Impact of Ricebran Oil and Diesel Mixture on Engine Performance in A Four Stroke Single Cylinder Engine with Dimethyl Carbonate as an Additive

[1]M. ADINARAYANA REDDY, [2]Dr.M.YOHAN

[1]PG Research scholar, Dept. of Mechanical Engineering (AICE), JNTUA College of Engineering, ANANTAPUR, AP., India., adinarayanareddy301@gmail.com

[2]Professor, Dept. of Mechanical Engineering , JNTUA College of Engineering, ANANTAPUR, AP, India, yohan.jntua.me@gmail.com

ABSTRACT - The energy consumption of the world has been increasing with industrial growth. The fossil fuels are depleting rapidly due to limited reserve and also population. Also various problem of discharge emission (CO, CO2, NOx, Soot, HC, etc.,) of pollutant gases in environment is major issue. In the view of fast depleting of conventional fuels leads to search alternative fuels has become inevitable. Rice bran oil is the best physical characterized with diesel. Higher viscosity is a major issue with vegetable oils which can be decreased by converting it into biodiesel by the process of Trans-esterification.

In this Project the rice bran oil which is high Cetane biomass derived fuel with diesel in different proportions (B05,B10,B20,B30,B40) and with additive DMC (500mg,1000mg) by volume and used as fuel in four stroke single cylinder diesel engine. The performance and emission characteristics of the engine were investigated. The experimental results shows reduction in consumption of fuel as the brake specific fuel consumption was found to decreased by 2% by volume for B20 and 4% by volume for B20+500mgDMC at maximum loads. Brake thermal efficiency improved nearly 2% compared to diesel at different volume of fuel with added additive DMC B20+500mg and also the factor affecting engine performance using biodiesel like engine wear, engine power, deposits, and clogging were studied.

Key words: 4-stroke diesel engine, Rice bran oil and diesel mixture, Trans-esterification, DMC-Dimethyl Carbonate.

I. INTRODUCTION

Fossil fuels have always been the main source of energy for the power production and transportation sector. Rapid increase in the vehicle population every year which will demands increase in crude oil imports. Due to limited reserve of petroleum products the steep hike in the price of crude oil. The continuous rise in prices of diesel fuel and increasing exhaust emissions leads to a major threat to environment. The environment pollution and supply of crisis fuel have adversely impacted in the developing countries like India. An enormous increase in environment pollution due to exhaust emissions polluted by diesel engines which demand strictly emission parameters has been implementation in our country. For long term energy security to search new alternative fuels is necessary. By Experimental research papers and several studies need for alternative fuel and additive which reduces exhaust emissions (co,co_2,hc,no_x,soot,etc.,) and improves engine properties. Bio diesel is the best alternative fuel which is directly replaced with diesel. Bio diesel is mono alkyl esters of long chain fatty acids mainly gleaned from the sources of vegetable oils, animal fats and algae. Vegetable oils are most promising alternative fuel for diesel engines. Rice bran oil is one of the most promising alternative fuel for diesel engine which offers advantage over diesel physical properties. Rice bran oil is famous for cooking and making frying at high temperature. Rice bran oil is inexpensive, non-conventional. Paddy is the largest cultivated crop in India and India is second largest producer of rice in world. Vegetable oils has major limitation is high viscosity which can be reduced by Trans-esterification. Due to high viscosity incomplete combustion, low volatility causes poor atomization, deposits of carbon content and clogging more wear and tear which was influenced in engine efficiency, fuel consumption, engine life, and engine exhaust emissions. From these suitable additive can be used to improve engine parameters in different proportions. Rice bran oil has high cetane number which can affect improvement in efficiency and absence of sulphur content compared with diesel fuel. The experimental investigation is carried out with diesel fuel and rice bran oil and adding DMC as an additive by different volume ratios.

