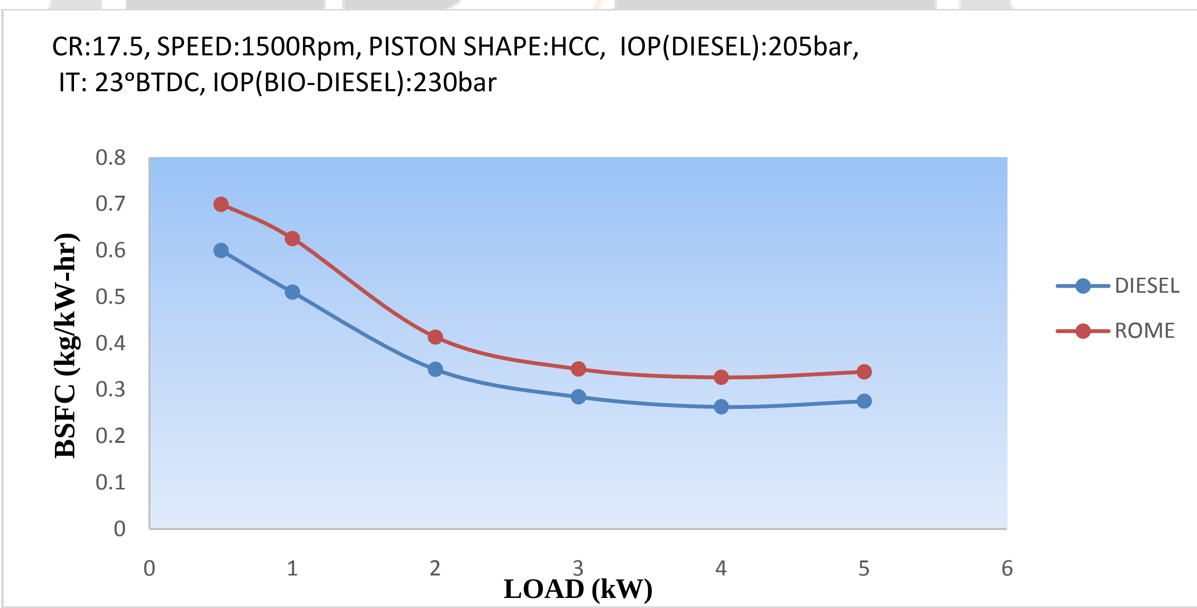

Fig: Variation of BSFC with Load

Figurerepresents the variation of BSFC with load.The BSFC for ROME is more comparing to diesel at all loads. Reason for this is low in energy value of ROME which requires more fuel to produce same power at same load compared to diesel fuel used. Values of BSFC at 100% load are 0.2752 kg/kW-hr& 0.3383 kg/kW-hr for diesel and ROME respectively.

