Performance Analysis of Diesel Engine using Biodiesel for Variable Compressible Ratio

[#1]**Mr. Sandip S. Shelkar**, [#2]**Prof. N.C.Ghuge**

[#1]**PG student,** Matoshri College of Engineering and Research Centre, Eklahare, Nashik, Maharashtra, India
[#2]**Project guide,** Matoshri College of Engineering and Research Centre, Eklahare, Nashik, Maharashtra, India

Abstract— With high technological advantage and modernization, use of petroleum based fuel is increasing .But pertroeum based fuels are depleting in nature. They are not renewable as a result, demand is more than supply. Fuel cost goes on increasing day by day. Besides availability of cost, environmental issues are very important; pollution caused by this fuel is destroying life of ecosystem. Thus there is a need to search alternative fuel to petroleum based oil.

In India, Jatropha, Soyabean and Karanja is used as a significant fuel source. These vegetable&non-vegetable based oils have drawn the attention of researchers in recent time, as a high potential substrate for production of biodiesel. The petroleum products play on important role in our modern life. The costs of these products depend on international markets and petroleum reserves are limited to nearly 30 years. India is projected to become the third largest consumer of transportation fuel in 2020, after the USA and China, with consumption growing at an annual rate of 6.8% from 1999 to 2020.

Vegetable based fuel have great potential as they are enviro-friendly. This paper focus on the use of Jatropha,Soyabean and karanja as alternative fuel and their comparative performance result shows that this vegetable based fuel has better performance and emission characteristic to compared diesel

Keywords— Jatropha, Soyabean and karanja ,fuel properties, blends, Diesel Engine test rig, performance, emissions.

I. INTRODUCTION

In 2005, India consumed 30 million tons of oil in the transport sector, of which 29% was gasoline and 71% was diesel. The Indian energy demand is expected to grow at an annual rate of 4.8% over the next couple of decades. It has been projected that India will double its oil consumption, at least, by 2030, when India will become the third largest oil consumer in the world. Bio-fuel production could, therefore, potentially play a major role in this respect.

The trials with such blends are on-going in various states of India. The governmentof India has set a target to increase the blend of biofuels and diesel to 20%by 2017.

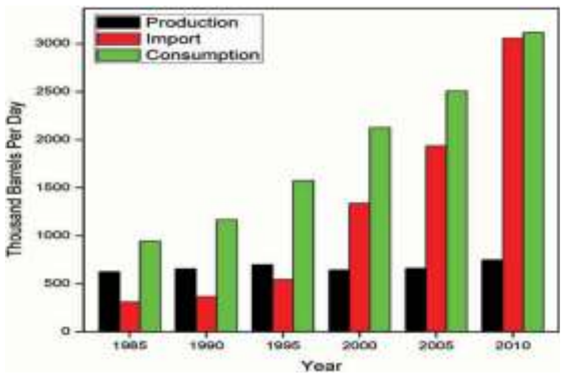


Fig. No.-1.1 Production, importation, and consumption of crude oil in India.

Jatropha curcas has drawn the attention of researchers in recent times as a high potential substrate for production of biodiesel. However, like many other substrates, fuel properties of its biodiesel vary with such factors as growing and climatic conditions. Since the last few decades, researchers world over have been trying to find new alternative fuels that are available, technically feasible, economically viable and environmentally acceptable. Biodiesel as an alternative fuel is one of the best alternatives among other sources due to its high potential to reduce levels of emissions such as HC, CO and smoke when used in engines, in addition to being renewable and biodegradable.

© 2015, IERJ All Rights Reserved

1.2 Motivation-

PCRA (Petroleum Conservation and Research Association) has reported that the world's available fossil fuel reserves may deplete in coming 50-79 years. Such reserves are concentrated in certain regions that are vulnerable to political, economic, social and military instability which could potentially pose serious problems in future.
In world, 1st largest in democracy ,7th largest by area and number 2 position in population we are having and at the same depend on gulf country for mineral fuel. Such Gulf countries are violent may not be supply fuel in future so we should prepare for the alternative. Second thing the acid rain, global warming and health hazards are the results of ill effects of increased polluted gases like SOx, CO and particulate matter in atmosphere.
Rising petroleum prices, increasing threat to the environment from exhaust emissions and global warming have generated an intense international interest in developing alternative non-petroleum fuels for engines.

