International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 3, Issue 05, March 2016
Available at http://internationaljournalofresearch.org

Investigation of the performance of Diesel engine fuelled with Sesame oil Biodiesel under various Injection timing

Bhavana Singh[1]&Mr. Sanjay Yadav[2]

ABSTRACT

Emission norms, Energy Crisis and environment degradation due to pollutants from automotive vehicles lead us to find the suitable alternative for petro-diesel. Non edible and edible grade vegetable oils are predominant feedstock for biodiesel production. Obviously biodiesel production from edible oil results in the high price of biodiesel. Realistically, non-edible oils only cannot meet the demand of energy consumption therefore, it has to be supplemented from some edible oils. Injection timing is altered by either addition or removal shims in pump. In this work a complete analysis on the performance of diesel engine using Sesame Oil Biodiesel has been carried out at various injection timings. The effect of varying injection timing with B50 blend of biodiesel has been carried out in terms of brake thermal efficiency, brake specific fuel consumption, hydrocarbons, Smoke. The performance and emission of blends of biodiesel are compared with diesel.

Keywords – B50; Brake Specific Fuel Consumption; Brake thermal efficiency; Brake Power, Smoke Opacity.

1. INTRODUCTION

The demand for energy along with maintaining performance of diesel engines has led to extensive research in domain of fuel. Results of various researcher have proved that performance of biodiesel is nearly similar to diesel engine and emission are also lesser. Injection parameters such as injection pressure, injection timing and compression ratio are also found to be significant factor to contribute in the performance and emissions of diesel engine fuelled with diesel. In the present paper performance of diesel engine at various injection timings (22°BTDC, 23°BTDC , 24°BTDC, 25°BTDC) for B50 blend is evaluated in terms of Brake Power , Brake thermal efficiency , Brake specific fuel consumption , hydrocarbon , CO emission , Smoke opacity.

2. LITRATURE REVIEW

Mittelbach and Tritthart., (1988) prepared methyl esters from used frying oil to investigate the effects of the ester on diesel engine exhaust emissions. **Reed et al., (1991)** converted waste cooking oils to their methyl and ethyl esters and tested pure biodiesel and a 30% blend in diesel fuel in a diesel-powered bus on a chassis dynamometer. **Peterson et al., (1995)** compared the engine performance and emissions of ethyl esters produced from waste hydrogenated soybean oil with No. 2 diesel fuel. **Van Gerpen et. al., (2001)** investigate the effect of the biodiesel produced from high free fatty acid feedstock's on engine performance and emissions. **K. Anbumani** and **Ajit Pal Singh ,(2010)** studied the feasibility of using two edible plant oils mustard and neem as diesel substitute . **T. Elango,** and **T. Senthilkumar**, **(2011)** investigated that the performance and emission characteristics of a diesel engine which was fuelled with different blends of jatropha oil and diesel (10-50%) **B.K.Venkanna et. al., (2009)** conducted experiment using honge oil and diesel fuel blend in direct injection diesel engine with increased injection opening pressure (IOP).

1-M.tech Scholar at IFTM University Moradabad(UP)
2-Assistant Professor at IFTM University Moradabad(UP)