 DOI : 10.18231/2454-9150.2018.0651

II. LITERATURE REVIEW

Banapurmath and Tewari[1] carried out Performance and emission characteristics of DI diesel engine operated on Honge, and methyl ester reported that Honge oil and blends of its esters mixed with diesel fuel at different volume ratios and used in single cylinder and multi cylinder water cooled diesel engines concluded B20 improves thermal efficiency and emissions reduces by using different pressure ratios of fuel mixture.

Sivakumar D.B.[2] carried out performance Evaluation with Rice bran oil in single cylinder diesel engine reported formation of rice bran oil into bio diesel in trans-esterification process and carried out in engine with different blends BSFC is decreased and emission parameters improved.

Gaurav Dwivedi[3] carried out Experimental study on Impact of Biodiesel and its blends with wood alcohol and diesel blends results B100 was 14.85% more than diesel and thermal efficiency are same with diesel.

R.Madhukumar[4] carried out study of combustion characteristics of rice bran oil in diesel engine reported that from evaluation and comparison of various types of fuels in diesel engine rice bran oil is suitable for running diesel engine and straight rice bran oil emits more pollutants compared to all other blends it can be used as fuel only with modification.

G.Venkata subbaiah, Syed Altaf Hussaian[5] carried out Rice bran Oil as an additive in Diesel-Methonol blends for diesel engine results that maximum brake thermal efficiency is 28.2% with the blend is B10E15 and BSFC is higher compared with diesel fuel and co emissions lower than diesel, HC emissions slightly increases with increasing maximum loads on engine.

Siddharth Jain [6] dispensed review study on Prospects of biodiesel from Jatropha in Asian nation. It has been found that Bio-diesel scores is nice possibility as Associate in Nursing alternate fuel of alternative because it helps in decreasing dependence on fossil – fuels and conjointly because it has nearly no sulphur. Higher cetane of biodiesel as compared to petro diesel implies it's a lot of improved combustion profile in an inside combustion engine. The waste material elements from exhaust are shrivelled by mistreatment biodiesel

The main aim of this study is to evaluate the performance and emission characteristics of diesel engine fuelled with various blends of Rice bran oil, Rice bran oil and additive DMC with diesel. The results showed that enhance increase in brake thermal efficiency at B20+500mgDMC and emissions such as CO and HC are reduced and NO_x slightly increased compared to diesel.

III. MATERIALS AND METHODS

3.1. RICE BRAN OIL (RBO)

Rice bran oil is a by product of the rice milling process (the conversion of brown rice into white rice), and it contains various antioxidants. Paddy is the India largest cultivated crop. Rice bran oil is extracted from the germ and inner husk of rice. Crude rice bran oil contains high fatty acids and by products which can reduced by refining process. Rice bran oil manufacturing process mainly includes expelling, extraction and refining. The crude RBO has high viscosity which undergoes trans-esterification process to convert into Rice bran oil biodiesel and the biodiesel is the oxygenated fuel which contains oxygen as a compound while combustion it helps complete combustion and emissions reduced.

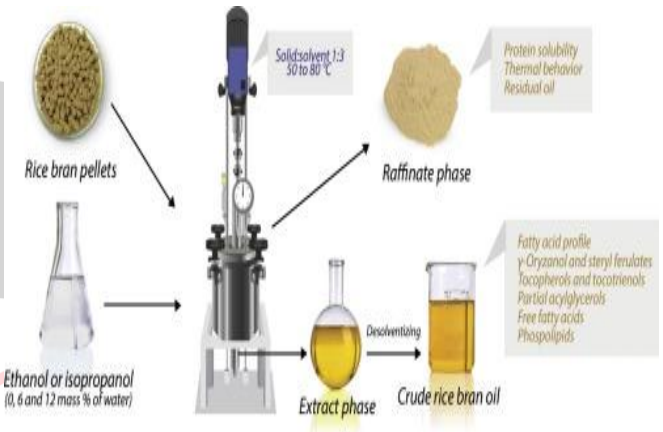

Figure 1: Rice bran oil manufacturing

3.2. TRANS-ESTERIFICATION

Rice bran oil cannot be used directly in engine due to high viscosity and containing free fatty acids which are difficult to react. So convert crude or refined rice bran oil into rice bran oil biodiesel (methyl ester) by reacting oil (Triglyceride) with methanol in the presence of NaOH to produce methyl ester and separates glycerol.