1.3 Objective-
The objective of this work is
1] To investigate performance characteristicsuch as thermal efficiency, and brake specific fuel consumption of biodiesel from Jatropha ,Soyabean and Karanja Oil blends 0n variable compression ratio.
2] To compare performance characteristic of biodiesel fuel to diesel.
3] To estimate Emission of HC, NOx, CO, and smoke of the exhaust gas measured.

1.4 **Literature Review-**

1] Shashi Kumar Jain, Technical Sustainability of Jatropha Biodiesel and its blends with diesel, Properties of jatripha biodiesel have been compared with properties of petro-diesel; showing a comparable regime for satisfactory performance of CI engine with biodiesel.
2**] Y. V. Hanumantha Rao , Andhra Pradesh**.
The fuel properties of Jatropha biodiesel such as kinematic viscosity, calorific value, flash point, carbon residue and specific gravity were found. Results indicated that B25 has closer performance to diesel and B100 has lower brake thermal efficiency, mainly due to its high viscosity compared to diesel.
3] Belachew Tesfa et al (2014), in their paper, the effects of biodiesel types and biodiesel fraction on the emission characteristics of a CI engine were study. The results also clearly indicate that the engine running with biodiesel and blends have higher NOx emission by up to 20%.
4]An *et al.* (2013) study on the performance and combustion characteristics of biodiesel and its blend fuels shows that biodiesel/blend fuels have high break specific fuel consumption of about 42% at 25% engine load and low engine speed. There was an increase in brake thermal efficiency of biodiesel compared to pure diesel at 50% and 100% load.
5] **Mayank Chabra, Noida-**Soyabean oil with blends B15,B25,B35 and B45 and effects on brake power, specific fuel consumption ,brake thermal efficiency studied and the test report at B15 blends of bio diesel can act as alternative fuel.
6]F.K. Forson, Department of Mechanical Engineering- An experimental investigation was conducted to explore the performance of jatropha oil and its fuel blends with diesel in a direct-injection single-cylinder diesel engine and the results obtained -Pure jatropha, pure diesel and blends of jatropha and diesel oil exhibited similar performance and broadly similar emission levels under comparable operating conditions.. The jatropha oil has substantial prospects as a long-term substitute for diesel fuels. The 97.4% diesel/2.6% jatropha fuel blend competed favourably with diesel fuel and offers a reasonable, if not even a better, substitute for pure diesel fuel.
7]As per Jehad (2012), the use of waste, oil biodiesel has showed an increase of 4.75% in fuel density compared to pure diesel and also there was a 13.43% decrease in calorific value of fuel and 7.24% for unused oil biodiesel. The biodiesel showed improvement in the power, thermal efficiency, torque and reduction in the specific fuel consumption
8]**JiantongSong,Jiang Lv,China**,-Experimental study on a Diesel engine fuelled wit soyabean biodiesel,with increase the biodiesel in blends brake power ,torque and brake specific efficiency increases ,except B10 smoke efficiency decreases and NOx emission increases.
9]Vivek and A AK Gupta- Biodiesel Production from Karanja Oil- Pressure 1 atmospheric ,temperature 68-80 degree Celsius, Reactant ratio 8-10 of (MeOH:oil) Reaction time 30-40min,Catalyst (KOH) 1.5 per cent.
10]A G Matani Mukesh Mane,Amravati India- karanja Blends 10%20,30,40,and 100%diesel compared at different injection perssur 150bar,170bar and 210bar.as pressure increase the brake thermal efficiency also increases and brake specific fuel consumption is lowered as the injection pressure is increases.
11]**Journal of the Taiwan Institute of Chemical Engineers 44 (2013) 214–220**
Jatropha oil methyl esters (JMEs) produced from jatropha (Jatropha curcas) oil were blended with dieselat various volumetric percentages to evaluate the variations in the fuel properties. Correlations betweenfuel properties, including the calorific heat, cold filter plugging point, density, kinematic viscosity, andoxidation stability of the JMEs–diesel blends, and the blending ratio of the JMEs have been established.As a result, a blending ratio of the JMEs with diesel was recommended up to 40 vol.% in comparison withthe relevant specifications for biodiesel–diesel blends. The combustion tests of the JMEs–diesel blendswere performed in a diesel generator. Higher brake thermal efficiency and lower brake specific fuelconsumption were clearly observed with higher output loading. The concentration of carbon dioxide andnitrogen monoxide in the exhaust gas increased with higher output loading while the concentration ofoxygen and carbon monoxide decreased..
12]S.M. Ashrafur Rahman*, H.H. Masjuki, M.A. Kalam, M.J. Abedin, A. Sanjid, S. Imtenan-The purpose of this study is to evaluate fuel consumption and emissions parameters underhigh idling conditions when diesel blended with Jatropha curcas

