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Research Paper

Performance characteristics of Bio- Diesel.

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Abstract: Ever increasing population and rapid depletion of fossil fuels led the world to look for alternative fuels. As transportation sector is the major consumer of conventional fuels, the feasibility of alternative fuels for internal combustion is gaining more and more attention day by day. Out of various alternative fuels available, biofuels are emerging as the most promising fuel as its combustion results in cleaner and renewable operation. Biodiesel is the most widely used biofuel worldwide. Due to their higher viscosity and low volatility of origin oils compared to conventional diesel fuel, these oils are to be first converted into biodiesel. We have selected various source oils like soya bean oil (edible), Mahua oil (non-edible), Animal fat and Waste frying oil *(W.F.O.).* We, then convert these oils into biodiesel and determined their properties like pour point, cloud point, flash point, absolute viscosity etc. After biodiesel production, various properties were analyzed like flash point, pour point, viscosity etc. It is observed that soya bean biodiesel gave the best results to be selected as a diesel substitute. The results for animal fat and waste frying biodiesel are acceptable and their blends can give very good and satisfying results. But the properties obtained for Mahua biodiesel found to be less significant and it is not advised to use it in winters or in cold countries. Engine parameters like brake thermal efficiency, indicated thermal efficiency, fuel consumption, brake power etc. had been calculated and performance characteristics had been plotted .The Emissions level *of CO2, CO,NOx,O2* etc. had also been measured and emission characteristics were plotted. The performance characteristics of the biodiesel is found to be very close to diesel fuel. And the efficiencies slightly less than the conventional diesel. However there is an appreciable decrease in the emission levels while running the engine with biodiesels. Out of the biodiesel produced refined soya bean biodiesel gives the best results and performance close to diesel fuel. The waste frying oil biodiesel is found to give worst performance as compared to other biodiesel.

Keywords: Bio Diesel, Air fuel*, BSFC*, Thermal Efficiency, emission.

1. Introduction

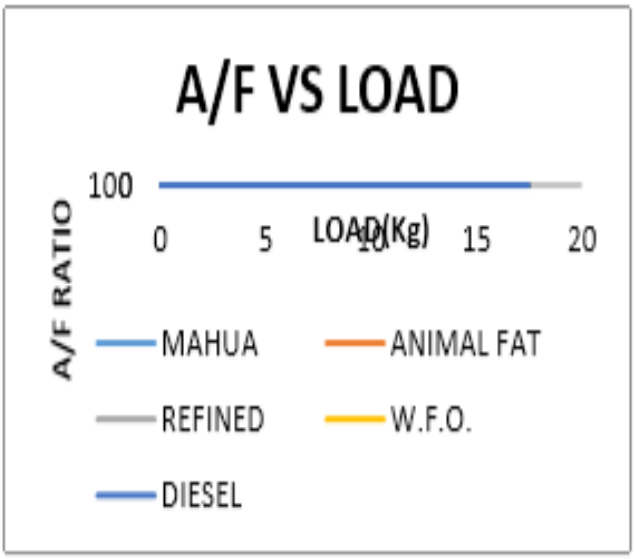
Nowadays, due to limited resources of fossil fuels, rising crude oil prices and the increasing concern for environment, there has been renewed focus on vegetable oils and animal fats as an alternative to petroleum fuels. Vegetable oil is easily available worldwide. It is a renewable fuel with short carbon cycle period (1-2 years compared to millions of year for petroleum fuels) and is environment friendly. It is important that long term running of diesel engines on Pure Plant Oil *(PPO),* for example Jatropha oil, is sustainable, i.e. the engines might have some more maintenance than usual, but they should not break down. The operation should become as reliable as operation on diesel fuel. The main advantages of using vegetable oil are that many of their properties are close to diesel and the seeds can be grown and processed in rural areas. A large number of experimental studies conducted on vegetable oils as a replacement of IC engine fuel by researchers from various parts of the world. Experiments were conducted by Agrawal et al. **[6]** using various blends of Jatropha oil with mineral diesel to study the effect of reduced blend viscosity on emission and performance of diesel engine. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine. The acquired data were analyzed for various parameters such as thermal efficiency, Brake Specific Fuel Consumption, *NOX, C02, CO* and *HC* emissions. Christopher et al. **[9]** conducted two tests in Chicago using Biodiesel as an alternative fuel for in-service motor coaches. This was an exploratory investigation to determine the effect of fuel on the engine performance characteristics and infrastructure needed to use this fuel. Another experiment was conducted on rapeseed methyl ester using waste cooling oil to produce it by Hohl **[11].** He observed that performance, emissions, oil changing intervals, engine wear and knocking characteristics remain unchanged when compared with the diesel fuel. Hemmertein et al. **[12]** conducted experiments on naturally aspirated, turbocharged, air-cooled and water-cooled engines using rapeseed oil.