H. M. Dharmadhikari et. al., (2012) analyzed the performance and emissions characteristics of compression ignition engine fuelled with the blends of mineral diesel neem oil methyl ester and Karanja oil methyl ester at the different injection pressures180 bar, 200 bar and 220 bar at the static injection timings of 24°BTDC at compression ratio of 16.5. **Nagarhalli. M. V** and **Nandedkar. V. M (2012)** produced biodiesel from transesterification of Jatropha and karanja oil and biodiesel was used in different proportions (10% to 90%) and neat biodiesel were tested for performance, brake thermal efficiency, brake specific energy consumption (BSEC) and their emissions CO, HC, NOx. at an injection pressure of 200 bar and 210 bar. **Pritinika Behera** and **S. Murugan (2013)** Investigated with used transformer oil (UTO) at five different injection nozzle opening pressures (200, 210, 220, 230, 240 and 250). **Muralidharan and Vasudevan (2011)** have evaluated the performance and emission of a single cylinder four stroke variable CR engine, fuelled with waste cooking oil methyl ester and its blends. **Hani Chotai (2013)** has reviewed that varying compression ratio follows almost similar results on engine running with diesel, blend of diesel and biodiesel & biodiesel. **Mohan raj** and **Kumar (2013)** experimented with tamanu oil Biodiesel with varying CR from 14:1 to 18:1 and load from 0 to 12 kg and at constant speed (1500 rpm). **Niraj Kumar** and **Varun et al. (2014),** has concluded that increased Compression ratio improved the brake thermal efficiency and brake specific fuel consumption as compared to diesel at original condition due to proper combustion of fuel. **O.M.I Nwafor (2000)** evaluate the performance of diesel engine with varying injection timing.

M. Pandian and **S.P. Sivapirakasam et. al. (2009),** has conducted by experiments on a four stroke twin cylinder direct injection water cooled compression ignition engine using Pongamia bio-diesel and diesel fuel blends. **Alp Tekin Ergenc et. al. ,(2012)** conducted experiment on an air cooled single cylinder, high pressured (600-1600 bar), PLC controlled research engine, fuelled With Diesel–Ester blends and Fuel Injection angle advances before the TDC modified to 25-20-17-15°CA.They evaluate the performance of diesel engine by Engine torque, brake power and brake specific fuel consumption values under these advance angles**. Sharun Mendonca** and **John Paul Vas (2013)** investigate the influence of varying injection timing, on a four stroke diesel engine while using simarouba biodiesel with diesel, **Purushotham Nayaka D S et. al., (2014)** studied the influence of injection parameters like injection pressure and injection timings on a four strokes, single cylinder diesel engine with blends of methyl ester of sesame and pongamia pinnata oil.

3.EXPERIMENTAL EQUIPMENT

This work was an investigation of the impact of biodiesel prepared from sesame oil on engine performance and exhaust emissions. Comparisons were made to B50 (Blend of biodiesel) and diesel. A Kirloskar four stroke water cooled Variable compression ratio engine is used for testing. Specifications of engine are given in the table 1.

Experimental work was done in three steps-

Step -1: Preparation of Biodiesel

Step -2: Evaluation of Properties of Biodiesel

Step-3: Experimental work on diesel engine fuelled with B50

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 3, Issue 05, March 2016
Available at http://internationaljournalofresearch.org

MAKE	Kirloskar
Model	TAFI
Rated Brake Power (KW)	3.5
Rated Speed (rpm)	1500
Number of Cylinder	1
Bore x Stroke(mm)	87.5x110
Displacement Volume (cc)	661 cc
Compression Ratio	17.5:1
Cooling System	Water Cooled
Starting system	Mannual hand start(with handle)

3.2. PROPERTIES OF BIODIESEL

Properties	**Diesel**	**Sesame Oil**	**SOME**	**B50**
υ (cSt)	3.166	26.67	4.61	4.27
ρ(kg/m^3)	805.2	986.4	981.6	965.2
Specific gravity	0.8052	0.9864	0.9816	0.9652
Calorific Value(kJ/kg)[41]	43000	39349	40210	38836