3. **Peak preassure rise**

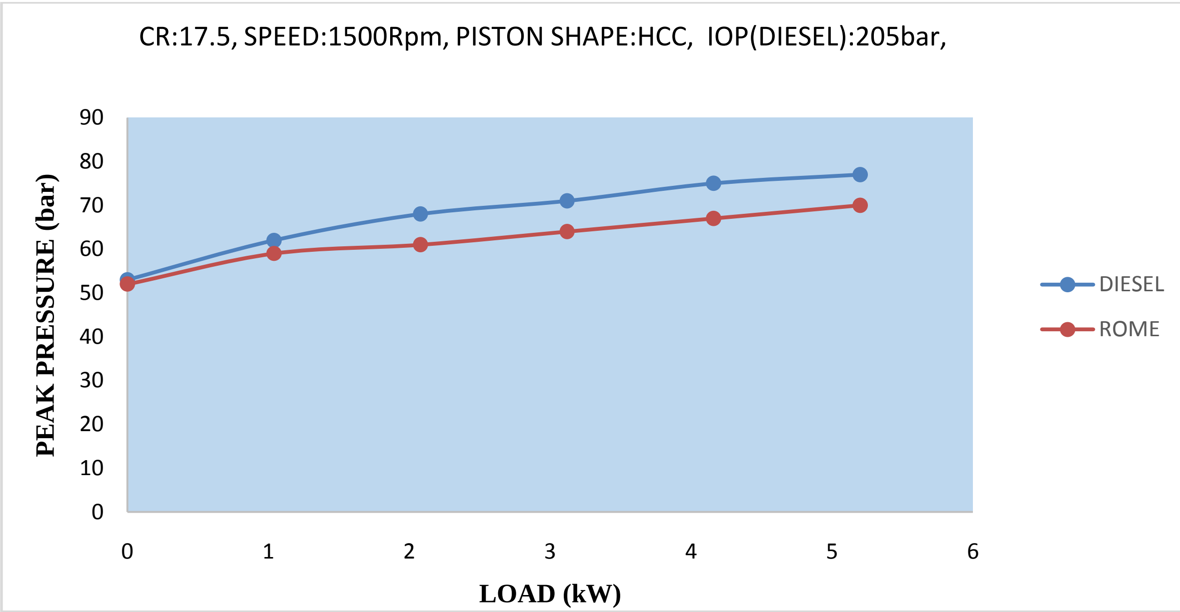

Fig: Variation of Peak Pressure with Load

Figure shows variation of peak pressure rise with load.The peak pressure for diesel opeartion is more compared to ROME. Reason is that the heat realse rate is high enough since the energy value is more for diesel compared to ROME and the values are 77 bar& 70 bar at 100% load respectively.

4. **Smoke emission**

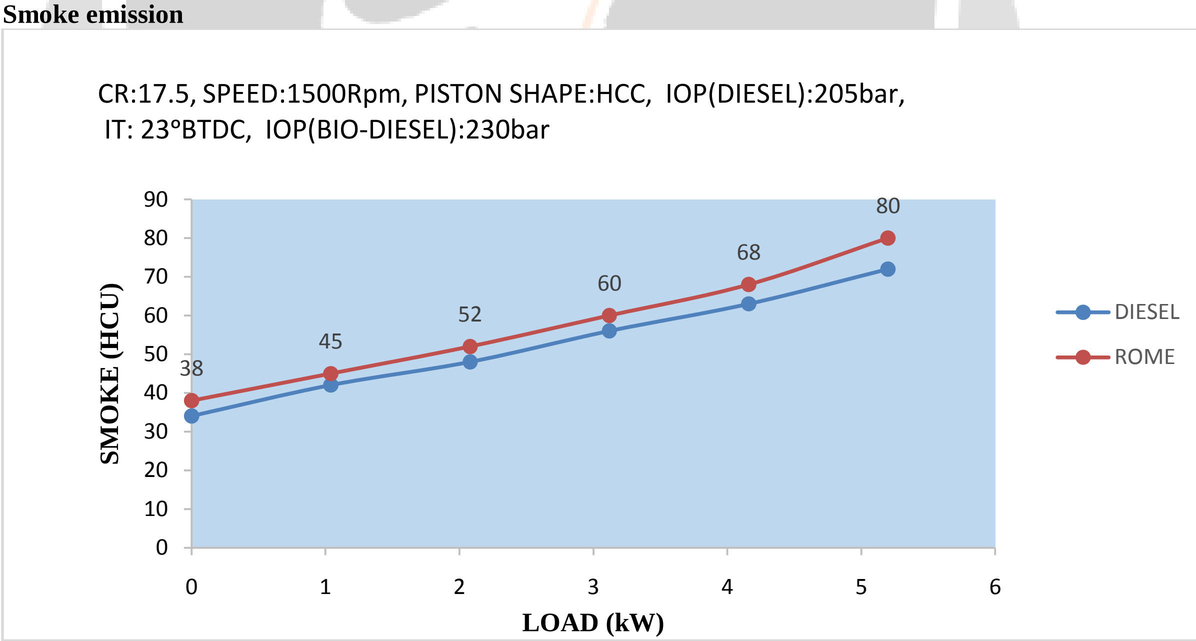

Fig: Variation of Smoke with Load

Figure indicates the variation of SMOKE with load for entire load range. The smoke emission for ROME oil is higher than diesel. The main reason for this is higher free fatty acid content and heavier molecular structure of vegetable oils which results in poor atomization and this leads to higher smoke emission. Smoke level at maximum power (100% load) is 72 HSU for diesel and 80 HSU for ROME.