2. Properties table

	MAHUA		SOYABEAN		ANIMAL FAT		WASTE FRYING	
	SOURCE	FUEL	SOURCE	FUEL	SOURCE	FUEL	SOURCE	FUEL
CLOUD POINT	21	18	0	-3	19	24	12	9
POUR POINT	15	15	-12	-8	16	21	8	8
FLASH POINT	>180	>180	>180	185	>180	>180	>180	185
DISTILLATION TEMP.		340		360		340		340
VISCOSITY(Pa s)	0.04595	0.0456	0.0329	0.007225	0.0275	0.0253	0.033	0.026995
DENSITY(g/l)	921.2	904.92	894.4	866.08	859.8	848.16	890.16	873.28
COLOR								

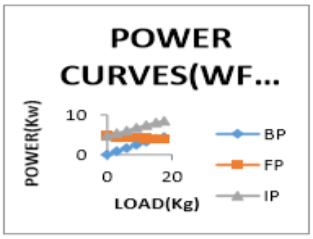
3.1. Performance characteristics

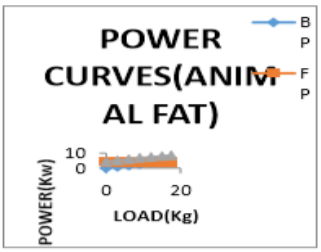
3.1.1. Air fuel ratio

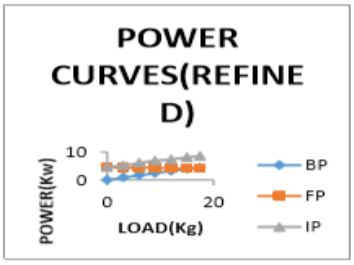


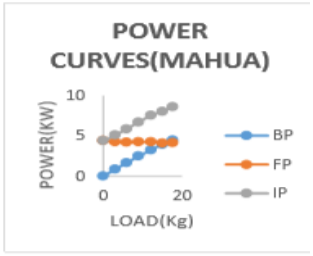
It is clearly visualized from the figure above that the *A/F* ratio of biodiesel is much lower than diesel. This is due to the fact that the engine load increase, the requirement of fuel increases. The specific gravity of biodiesel is greater than that of the diesel. Hence the mass of the fuel entering the combustion chamber is more as compared to diesel at that load.