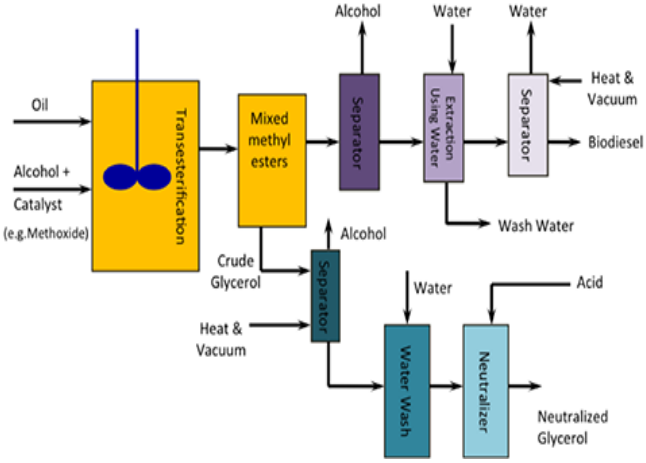

Figure 2: Trans-esterification process

3.3. DIMETHYL CARBONATE (DMC)

Fuel additives are chemical substances which are added to diesel fuel and its blend improves some properties. Dimethyl carbonate is an organic compound with chemical formula $C_3H_6O_3$ and it is colourless and flammable liquid. DMC improves thermal efficiency and reduces emissions.

 DOI : 10.18231/2454-9150.2018.0651

Properties of DMC

Chemical Formula	$C_3 H_6 O_3$
Density (g/ml)	1.70
Viscosity(mm^2/sec)	0.625

3.4. PROPERTIES OF BIO DIESEL

3.4.1 Properties of fuels

Property	Rice bran oil	Diesel
Density (kg/m3)	908	840
Kinematic Viscosity @40°C (cSt)	4.35	2.86
Flash Point (°C)	162	56
Fire Point (°C)	168	63
Calorific Value (kJ/kg)	39585	43000

3.4.2. Properties of Biodiesel blends

Property	B05	B10	B20	B30	B40
Density (kg/m^3)	848	857	863	869	876
Kinematic viscosity @40°C (cSt)	3.2	3.31	3.39	3.43	3.49
Flash Point (°C)	50	53.5	56.5	61	62.5
Fire Point (°C)	53	56	58.5	63	64
Calorific Value (kJ/kg)	42482	42198	41984	41536	41117

3.4.3. Properties of Biodiesel blends with adding additive DMC

Property	B20+500 mgDMC	B20+1000 mgDMC
Density (kg/m3)	864.2	864.8
Kinematic Viscosity @40°C (cSt)	3.4	3.41
Flash Point (°C)	56.8	57
Fire Point (°C)	59	59.2
Calorific Value (kJ/kg)	41964	41872

Blends used

1. B05 (5% of Rice bran Oil + 95% of Diesel)
2. B10 (10% of Rice bran Oil + 90% of Diesel)
3. B20 (20% of Rice bran Oil + 80% of Diesel)
4. B30 (30% of Rice bran Oil + 70% of Diesel)
5. B40 (40% of Rice bran Oil + 60% of Diesel)
6. B20+500mgDMC (20% of Rice bran Oil + 80% of Diesel + 500mg of DMC)
7. B20+1000mgDMC (20% of Rice bran Oil +80% of Diesel +1000mg of DMC)

IV. EXPERIMENTAL SETUP

The experimental study was carried out on Single cylinder four stroke water cooled C.I. engine to investigate performance and emission characteristics of engine with rice bran oil biodiesel, adding additive and diesel. The experimental setup consists of water cooled vertical axis Kirloskar engine, mechanical loaded rope brake dynamometer coupled with engine, fuel consumption measuring equipment, and emissions measuring equipment exhaust gas analyzer. The experimental setup and engine specifications mentioned below figure 3.