© 2015, IERJ All Rights Reserved

biodiesel is used to operate a dieselengine. Although biodieselediesel blends decrease carbon monoxide and hydrocarbon emissions, theyincrease nitrogen oxides emissions in high idling modes. Compared to pure diesel fuel, fuel consumption
also increases under all high idling conditions for biodieselediesel blends, with a further increaseoccurring as blend percentage rises.

13]Lu-Yen Chen a, Yi-Hung Chen b,*, Yi-Shun Hung b, Tsung-Han Chiang b, Cheng-Hsien Tsai- Correlations betweenfuel properties, including the calorific heat, cold filter plugging point, density, kinematic viscosity, andoxidation stability of the JMEs–diesel blends, and the blending ratio of the JMEs have been established.As a result, a blending ratio of the JMEs with diesel was recommended up to 40 vol.% in comparison withthe relevant specifications for biodiesel–diesel blends. The combustion tests of the JMEs–diesel blendswere performed in a diesel generator. Higher brake thermal efficiency and lower brake specific fuelconsumption were clearly observed with higher output loading. The concentration of carbon dioxide andnitrogen monoxide in the exhaust gas increased with higher output loading while the concentration ofoxygen and carbon monoxide decreased.

14]**Venkata Ramesh Mamilla a, M.V.Mallikarjun b, Dr. G.Lakshmi Narayana Rao-**The experimental investigations on the effect of 20% Jatropha methyl esters (JTME) with diesel on performance, combustion andemission characteristics of diesel engine with different combustion chamber geometries (Spherical, toroidal and Re-entrant).Brakethermal efficiency for toroidal combustion chamber was found higher than that of other two combustion chambers. Smoke density, carbonmonoxide and hydrocarbons was observed slightly lower for toroidal combustion chamber compared to the other two but those are lowerwhen compared with standard diesel (SCC).

15]S. Premnath a,n, G.Devaradjane-Theobjectiveofthisresearchworkistoimprovetheperformanceand emission characteristicsofadieselengineinthemodified re-entrantcombustionchamberusingadiesel and Jatrophamethylesterblend(J20)atthreedifferentinjectionpressures.Fromtheliterature,itis revealedthattheshapeofthecombustionchamber and the fuelinjectionpressurehaveanimpactonthe performance andemissionparametersoftheCIengine.Inthiswork,are-entrantcombustionchamber with threedifferentfuelinjectionpressures(200,220and240bars)hasbeenusedintheplaceofthe conventionalhemisphericalcombustionchamberfordieselandJ20.Fromtheexperimentalresults,itis found thatthere-entrantchamberimprovesthebrake thermal efficiency ofdieselandJ20inallthe testedconditions.Itisalsofoundthatthe20%blendofJatrophamethylestershowed4%improvementin the brakethermalefficiency inthere-entrantchamberat themaximuminjectionpressur.