3.1.2. Effect on power



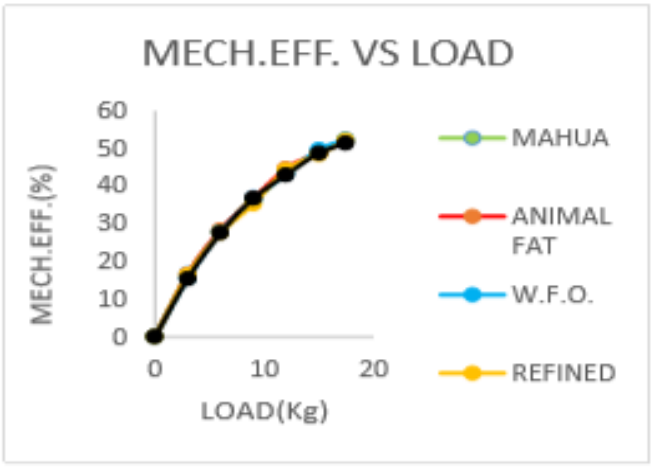






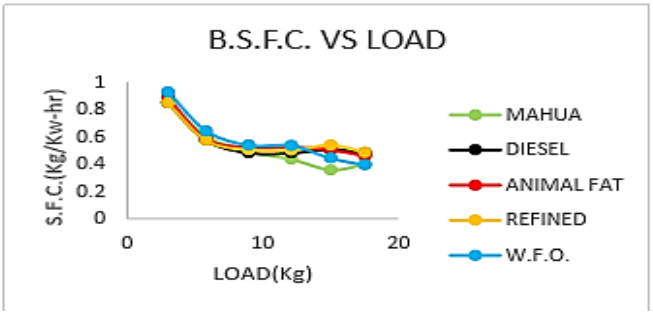
The behavior of indicated, brake power and the friction power of the diesel engine when run on diesel and different biodiesel is shown above. In all the cases, the indicated power and brake power increase with load while friction power almost remains constant with load. The friction power is nearly remains same in magnitude in these cases as that of engine ran bio diesel oil because the engine is run on the same speed and under same conditions.

3.1.3. Mechanical efficiency



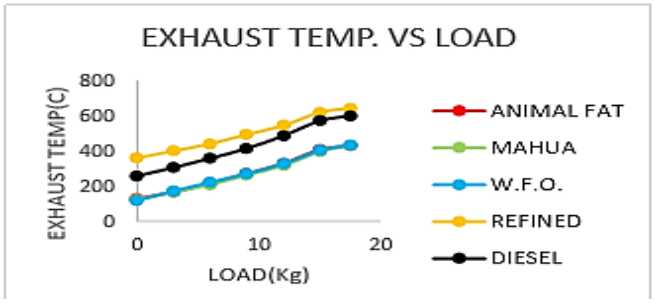
The difference between indicated powers is the indication of power loss due to friction in mechanical components of the engine which form the basis of mechanical efficiency. The high value of viscosity may lead to some problem in pumping and atomization in the injection system of the diesel engine which reduces mechanical efficiency of biodiesels.

3.1.4. Brake specific fuel consumption



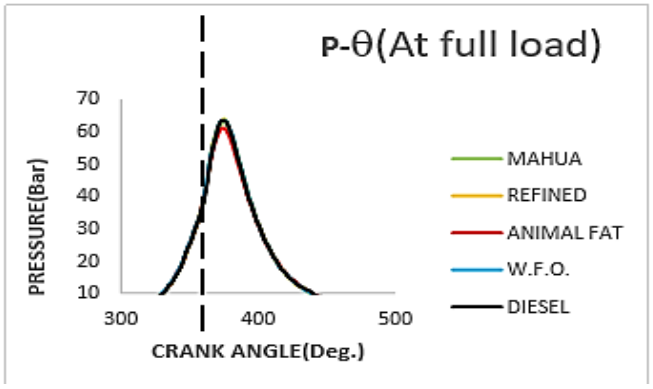
From the above figure we can see that BSFC decreases exponentially with load. Out of the fuel used, waste frying oil is found to have highest BSFC due to least energy content and diesel has the lowest BSFC.

3.1.5. Exhaust temperature



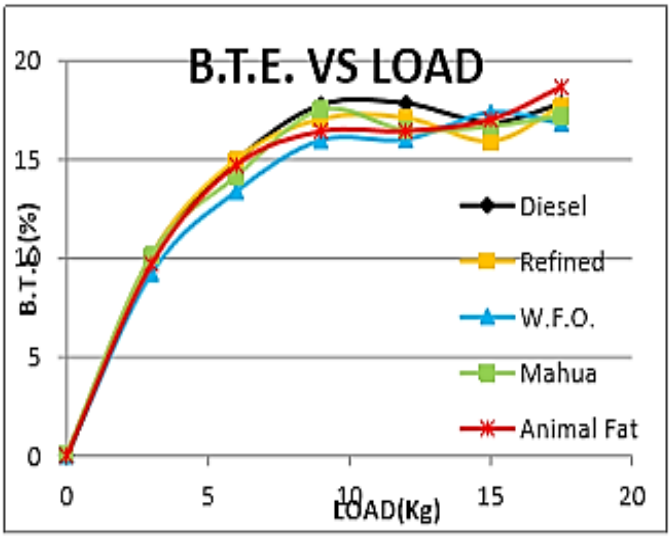
Biodiesel has higher exhaust temperature than diesel because of high loads .This is due to the fact that biodiesel includes constituents having higher boiling point than diesel. Thus the constituents were not adequately evaporated during the main combustion phase and continue to bur in the late combustion phase. Above figure shows the variation the variation of exhaust gas temperature vs load