3.3. EXPERIMENTAL PROCEDURE

Table. 1. Specification of Variable Compression ratio engine

3.1. PREPARATION OF BIODIESEL

1.5 litres of sesame oil is taken in a 2 litre beaker and it is heated at a temperature 60°C on a magnetic steam heater. Potassium hydroxide (10.5 gm) is mixed with 351 ml of methanol. Mixture of Potassium hydroxide and methanol is added to sesame oil and this mixture is heated. The reaction is carried out at 60°C and at atmospheric pressure for 90 minutes with vigorous stirring. Methanol is used in a Molar ratio of 6:1 to oil. After 90 minutes the reaction is stopped by adding stoichiometric amount of Concentrated H_2SO_4 and then the content was allowed to cool. As soon as the reaction time is over, the mixture is placed in separating funnel for 24 hours. Three separate layers are observed. Upper layer is methyl ester (Biodiesel), middle layer is excess methanol and lower layer is mixture of soap, crude glycerol and catalyst. The Biodiesel layer is separated and this layer is opaque as it contained some catalyst, methanol, triglycerides and soap. The ester is then washed twice with distilled water. Again this Biodiesel and water is placed in separating funnel to separate water and ester for 12 hours.

The set include a control panel which is fitted with an alternator to provide the load to the engine. Fuel from the fuel tank is admitted to the engine. A burette and a fuel sensor is included in the fuel circuit to measure the fuel consumption and give input to the computer. In the fuel line a fuel filter and fuel pump is also connected. Atmospheric air enters the intake manifold of the engine through an air filter and an air box. An air flow sensor fitted in the air box gave the input for the air consumption to the data acquisition system. All the inputs such as engine brake power, air and fuel consumption are recorded by the data acquisition system, stored in a computer and displayed in the monitor. An AVL DiGas444 exhaust gas analyzer is used to measure the engine exhaust gas components in percentage. All the tests are conducted by starting the engine with diesel only at 0%, 20%, 40%, 60% ,80% and 100% loads at (22°BTDC ,23°BTDC,24°BTDC,25°BTDC) different injection timings. Alteration in injection timings has been done by increasing or decreasing the advance shim in the pumps **[25]**.In the beginning engine was started with pure diesel.After the engine warmed up, it is switched to biodiesel blends operation. At the end of the test , the fuel is switched back to diesel and engine is kept running for a while before shut down to flush Biodiesel blends from fuel line and the injection system.

4. RESULT AND DISCUSSION

4.1 EFFECT ON PERFORMANCE OF ENGINE

4.1.1. EFFECT ON BRAKE THERMAL EFFICIENCY

The ratio of output of engine and energy introduced through fuel determine the brake thermal efficiency.

Value of BTH for B50 (22 ° BTDC, 23 °

Result shows that the maximum efficiency obtained was 34.77% which is at 24° BTDC. The Brake thermal Efficiency of B50 at 80% load is 32.69% while diesel is 31.76%. Therefore, BTH of B50 is slightly (0.93%) better than diesel.

load is lesser than that BTH at higher load. This trend is due to the raised temperature inside the cylinder and reduced heat loss which results in increase in power developed with increase in load. At Original condition (ORGC) that means at 23 ° BTDC the brake thermal efficiency of biodiesel is less than that of diesel.

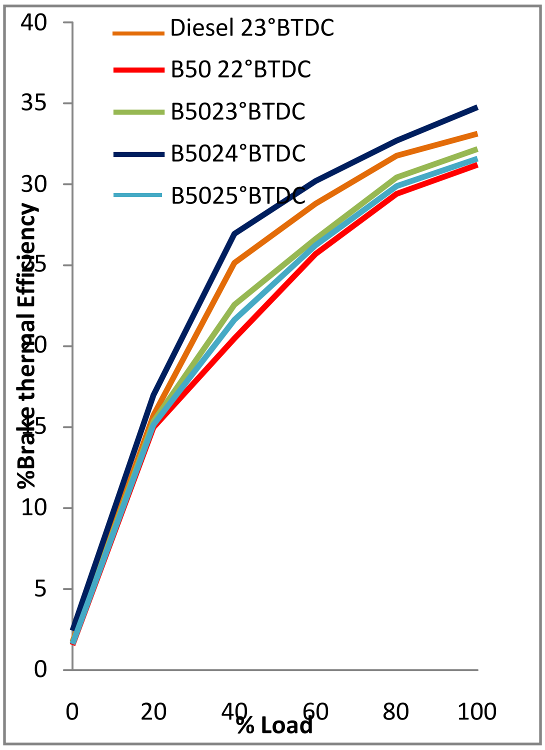


Fig 4.1.1.Comparison of variation of Brake thermal efficiency vs. Load

This is due to poor atomization, less vaporization and inferior combustion.