Figure 3: Experimental setup

The engine was operated first on diesel fuel at different load conditions at rated speed of 1500rpm and then different blends of biodiesel and adding additive at different volume proportion test was conducted by varying load conditions at constant speed. With the noted readings at each stage of different loads are used to compare performance and emission characteristics of engine.

Table : Engine Specifications

S.No.	Parameter	Specification
1	Engine Type	Vertical, 4- Stroke
2	No. Of Cylinders	01
3	Ignition Type	Compression Ignition
4	Cooling Type	Water Cooled
5	Bore(D)	80mm
6	Stroke(L)	110mm
7	Rated Speed	1500 Rpm
8	Rated Power	3.7 Kw
9	Compression Ratio	16.5:1

 DOI : 10.18231/2454-9150.2018.0651

V. RESULTS AND DISCUSSIONS

5.1. Performance Characteristics

5.1.1. Brake Thermal Efficiency

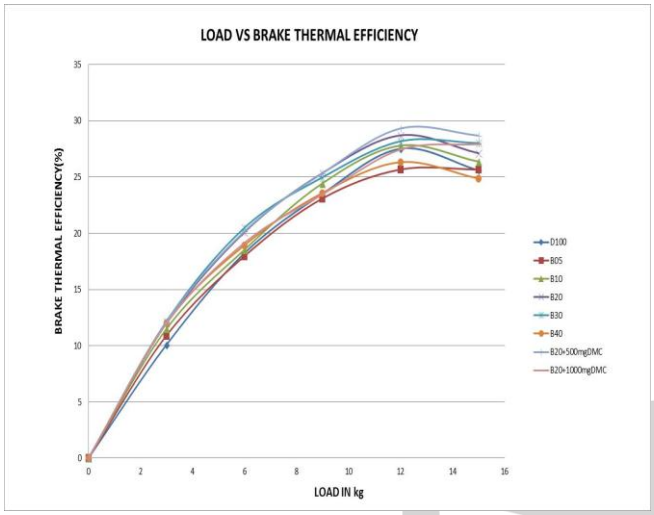

Figure 4: Load vs Brake thermal Efficiency

Above figure shows that brake thermal efficiency increased maximum with the blend B20+500mg compared to diesel. The efficiency of B20 increased 1.2% at 70% of load compared to diesel but at full load slight fall down in efficiency due to incomplete combustion and high viscosity. B20+500mgDMC indicated that nearly 2% of efficiency increased at 70% of load conditions compared to diesel fuel. Due to homogeneous mixture and proper combustion leads to improvement in thermal efficiency

5.1.2. Brake Specific Fuel Consumption

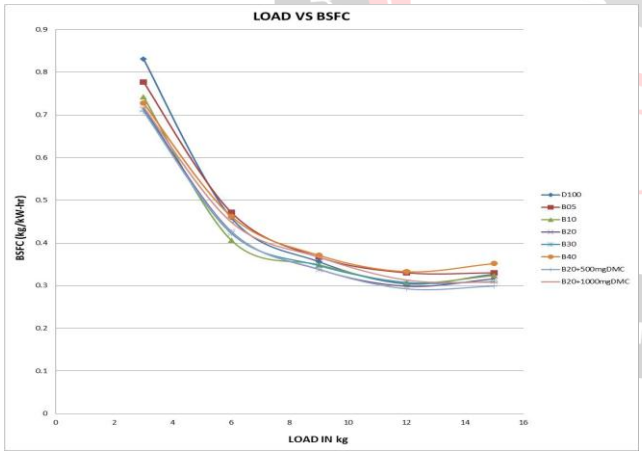

Figure 5: Load vs BSFC

Above figure shows that BSFC decreases with varying load by changing bio diesel volume, as results that B10 and B30 are closer to diesel at 70% of load variation and B20 BSFC is decreased as increasing load. Adding additive blends for B20+500mgDMC of BSFC is decreased by 0.0117 kg/kWhr at maximum load conditions. Adding additive gives the decrease in the BSFC at full load condition by varying the proportion of rice bran oil.