3.1.6. Pressure vs crank angle



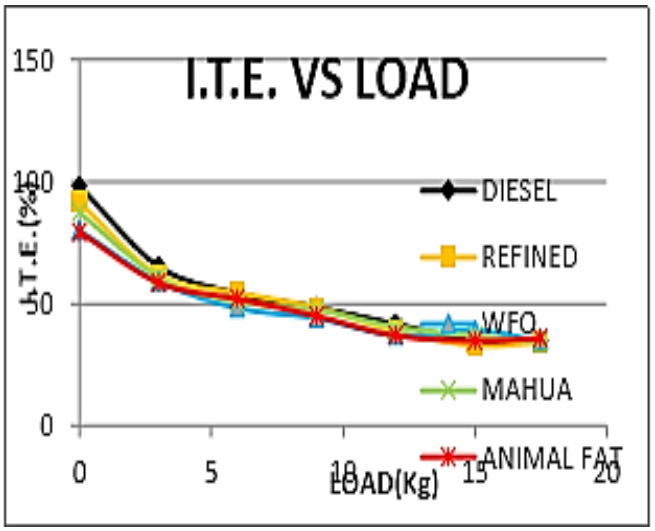
From the above figure, it is clear that the pressure is maximum of SOYABEAN followed by diesel and then mahua and *WFO*. However, the animal fat shows least pressure as shown above.

3.1.7. Brake thermal efficiency



From the graph it is readily observed that for most of the case diesel fuel gives the best thermal efficiency due to highest energy content of diesel fuel. However at some higher loads there is some fluctuation in the trend. This is may be due to the fact that engine runs at its full capacity and vibrational and frictional losses are quite significant. Waste frying oil gives the lowest brake thermal efficiency due to the overheating of oil during the cooking process. Thus its thermal energy content is quite low.

3.1.8. Indicated thermal efficiency



Out of the biodiesel produced Soya bean gives the indicated thermal efficiency very close to the diesel. As the source soya bean oil was quite fresh and similarly waste cooking oil gives the least thermal efficiency due to overheating.

3.2. Emission curves

3.2.1. Co emission

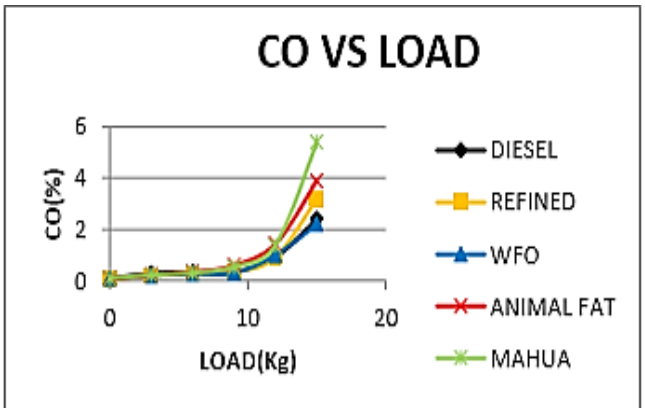
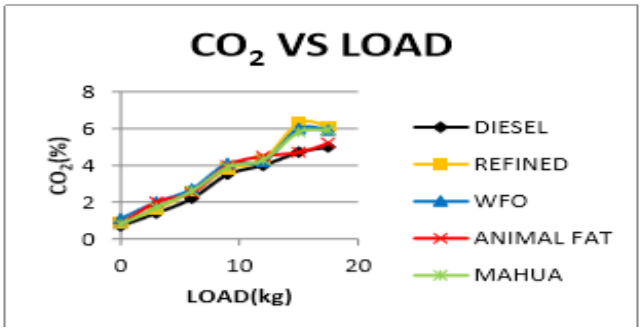


Fig. shows the variation of co with respect to load. It is learned that the variation in *CO* emissions for all biodiesel blends and diesel is fairly small. This may be due to the oxygen content and less *C/H* ratio of biodiesel that causes complete combustion. However, it is revealed that the decreasing trend of *CO* emission does not rely on biodiesel percentage in the blends

3.2.2. CO_2 emission



The above figure shows the variation of percentage of *CO2* vs load. It is clearly seen from the figure that with the addition of biodiesel with the diesel engine causes higher amount of carbon dioxide at tail pipe. For most of the load waste frying oil has highest percentage of co2 emission due to highest oxygen content.