16]Dhandapani Kannan a,⇑, Senthilkumar Pachamuthu b, Md. Nurun Nabi a, Johan Einar Hustad a,Terese Løvås-It is found that blending of oxygenated fuels with diesel modifiesthe chemical structure and physical properties which again alter the engine operating conditions,combustion parameters and emissions levels. However, the injection of only 5% ethanol through portinjection allows for a total of 25% blending of biofuels into diesel yet keeping the fuel characteristics closeto that of conventional diesel. However, both experimental and numerical results show that ethanol additionin JME blended diesel results in a slight increase in fuel consumption and thermal efficiency for thesame power outputs as that of conventional diesel fuel.

17]S. Imtenan, H.H. Masjuki, M. Varman, M.A. Kalam, M.I. Arbab, H. Sajjad, S.M. Ashrafur Rahman-this experimental investigation was conducted to improve the blend of these twobiodiesels (20% biodiesel blend, named P20 and J20, respectively) with the help of oxygenated additives.The comparative improvement of P20 and J20 blends with ethanol, n-butanol, or diethyl ether as additiveswas evaluated in terms of performance and emissions characteristics of a four-stroke single cylinder dieselengine. The final blend consisted of 80% diesel, 15% biodiesel, and 5% additive. Tests were conducted at differentspeeds (1200–2400 rpm) at constant full load conditions. Use of additives significantly improvedbrake power and brake thermal efficiency (BTE).Compared with P20 blend, the use of diethyl ether asadditive increased brake power and BTE by about 4.10% and 4.4%, respectively, at 2200 rpm. A similar
Improvement was observed for J20.

II. EXPERIMENTAL SET UP

Single cylinder, four stroke, water cooled engine was used in the present study. The detailed specification of the engine is given below. The experimental set up consists of engine, dynamometer, load cell and temperature sensors etc. Eddy current-dynamometer was used for engine loading.

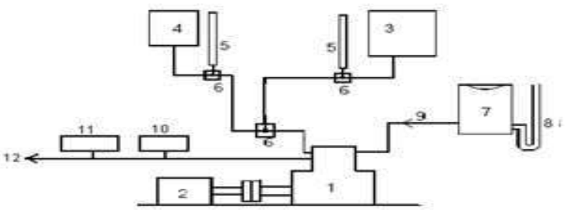


Fig No-4.1 Experimental setup of Single cylinder engine.

1. Engine	7. Air box
2.Brakedrum dynamometer	8. Manometer
3. Fuel tank (biodiesel)	9. Air flow direction
4. Diesel tank	10. Exhaust analyzer

© 2015, IERJ All Rights Reserved

5. Burettes 11. Smoke meter
6. Three way valve 12. Exhaust flow

The technical specifications of diesel engine are given below-
Manufacturer **: Kirloskar engines Ltd, Ambad, Nashik, India**
No of cylinders : One
Bore & Stroke : 80 & 110 mm
Power o/p : 5Hp
Speed : 1500 rpm
For comparison, the experimental plan for the engine tests were designed to run at constant speed of 1500 rev/min (rated power speed) at compression ratio of 16.5:1 To 18:1..There were no changes for the engine running parameters.

3. Blending(%) ,Calorific value(KJ/Kg) and Density(gm/ml)

Blending of soybean with diesel by volume basis shown Calorific Value and Density. in table given below-

Table no 3.1-Soya-diesel blends

% of Soybean in Diesel	Calorific value(KJ/Kg)	Density(gm /ml)
00	45000	0.87
10	44750	0.796
20	44350	0.804
30	43600	0.812
40	43050	0.819
50	42498	0.827
60	41200	0.839
70	40560	0.857
80	39360	0.853
90	38570	0.892
100	38000	0.924

3.1 Observation Table-

A] 90% diesel and 10% soybean with C.V. =44750 kJ/Kg
Table No 3.2 blend-90% diesel and 10% soybean

Load (Kg)	Speed(rpm)	B.P.	Time(sec)	Mf(Kg/Hr)	BSFC(MJ-Hrs)	Thermal Efficiency
0	1490	0.302	69	0.417	62.44	5.82
3	1475	1.077	57	0.505	19.84	17.13
5	1450	1.56	50	0.575	16.69	21.77
7	1430	2.032	45	0.642	14.24	25.52