5.2. Emission Characteristics

5.2.1. CO Emissions

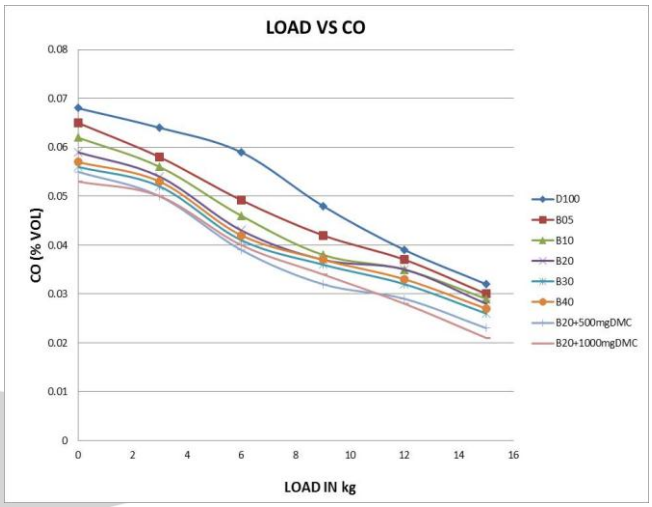

Figure 6: Load vs CO emissions

From Above figure it is clear that CO emissions is decreased due to complete combustion and large availability of oxygen content in biodiesel, so at high temperature leads to proper combustion. B20 shows that 15% of decreases CO and added additive B20+500mgDMC, B20+1000mgDMC shows that 20% and 25% decreased compared to diesel.

5.2.2. CO_2 Emissions

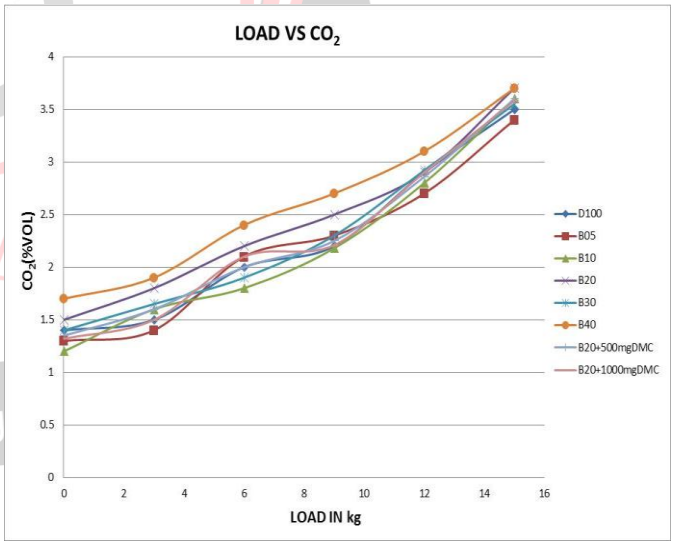

Figure 7: Load vs CO_2 Emissions

From the Above figure it is clear that CO_2 emissions are slightly increased at full load condition compared to diesel fuel due to incomplete combustion at full load with high temperatures and high viscosity of fuel. At minimum load (below 50%) CO_2 decreased for the blends B10, B20+500mgDMC and B20+1000mgDMC by 0.1% vol lesser than that of diesel. Large availability of oxygen at high temperature forms CO_2 emissions.