5. **HC Emissions**

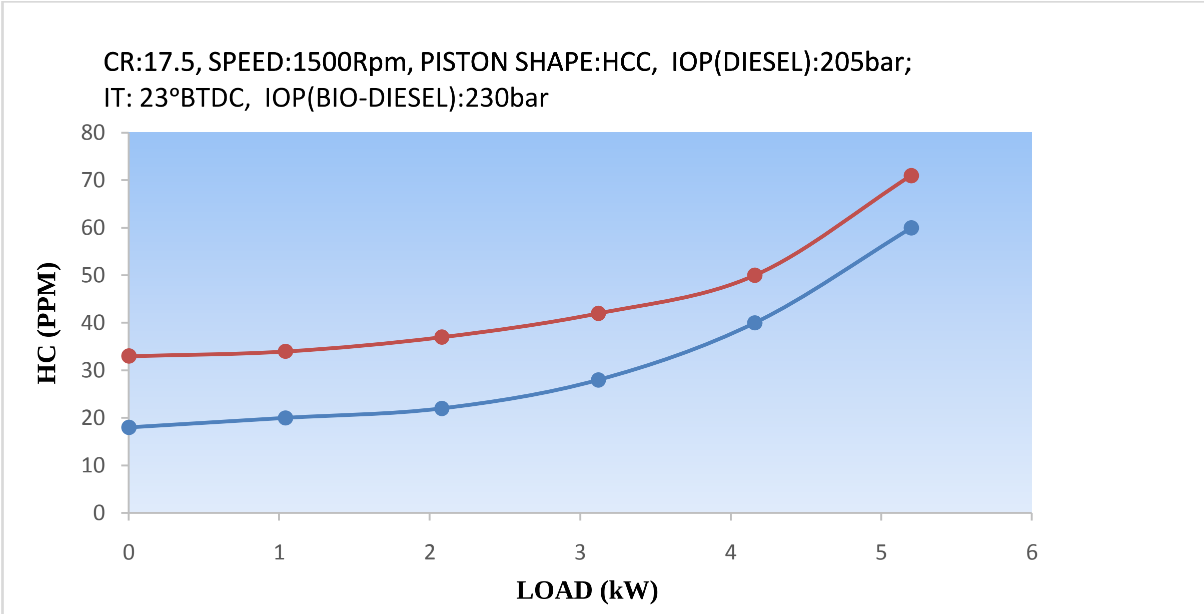

Fig: Variation of HC with Load

Figure indicates the variation of HC for entire load range. The HC emission for ROME is higher than the diesel. The main reason for HC emission is incomplete combustion due to poor mixture formation tendency of Rice bran oil methyl ester that leads to high hydrocarbon emissions. At full load the values of HC for diesel and ROME are 60 PPM and 71 PPM respectively.