4.1.2. EFFECT ON BRAKE POWER

Brake power is the power actually delivered by the engine and is therefore the capacity of the engine.

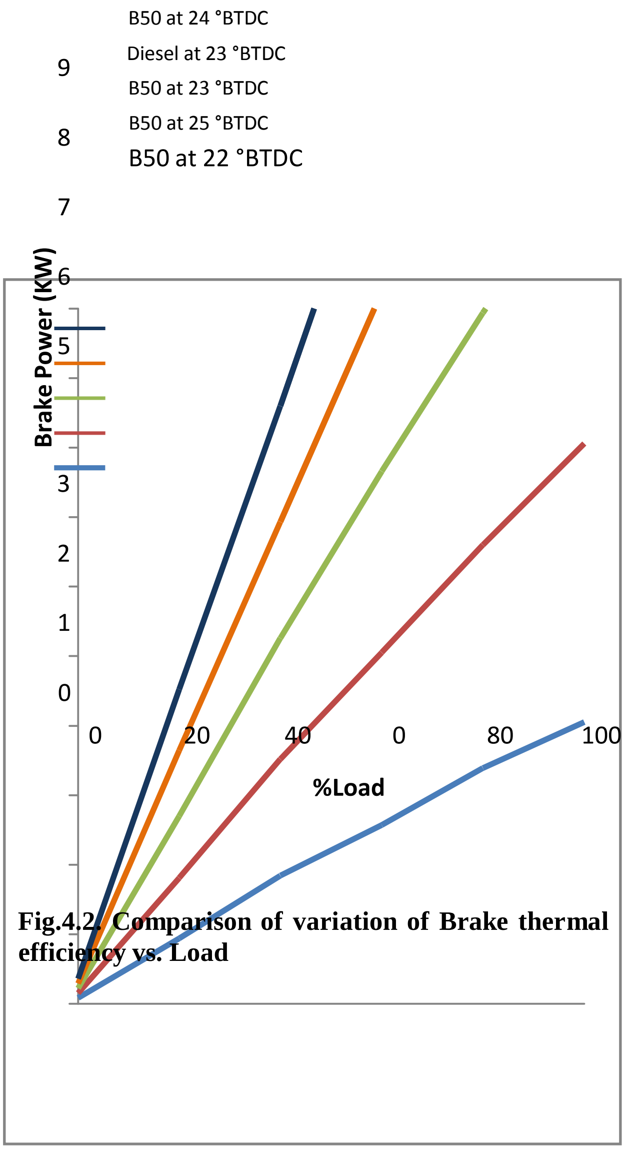


Fig.4.2. Comparison of variation of Brake thermal efficiency vs. Load

BP of diesel is better than B50. While at the injection advance (24°BTDC) pressure and temperature inside the cylinder is higher which reduces heat losses and fuel burned properly and results in increased brake power than that of diesel. Further increase in injection advance that means at 25° BTDC it tends to decrease.

4.1.3. EFFECT ON BRAKE SPECIFIC FUEL CONSUMPTION

Brake specific fuel consumption (BSFC) indicates how efficiently fuel burn. The variation in BSFC with load for different fuels shows decline with increase in load. In other words, this could be due to more increase in brake power with load as compared with fuel consumption. At Original injection timing 23°BTDC Brake specific fuel consumption is more than that of diesel because large amount of biodiesel is supplied to the engine compared to that of diesel.