© 2015, IERJ All Rights Reserved

10	1415	2.757	39	0.738	12.10	30.04
12	1380	3.221	35	0.822	11.55	31.54
15	1350	3.91	28	1.028	11.54	30.60

B] 60% diesel and 40% soybean with C.V. =43050 kJ/Kg.
Table No 3.3 blend-60% diesel and 40% soybean

Load (Kg)	Speed(rpm)	B.P.	Time(sec)	Mf(Kg/Hr)	BSFC (MJ-Hrs)	Thermal Efficiency
0	1450	0.294	58	0.496	76.44	4.96
3	1400	1.023	49	0.587	26.27	14.57
5	1380	1.918	43	0.699	20.77	18.20
7	1350	2.788	39	0.738	18.10	21.73
10	1250	2.8	31	0.928	15.10	25.08
12	1240	3.521	29	0.993	15.62	24.15
15	1230	3.5	25	1.128	14.54	25.54

III. PERFORMANCE PARAMETER

- **SOYABEAN-**

A] Thermal efficiency-

For accessing the engine capability to burn the biodiesel, to know thermal efficiency is more important parameter, shown in fig. -4.1. At different load and speed showing Brake –Thermal efficiency Vs. Brake Power, it is observed that as load on engine increases, thermal efficiency decreases with increase in percentage of soybean oil contain in diesel as compare to diesel.

Up to 40% soybean blend, decrease in thermal efficiency is small and shows the ability of combustion system to accept the soybean oil.

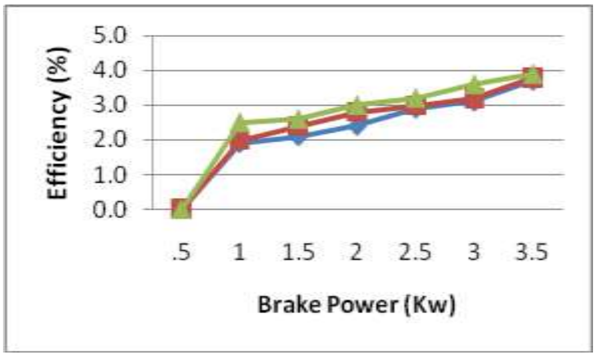


Figure:4.1variation of mechanical efficiency with brake power

B] Brake Specific Fuel Consumption-

It is important parameter that reflects how good the engine performance is shown in fig.-4.2, BSFC curve at different loads, As the percentage of soya bean oil content in diesel increases BSFC increases suddenly. BSFC increases as the soybean oil friction in diesel increases. This shows increases in fuel consumption at constant output.

© 2015, IERJ All Rights Reserved

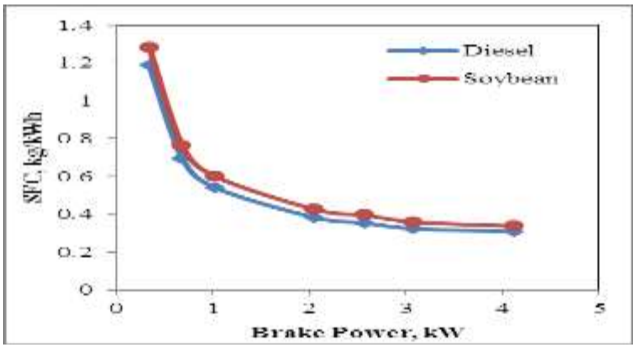


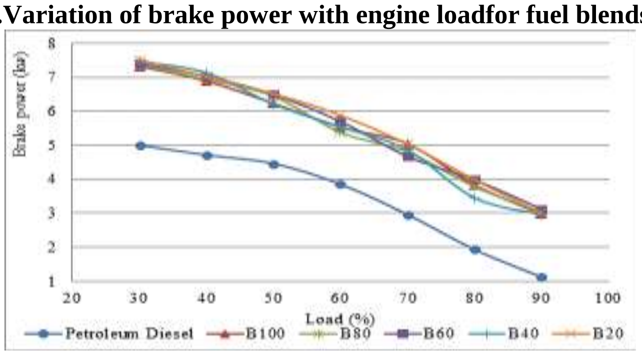
Figure: 4.2 Variation of specific fuel consumption with brake power