6. **CO Emissions**

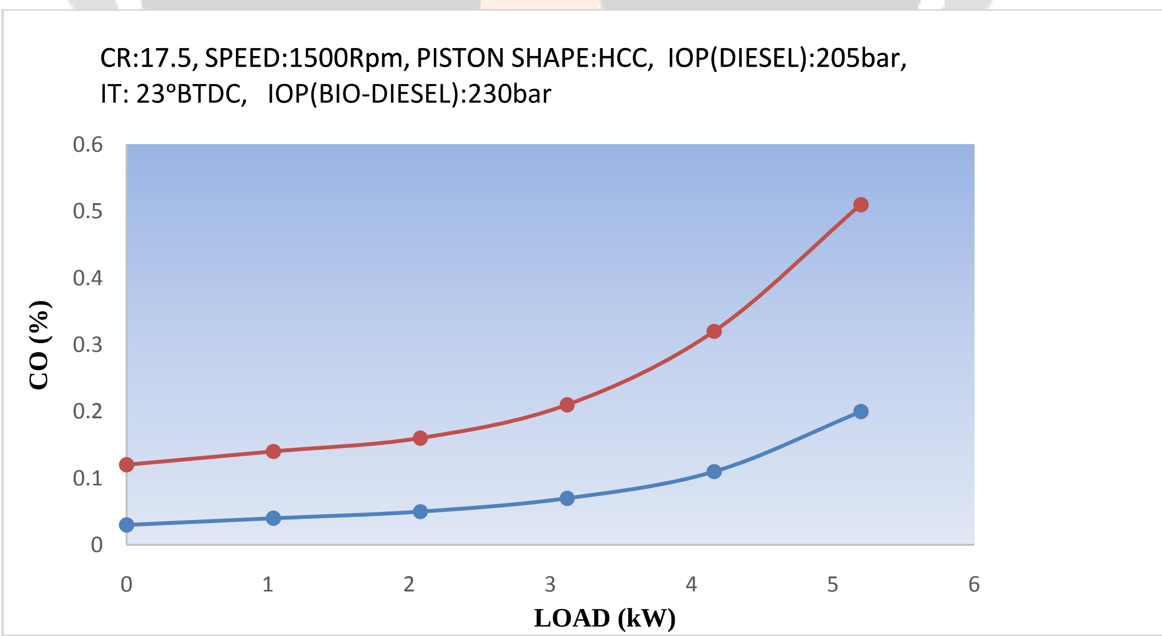

Fig: Variation of CO with Load

Figure indicates the variation of CO for entire load range. The reason for CO emission is incomplete combustion. Even though oxygen atoms may be present in the biodiesel still it's not high enough to produce complete combustion due to improper mixing of atomized fuel and high pressure air. And also from graph it is clear that atfull load (100%) CO increases rapidly due to reduced air volumetric efficiencyat top load. the values of CO for diesel and ROME are 0.2% and 0.51% respectively at 100% load.