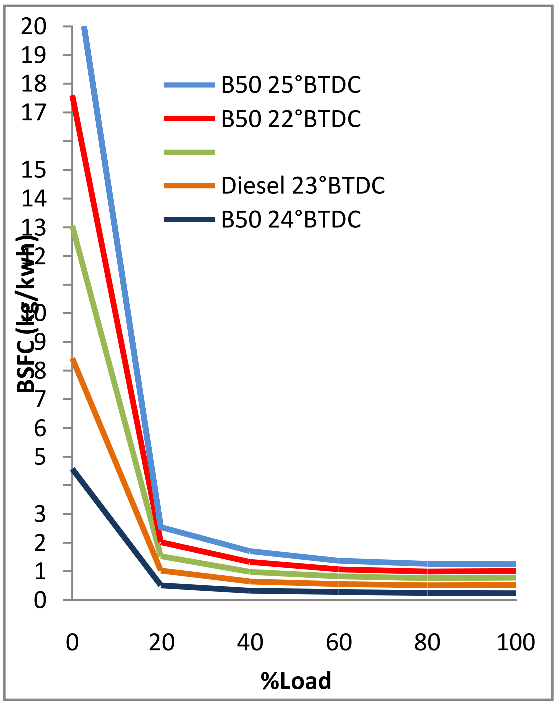


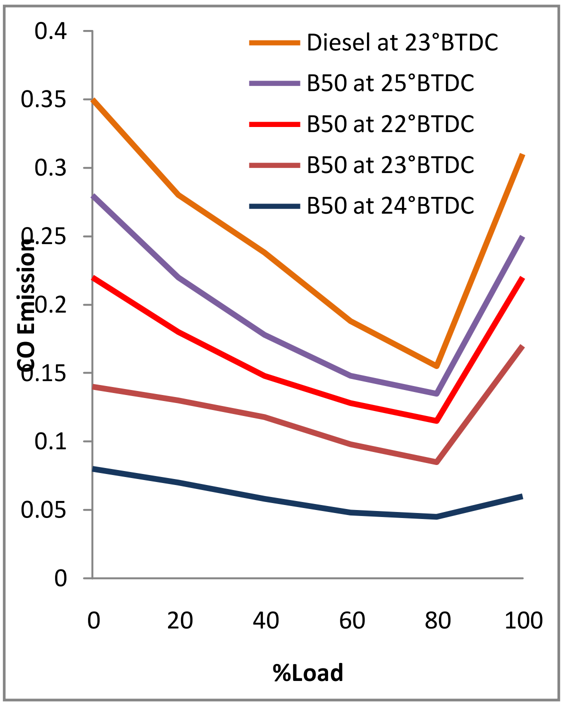
Figure4.3. Comparison of variation of BSFC vs. Load

At the injection retard of 1° (22 ° BTDC) Brake specific fuel consumption of fuel is more than that of diesel.
At the injection advance (24°BTDC) B50 exhibit better results as compare to diesel at standard injection time.
Further increase in the injection timing increase the tendency of knocking. At 25°BTDC incomplete combustion takes place because piston starts retarding.

4.2 EFFECT ON ENGINE EMISSIONS

4.2.1. EFFECT ON CO EMISSIONS

It was observed that for both diesel and B50, as the load increases, CO emission levels decrease. CO emission from a diesel engine mainly depends upon the physical and a chemical property of fuel. The biodiesel itself contain 11% of oxygen which helps in complete combustion of fuel. CO emissions have less dependence on injection advance while retarded timing significantly increases the CO emissions with B50 at because of incomplete and late burning caused by retarded injection timing.



Same results are obtained by other authors (S. Jaichander 2012).

Figure.4.4 Effect on CO emission

4.2.2 EEFECT ON HC EMISSIONS

On retarding or advancing injection timing from original condition (23°BTDC to 22°BTDC , 24°BTDC, 25 °BTDC) .Unburned hydrocarbon are lesser in all condition than diesel because of better ignition quality and higher oxygen content of the fuel.

Results show that best results were obtained at 24 °BTDC.