 DOI : 10.18231/2454-9150.2018.0651

5.2.3. HC Emissions

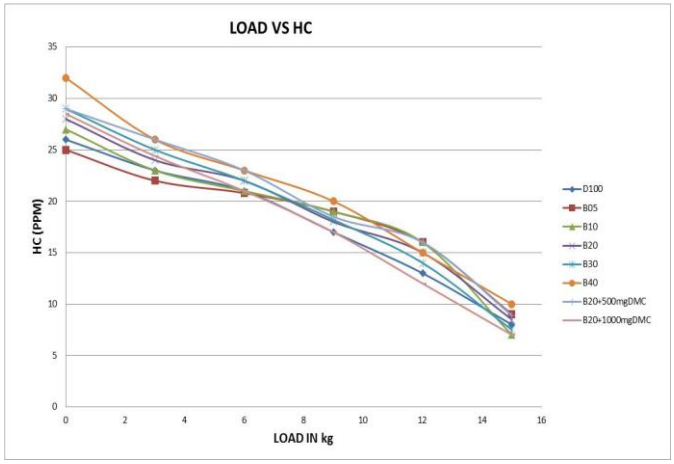

Figure 8: Load vs HC Emissions

Above figure shows that HC emissions of blends increased by increasing loads. The emissions of B20+1000mgDMC were decreased at maximum load compared to diesel. Due to incomplete combustion at high temperatures gives unburnt hydro carbons. B10, B20+500mgDMC and B30 are closer and slight decrease HC emissions at maximum load conditions.

5.2.4. NO_x Emissions

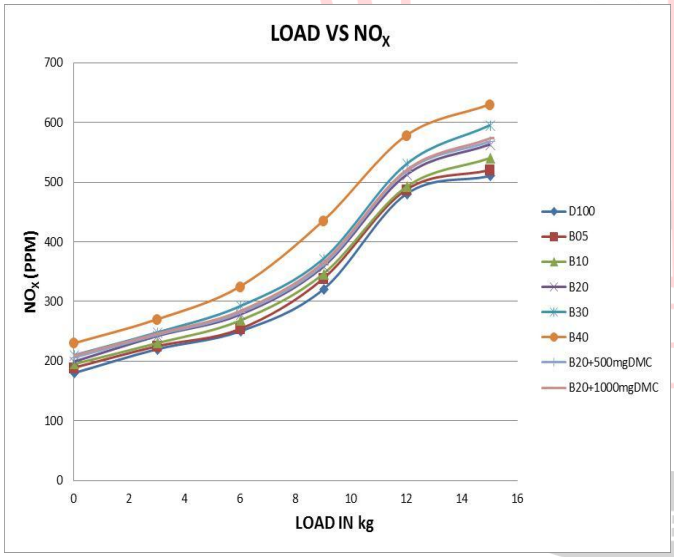

Figure 9: Load vs NO_x

Above figure shows that formation of NO_x emissions due to heat transfer rate and evaporation rate of fuel. NO_x emissions of biodiesel blends are increased from no load to maximum load condition compared to diesel due to large availability of oxygen content and higher temperatures. But by adding DMC it shows that compared B20, B20+500mgDMC and B20+1000mgDMC were gives small ppm reduction of NO_x emissions at maximum loads.

VI. ANALYSIS

The experiments were carried out with Rice bran oil biodiesel and DMC as an additive on four stroke single cylinder diesel engine has been studied and investigated the performance and emission characteristics. The following conclusions are drawn,

- The fuel properties like density, kinematic viscosity of B10&B20 are measure terribly closer to diesel, which can be easily substitute for diesel.
- The brake thermal efficiency increased nearly 2% and 1.2% for B20+500mgDMC and B20 respectively with compared to diesel.
- The blend B20 and B20+500mgDMC of biodiesel shows 0.0056 and 0.0117 lower than diesel at maximum load conditions. Blends B10, B30 and B20+1000mg are closer to diesel.
- CO emission were slightly decreased with increase of percentage of blends and increasing loads it found that blend B20 gives 15% vol lesser than diesel and blend B20+500mgDMC gives 20% vol lesser than diesel and blend B20+1000mgDMC gives 25% lesser than diesel.
- CO_2 emissions of blends were decreased at minimum load and slightly increased at maximum load compared with the diesel. B20+1000mgDMC emissions are 0.1% vol lesser than diesel at minimum load conditions.
- HC emissions are slightly increased compared with diesel and the blends B10,B30 and B20+500mgDMC emissions are closer and slightly lower than diesel at maximum loads
- NO_x emissions of biodiesel blends were increased by increasing load conditions and additive DMC proportion increases might be decreased emissions compared blends.