7. **NO_X Emission**

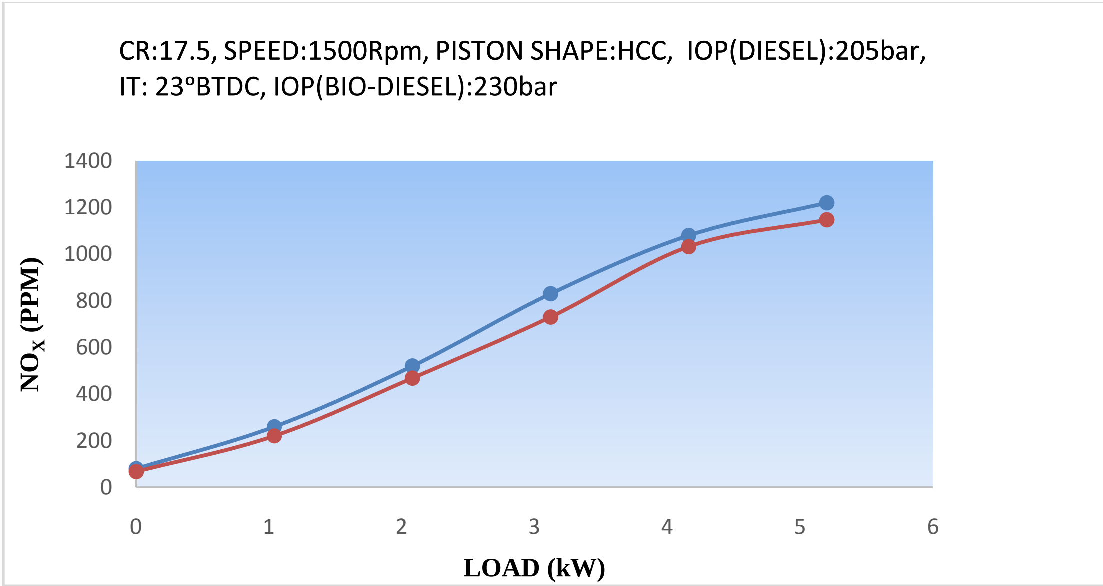

Fig: Variation of NO_X with Load

Figure indicates the effect of brake power on nitrogen oxides emissions. It was observed that NO_X emissions were higher for diesel operation compared to vegetable oils. This NO_X is a temperature dependent factor and therefore, for any fuel operation, the higher NO_X emissions may be due to higher temperature of the combustion chamber so while operating engine with standard diesel operation there is a release of high heat rate during premixed combustion phase which is high enough to produce high temperature in combustion chamber. Nitrogen oxides emission value is 1147 ppm for ROME compared to 1120ppm with diesel operation at 100% load.

IV. CONCLUSION

From test results the following conclusions are made, the brake thermal efficiency of diesel was higher than ROME.The brake specific fuel consumption of diesel was lower than ROME.Peak pressure rise of diesel was higher than ROME.Smoke emission of diesel was lower than ROME.HC emission of diesel was lower than ROME.CO emission of diesel was lower than ROME.NO_Xemission of diesel was lower than ROME.

REFERENCES

1. Umesh T., Manjunath H. N., Rukmangadha P., Dr. Madhu D., "Experimental Study of Performance &Emission Analysis of Rice bran oil as an Alternative fuel for an I.C.Engine", IOSR Journal of Mechanical andCivil Engineering (IOSR-JMCE), Volume-11, Issue-4, Pages 130-134, 2014.
2. Jasanpreet Singha, Narinder Kumarb, S. K. Mahlac, "Rice Bran Oil Biodiesel as an Alternative in SingleCylinder CI Engine with DI Ethyl Ether Blends", International Journal of Emerging Science and Engineering(IJESE), Volume-1, Issue-12, Pages 31-34, 2013.
3. Dhanesh C., Arunkumar G., Anantha Raman L., Vivek M., Santhoshkumar A., "Rice Bran Oil Biodiesel: analternate fuel for CI engine", Indian Journal of Engineering, Volume-4, Number-10, Pages 28-30, 2013.
4. Hariram V., Shanil George Chandy, "Influence of injection timing on combustion and heat releaseparameters using biodiesel of Neem, Rice bran and Pongamia in a direct injection compression ignition engine",International Journal of Engineering and Science, Volume-2, Issue-11, Pages 36-43, 2013.

5. Sharanappa Godiganur, R. P. Reddy, "Performance and emission study of rice bran oil methyl ester in a 4-stroke natural aspirated direct injection diesel engine", CHEMXPRESS 1(1), 2012.
6. Wahome A., Ngunjiri G. M. N., Shitanda D., Ogola W. O., "Performance Characteristics of Blended RiceBran Biodiesel In a Diesel Engine", International Journal of Engineering Science Invention, Volume-2, Issue-5,Pages 35-41, 2013.
7. Sunil I. Patel, Dipak C. Gosai, Vandana Y. Gajjar, "Performance and Exhaust Emission Analysis ofThermal Barrier Coated Diesel Engine Using Rice Bran Oil Biodiesel", International Journal of Engineering andAdvanced Technology (IJEAT), Volume-2, Issue-4, Pages 734-739, 2013.
8. S. S. Naga Prakash Chokka, Y. Dhanasekhar, M.V.H. Satish Kumar, "Study, Analysis of Performance andEmission Characteristics of Transesterificated Biodiesel-An Experimental Approach with Diesel-Rice BranBiodiesel Blends", International Journal of Engineering Research & Technology (IJERT), Volume-4, Issue-1,Pages 69-74, 2015.
9. G. Venkata Subbaiah, K. Raja Gopal, Syed Altaf Hussain, B. Durga Prasad & K. Tirupathi Reddy, "RiceBran Oil Biodieselasan Additivein Diesel-Ethanol Blends for Diesel Engines", IJRRAS 3 (3), Pages 334-342,2010.