At all injection timing smoke opacity of

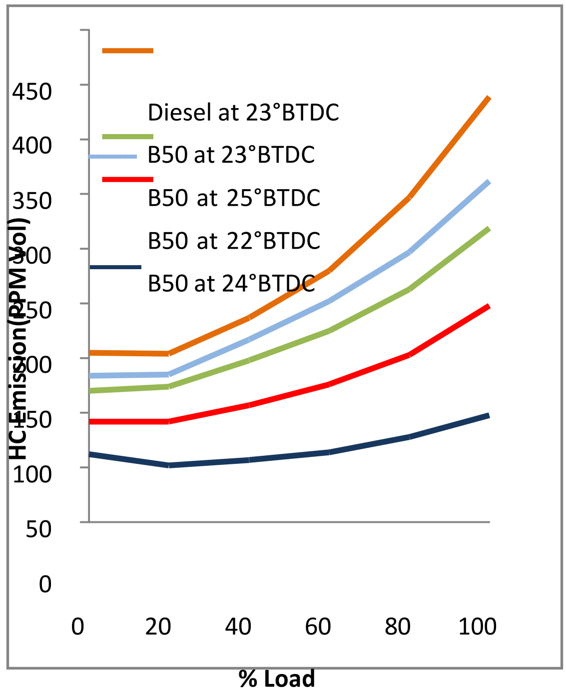


Figure.4.5 Effect on HC emission

4.2.3 EFFECT ON SMOKE OPACITY

In general, reduced smoke density is observed with biodiesel operation as compared to diesel under any operating condition for a given injection timing.

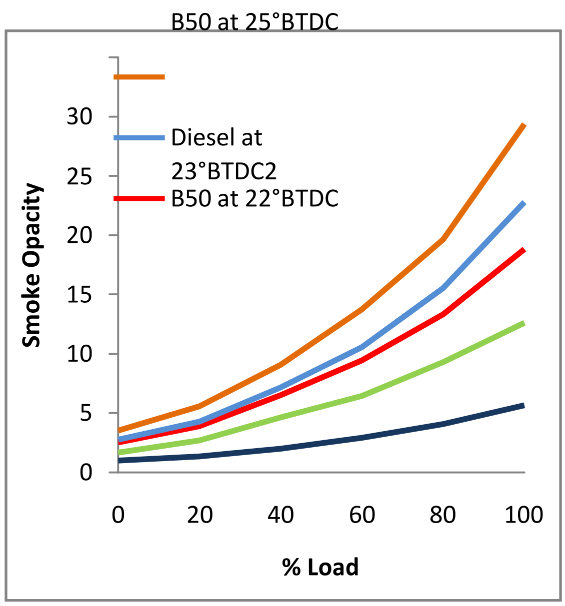


Figure.4.6 Effect on Smoke Opacity

diesel is more than B50. For an advanced timing 24 °BTDC , smoke density is decreased for indicated load due to better combustion on account of more time available (leading to better mixing) for the oxidation process to occur caused by early injection. However, at retarded injection

is increased for a given load. Further increase in injection timing 25°BTDC the

given load and injection timing.

5. CONCLUSION

1. Sesame oil biodiesel is suitable as fuel for a diesel engine. Its B50 blend at 24° BTDC proved potentially suitable for diesel engine. Because BTE, BP is increasing and BSFC is decreasing.
2. Use of Sesame oil Biodiesel in diesel engine is suitable only for short term without any modification. For long term tests may reveal clearer picture of engine operation and life.
3. Recommendations may be made to produces sesame oil not only for edible and medicinal purposes but also for fuel by creating the awareness among the farmers.

characteristics are better with Sesame oil than diesel. Though there is slight increase in BTE, BP and slight decrease in BSFC but emission are much less than diesel.

REFERENCES

1. Bettis BL, Peterson CO, Auld DL, Driscoll DJ, Peterson ED. (1982), ―Fuel characteristics of vegetable oil from oil seed crops in the Pacific Northwest‖. Agronomy Journal; 74:3359.
2. Pryor RW, Hanna MA, Schinstock, Bashford LL. (1983), ―Soybean oil fuel in a small Diesel engine‖. Transactions of the ASAE; 26:333–7.