- **JATROPHA-**

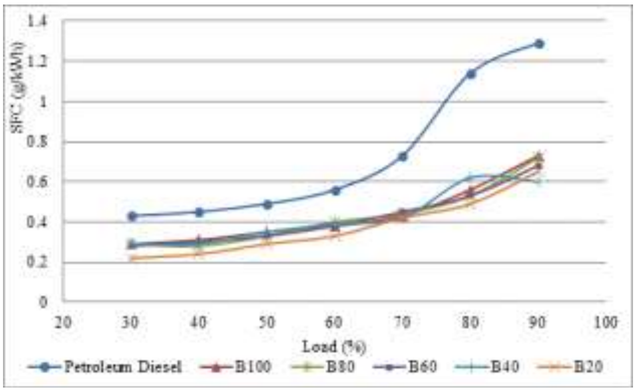
The engine performance indicators consideredwere brake power, specific fuel consumption (SFC) andbrake thermal efficiency (BTE). Figure-2(a) shows theengine brake power plots for various biodiesel fuel blendsat engine load points varying from 30% to 90%. Brakepower is the useful power available at the crank shaft ofthe engine and its magnitude is dependent on the nature of

the fuel. Despite petroleum diesel having a marginallyhigher heating value than jatropha methyl ester and itsblends, with a maximum difference of 9.5%, jatrophamethyl ester and its blends produced relatively high brake
power than petroleum diesel across all load points. This
can be attributed to more efficient combustion due to inboundoxygen in the biodiesel. However for all the fuels,
brake power decreased with increase in engine load.The specific fuel consumption is a measure ofvolumetric fuel consumption for any particulate fuel.
1.Inthis work, petroleum diesel fuel had the highest specificfuel consumption throughout the load settings and B20had the lowest. The maximum variation between these twofuels was 49% at 90% engine load, and the minimum was40% at 50% engine load. Since energy content andviscosity are marginally different between petroleumdiesel and jatropha methyl ester and its blends, the trendshown in Figure 1 may be due to efficient combustionof the methyl ester and its blends as a result of the inbound oxygen.
Figure-3 shows variation in thermalefficiency for the fuels with increase in engine load. It wasobserved that for all the loads, petroleum diesel fuelshowed the lowest thermal efficiency when compared withblends. B20 showed the highest thermal efficiency, with amaximum value of 60.3% at 30% engine load and aminimum value of 20.6% at 90% engine load. Generally,brake thermal efficiency decreases with increase in engine
load for all fuels.

1.Variation of brake power with engine loadfor fuel blends.

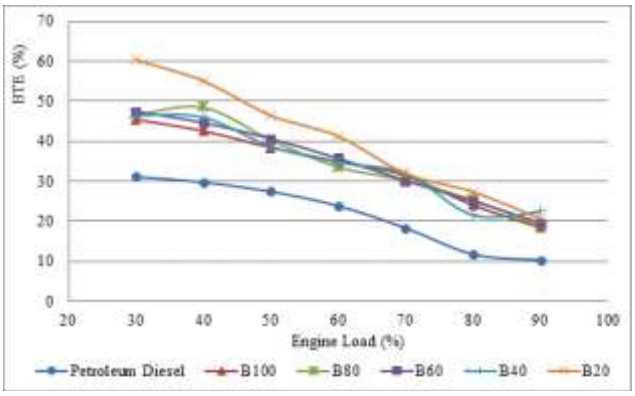


2.Variation of SFC with engine load forfuel blends



3.Variation of BTE with engine load for fuelblends.

© 2015, IERJ All Rights Reserved



A .Brake Power-

B.P.=(2*3.14*N*T)/60

Torque= Force *perpendicular distance.

=W*D/2………where D is effective diameter.

B .Brake Specific fuel Consumption:

B.S.F.C.= (Fuel flow rate) / B.P.