VII. CONCLUSIONS

This experiment concluded that RBO is an environmental friendly fuel and adding additives to this biodiesel blends will reduce emissions to a sufficient level and also the engine performance enhances to some extent compared to diesel. Hence RBO as biodiesel can be used as an alternative for diesel in all the industry applications. Research in future can be done on the RBO by adopting advanced techniques in purification and extraction of biodiesels which decrease the pollutants once the biodiesel is used. Further research can also be done by increasing the additive contents and also pure biodiesel without mixing diesel as a blend can be tested for the performance and emission characteristics.

REFERENCES

[1] Banapurmath, N.R., Tewari, P.G. and Hosmath R.S. (2008), "Performance and Emission Characteristics of a DI Compression Ignition Engine Operated on Honge, Jatropha and Sesame Oil Methyl Esters".

[2] Sivakumar d.b., T.Senthil kumar (2009), "Performance evaluation of a single cylinder diesel Engine fuelled with rice bran oil as alternative fuel". IJEPCM.

 DOI : 10.18231/2454-9150.2018.0651

[3] Gaurav Dwivedi, Siddharth Jain, M.P. Sharma, 'Impact of Biodiesel and its Blends with Diesel and Methanol on Engine Performance'- International Journal of Energy Science Vol.1 No.2 2011 PP.105-109.

[4] V.Nageswar Reddy, R.Madhu Kumar, R.Vidya sagar Raju "Performance tests and study of combustion characteristics of Rice Bran Oil as a CI Engine Fuel" Vol 3, 2014, International Journal of Engineering Research.

[5] G. Venkata subbaiah, Syed Altaf Hussain, B.Durga Prasad "Rice bran oil biodiesel as an additive in diesel-ethanol blends for diesel engines"-IJRRAS.

[6] Siddharth Jain dispensed review study on Prospects of biodiesel from Jatropha in Asian nation.

[7] Bhattacharyya, D.K., M.M. Chakrabarty, R.S. Vaidyanathan, A.C Bhatachryya, (1983), A Critical Study of The Refining of Rice Bran Oil, J. Am. Oil Chem. Soc, 60: 467-471.

[8] Agarwal, A. K. (2007), Biofuels (Alcohols and Biodiesel) Applications as Fuels for Internal CombustionEngines. Prog. Energy and Comb. Science, 33, 233-271.

[9] Subhan Kumar Mohanty "A Production of biodiesel from rice bran oil and experimenting on small capacity diesel engine" Vol3.2013 International small capacity small capacity diesel engine" Vol.3. 2013,International Journal For Modern Engineering Research.

[10] Dhruva D, 2,Dr. M C Math '' Investigation of Fuel Properties of Crude Rice Bran Oil Methyl Ester and Their Blends with Diesel and Kerosene''-International Journal of Engineering Science Invention ISSN (Online): 2319 –6734, ISSN (Print): 2319 – 6726 www.ijesi.org Volume 3Issue 6‖ June 2014 ‖ PP.04-09.

[11] Selim M Y E, Radwan M S & Elfeky S M S, "Combustion of jojoba methyl ester in an indirect injection diesel engine", Renewable Energy, 28 (2003) 1401-1420.

[12] B.K.Venkanna, C. Venkataramana Reddy, Swati B Wadawadagi "Performance, Emission and Combustion Characteristics of Direct Injection Diesel Engine Running on Rice Bran Oil / Diesel Fuel Blend"-International Journal of Mechanical and Mechatronics Engineering Vol:3, No:3, 2009.

[13] Puhan. S, Vedaraman. N,Sankaranarayanan G, Ram BVB.(2015) "Performance and emission of Mahua oil ethyl ester in a 4-stroke natural aspirated direct injection diesel engine". Energy Sources, Part A: Recovery, Utilization and Environmental Effects. Volume 37, 2015 – Issue 14

 DOI : 10.18231/2454-9150.2018.0651