3. Strayer RC, Blake JA, Craig WK. (1983), – Canola and high erucic rape seed oil as Substitutes for diesel fuel: preliminary tests‖. JAOCS; 60:1587–96
4. Ryan TW, Dodge LG, Callahan TJ (1984), –The effects of vegetable oil properties on Injection and combustion in two different diesel engines‖.
5. Laforgia D., Ardito V., (1994). –Biodiesel fueled IDI engines, performances emissions and heat release investigation‖. ELSEVIER, Bioresource Technology, vol. 51, p. 53-59
6. Ahn E, K. M. (1995). – A Low Waste process for production of biodiesel. Separation Science and Technology‖ ;302021-33.
7. Cvengro J, P. A. (1996). – Production and treatment of rapeseed oil methyl esters as alternative fuels for biodiesel engines‖ . Biosource Technology , 55:145-50
8. Ma F, H. M. (1999). – Biodiesel Production with waste cooking oil: a review‖. Bioresour Technol , 70(1).
9. Ma Fangrui, H. M. (1999). – Biodiesel Production: a review‖. Bioresource Technology , 70:1-15.
10. Kaieda Masaru, S. T. (1999). –Biodiesel fuel production from plant oil catalyzed by rhizopus oryzae lipase in a water containing system without an organic solvent‖. Journal of ?Bioscience and Bioengineering , ;88:627-31.
11. Uosukainen E, Lamsa M, Linko Y, Linko P, Leisola M(1999). –Optimization of enzymatic transesterification of rapeseed oil‖ , Enzyme and Microbial Technology , 25:236-43.
12. Ikwuagwu OE, O. I. (2000). – Production of Biodiesel using rubber(Hevea brasiliensis kunth Muell) seed oil‖ . Industrial crops products , 12:57-62
13. Samukawa Taichi, K. M. (2000). – Pretreatment of immobilized Candida Antartica lipase for biodiesel production fro plant oil ‖. Bioscience and Bioengineering , 90:180-3.
14. Crabbe Edward, N.-H. C. (2001). –Biodiesel production from crude palm oil and evaluation of butanol extraction and fuel properties‖. Process Biochemistry , 37:65-7.
15. G.H. Abd Alla, H.A. Soliman, O.A. Badr, M.F. Abd Rabbo (2002),–Effect of injection timing on the performance of a dual fuel engine‖ ,Energy conversion and Management vol. 43 pp. 269-277
16. M. Senthil kumar, A. Ramesh, (2003) ―An experimental comparation of methods to use methanol and Pongamia oil in a compression ignition engine‖ , Biomass and Bioenergy.
17. Nazar J, R. A. (2004). – Performance and Emission Studies on use SVO and Biodiesel from different Indian Feedstock‖ . SAE Paper , 28-071.
18. Hountalas D.T., Kouremenos D.A. and Mavropoulos G.C. (2004) , ‟ Multi-Zone Combustion Modeling as a Tool for DI Diesel Engine Development-Application for the Effect of Injection Pressure‟-01-011.5
19. Leon G. Schumacher , Jon Van Gerpen , Brian Adams (2004) , –Biodiesel Fuels‖.
20. Usta N, Ozturk E, Can O, Conkur ES, Nas S, C¸on AH, et al.(2005), –Combustion biodiesel fuel produced from hazelnut soapstock/waste sunflower oil ture in a diesel engine‖. Energy Conversion and Management;46:741–55
21. Sinha S, Agarwal AS. (2005) , –Combustion Characteristics of Rice Bran Oil Derived Biodiesel in a Transportation Diesel Engine‖. SAE paper -26-354.
22. Kumar, C., Babu G.M.K., Das, L.M., (2006) –Experimental Investigations on a Karanja Oil Methyl Ester Fueled DI Diesel Engine‖, SAE Paper, 2006-010238
23. Ke Zeng,Z.Huang et al.(2006)‖ Combustion characteristics of a direct injection natural gas engine under various fuel injection timings‖Applied thermal Engineering. Vol.26,pp.806-813
24. Lif Anna, Holmberg Krister (2006). –Water-in-diesel emulsions and related systems‖. Advances in Colloid and Interface Science; 123–126:231–9.
25. Cenk Sayin, Kadir, Mustafa Canakci (2007), –Influence of injection timing on the exhaust emissions of a hdual fuel CI engine‖ Renewable energy.
26. Saikishan S, Vijay Manikandan Janakiraman, Jayanth Sekar, Lakshmi ayana Rao G. (2007), –Prediction of cetane number of a biodiesel based on physical properties and a study of their influence on cetane number‖. SAE paper;01-0077
27. M.C. Math , Sudheer Prem Kumar, Soma V. Chetty. (2007), –Technologies for biodiesel production from used cooking oil — A