Fuel flow rate=Kg/Hr.

C .Brake Specific Energy Consumption:

BSEC= (CV*Mf) / (1000*B.P.)

D. Brake Thermal Efficiency:

BTE=(BP *3600*100)/(Mf * CV)

IV. EMISSION

A. Oxides of Nitrogen

Oxides of nitrogen are the important emission in diesel engines. The oxides of nitrogen in the emissions contain nitric oxide (NO) and nitrogen dioxide (NO2). The formation of NOx is highly dependent on in-cylinder temperature and oxygen concentration. Figure 6 shows the variation of oxides of nitrogen with brake power. It can be observed that NOx emission increases in the soybean bio diesel operation. At part load conditions the increase in NOx emissions is 2.88% whereas it reduces as the load increases and reached the value of 12.3% at fullload.

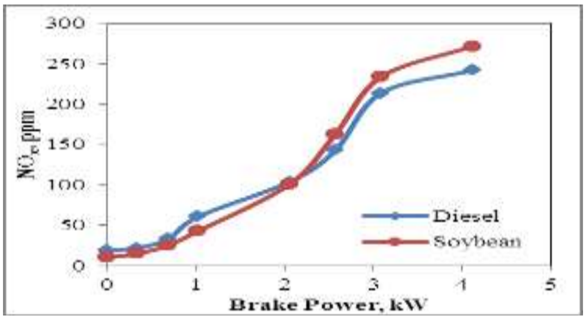


Fig.No-4.3 variation of oxides of nitrogen with brake power

B.Smoke

Smoke is nothing but solid soot particles suspended in exhaust gas. Figure 8 shows the variation of smoke with brake power. Smoke opacity varies from 0.7HSU to 41 HSU for diesel operation and from 3.8HSU (Hatridge smoke unit) to 21.5 HSU for soybean biodiesel. It can be noticed that the smoke level for soybean biodiesel is higher than diesel at part load and lower than the diesel at full load. The reason for the reduced smoke is the availability of premixed and homogeneous charge inside the engine well before the commencement of combustion. Higher combustion temperature, extended duration of combustion and rapid flame propagation are the other reasons for reduced

© 2015, IERJ All Rights Reserved

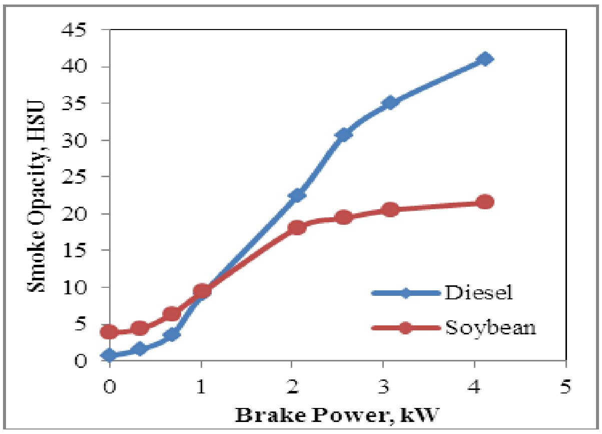
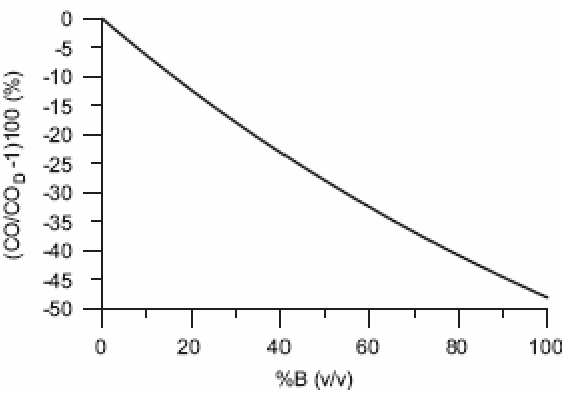


Figure: 4.4 variation of Smoke Opacity with Brake power

C. Carbon monoxide (CO)

Some researchers, found a decrease in CO emissions when substituting diesel fuel with biodiesel. Most of the authors have explained this to better combustion in biodiesel fuelled engine. Since biodiesel is an oxygenated fuel, it promotes combustion and results in reduction in CO emissions. Nevertheless, other authors found no differences between diesel and biodiesel and even noticeable increases when using biodiesel.



V. CONCLUSION

Biodiesel is a viable substitute for petroleum-based diesel fuel. Its advantages are improved lubricity, higher cetane number, cleaner emissions (except for NOx), reduced global warming, and enhanced rural development. Vegetable based oil has potential as an alternative energy source. The use of vegetable biodiesel reduces environmental impact of transportation, the dependency on crude oil import and may offer business possibilities to agriculture sector for the excesses production.

Use of vegetable based biodiesel and its blends will give better engine performance and emission, when fuelled single cylinder compression ignition engine.

REFERENCES

1] International Journal of Advanced Research Foundation,Website: www.ijarf.com, Volume 2, Issue 1, January 2015)-A Critical Review of Nusselt Number and Performance Characteristics of I.C. Diesel Engine Using Alternative BioFuels -K Ashok Reddy Professor, Department of Mechanical Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatanam, R R Dist-501 506 , Hyderabad, Telangana State

2] Ayhan Demirbas . Professor of Energy Technology Sila Science and Energy Trabzon Turkey- “Biodiesel-A Realistic Fuel Alternative for Diesel Engines”.Page no 100 to 120,Library of Congress Control Number: 2007942233 © 2008 Springer-Verlag London Limited

3] Journal of Engineering Research and Studies E-ISSN0976-7916 JERS/Vol. III/ Issue I/January-March, 2012/34- Review Article- Emission and Performance of diesel engine using waste cooking oil bio diesel blends a review by -Parekh P R1*, Goswami J2 Address for Correspondence 1 PG Student, Department of Mechanical Engineering, Government Engineering College, Bhuj – 370 001 (Kutch – Gujarat - INDIA) 2Associate Professor, Department of Mechanical Engineering, Government Engineering College, Bhuj – 370 001 (Kutch – Gujarat - INDIA)

4]IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 10, Issue 5 (Jan. 2014), PP 16-21 www.iosrjournals.orgwww.iosrjournals.org 16 | Page Evaluate the Performance and Emission using EGR (Exhaust gas recirculation) in Compression-ignition engine fuelled with blend.

Hardik B. Charola1, C. D. Sankhavara2, M.B.Charola3 1PG Student, R K University, Rajkot, Gujarat, INDIA. 2 Dean - Faculty of technology, R K University, Rajkot, Gujarat, INDIA 3Asst. Prof, LTIET Engineering College, Rajkot, Gujarat, INDIA.

© 2015, IERJ All Rights Reserved

5]vol. 8, no. 11, november 2013, issn 1819-6608. arpn Journal of Engineering and Applied Sciences ©2006-2013 Asian Research Publishing Network (ARPN). All rights reserved. **fuel properties of jatropha methyl ester and its blends with petroleum diese**L Jerekias Gandure1, Clever Ketlogetswe1 and Abraham Temu2 1Department of Mechanical Engineering, University of Botswana, Gaborone, Botswana 2Department of Chemical and Mining Engineering, University of, Dar es Salaam, Tanzania

6] Life Cycle Inventory of Biodiesel and Petroleum Diesel, NREL/SR-580-24089.
Page No-171-189.

7] A Biodiesel technology, performance and regulatory overview-BIODIESEL,Post Office Box 104898 1907 Williams Street, Suite B Jefferson City, MO 65110-4898 Phone: (800) 841-5849 Fax: (573) 6357913.Page No-39 to 60.

8] International Journal Of emerging technology and advanced Engineering,Volume 2,Issue 4,March 2012,performance and Emision Characteristic of a Slow Speed Diesel Fueled with Soyabean Biodiesel,N Ravi Kumar, Department Of Mechanical Engineering AP India.

9]Ird India,ISSn,Volume -4 Issue-1 2015,Critical review of Effect of EGR on CI Engine Running on Biodiesela and Its Blends.