review‖.

28. N.R. Banapurmatha,, P.G. Tewaria, R.S. Hosmathb (2007) , ―Performance and emission characteristics of a DI compression Rathod (2014); ―Performance and Emission Analysis of Diesel Engine using palm seed oil and diesel blend‖.

29. Syed Ameer Basha, K. (2008). ―A review on biodiesel production , combustion ,emission and performance‖. Renewable and Sustainable Energy Reviews , 8-3

30. AA, K. (2009).‖ Novel process for biodiesel by reactive absorption‖. Sep Purif Technol , 69(3):280e7.

31. M. Padian , S.P. Sivapirakasam and M. Udayakumar (2009) , ― Influence of injection timing on performance and emission characteristics of naturally aspirated twin cylinder CIDI Engine using Biodiesel‖ .

32. K.Anubumani and Ajit pal Singh (2010), ―Performance of Mustard and Neem oil blends with Diesel Fuel in C.I. Engine‖. Arpsn Journal of Engineering and Applied Sciences.

33. E.F. aransiola, T. O. (2012). ―A review of current technology for Biodiesel Production: State of Art‖.

34. H. M. Dharmadhikari , Ravi Kumar, Srinivasa Rao (2012) , ―Performance and emissions of CI Engine using blends of biodiesel and diesel at different injection pressures‖.Vol-2

35. Meyyappan Venkatesan (2013), ―Effect of injection timing and injection pressure on a single cylinder diesel engine for better performance and emission characteristics for jatropa bio diesel in single and dual fuel mode with CNG‖. IJAET ISSN 2231-1963

36. Shailja. M , A. Aruna Kumari , A V Sita Rama Raju (2013) , ― Performance Evaluation of a Diesel Engine with Sesame Oil Biodiesel and its blends with Diesel‖.

37. Niraj Kumar ,Varun , Sant Ram Chauhan (2013),― Performance and emission characteristics of biodiesel from different origins: A Review pp. 633-658

38. Pritinka Behera & S. Murugan (2013) , ―Studies on a diesel engine fuelled with used transformer oil at different fuel injection nozzle opening pressure‖

39. Maulik A Modi, Tushar M Patel, Gaurav Rathod (2014); ― Performance and emission analysis of diesel engine using palm seed oil and diesel blend‖.

40. P Rathod (2014); ―Performance and Emission Analysis of Diesel Engine using palm seed oil and diesel blend‖.

41. Ashik Sathish' Brian R. Smith and Ronald C. Sims (2014), ―Effect of moisture on in situ transesterification of microalgae for biodiesel production‖. Pages 137–142

42. Yarbrough CM, lepori WA, Engler C.R. , ―Compression ignition performance using sunflower seed oil. SAE Paper 81-357‖.

43. S.Bari, C.W. Yu, T.H. Lim, ―Effect of fuel injection timing with waste cooking oil as a fuel in a direction injection diesel engine‖, Vol.218,part D:J. Automobile Engineering,pp.93-104