3.2.3. Oxides of nitrogen emissions

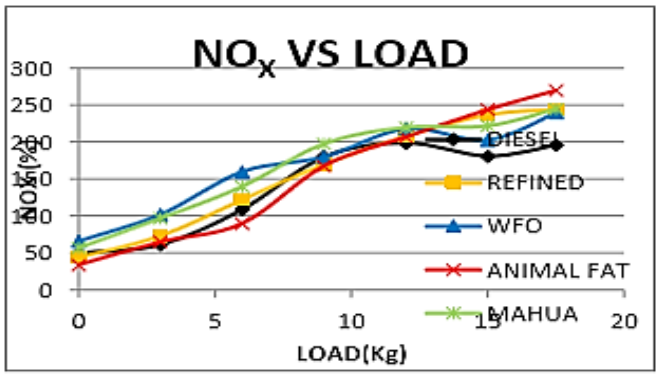


Figure shows the variation of *NOx* with load. *NOx* emissions of all biodiesel blends are higher than that of conventional diesel. The high combustion temperature and the presence of extra oxygen are the main parameters for more *NOx* emissions. This can be reduced with proper adjustment of injection timing and recirculating the small portion of exhaust gas with fresh air during the induction process.

3.2.4. *HC* emissions

Unburned hydrocarbon *(UBHC)* pollutants are formed when the fuel is not completely burned. UBHC is one of the important parameters for determining the emission behavior of diesel engine it is observed that UBHC reduction is due to the presence of oxygen content in the biodiesel that leads to faster the combustion chemical reaction.

4. Conclusion

The main objective of the present investigation was to compare the characteristics of soya bean biodiesel, animal fat biodiesel, mahua biodiesel and waste frying biodiesel with the mineral diesel and to prove its viability as a substitute for diesel fuel. The following conclusions can be drawn from the experimental work. *1.* The performance characteristics of soya bean biodiesel is found to be quite satisfactory and close to the minerals diesel and that of waste frying oil is quite low in comparison to diesel *2.* Exhaust gases temperature increases with load due to corresponding high

temperature inside the cylinder. *3.* Soya bean biodiesel gives the highest exhaust gas temperature. *4.* The peak pressure is highest for Soya bean oil compared to other fuels. 5. The emissions of *CO, CO2* and *HC* is found to be quite low compared to mineral diesel. 6. The emission of *NOX* is higher for biodiesel. The prepared biodiesel will provide an environmentally friendly substitute for the diesel. Although the performance characteristics and the emissions level of biodiesel is quite satisfactory and has been tested in diesel engine successfully, the relative high viscosity of these oils and higher specific fuel consumption causes low thermal efficiency and brake power etc. In order to counter these problem future endeavors must be directed towards the researches which confirm these biodiesels as a substitute of fossil fuels.

References

1. E.Griffin Shay. Diesel fuel from vegetable oils: Biomass Bioenergy, 4:227-242,1993.
2. M.Zejewski, H.Goettler and L.Pratt. Influenze of vegetable oil based alternative fuels on residue deposits and components wear in a diesel engine. SAE, paper no. 860302:297-307,1986.
3. T.W.Ryan and M.O.Bagby. Identification of chemical changes occurring during the transient injection of selected vegetable oils. SAE, paper no. 930933:1440-1494, 1993.
4. I.Czerwinski. Diesel engine with addition of ethanol and rapeseed oil.SAE, 940- 945, 1994.
5. P.Srinivasa Rao and K.Y.Gopalakrishnan. Esterified oils as fuel in diesel engines. 11th National Conference on 1.C. Engines, I.I.T. Madras, India, 1983.
6. A.s.Ramadhas, S.Jayaraj, K.Lakshmi Narayana Rao. Experimental investigation on non-edible vegetable oil operation in diesel engine for improved performance. National Conference on Advances in Mechanical Engineering, J.N.T.U., Anantapur, India, 2002.
7. V.Domkundwar. A course on I.C. engines. First edition, Dhanpat Rai & Co, New Delhi, 2001.
8. Recep Altan, Selim Cetinkay and Huseyin Serdar Yucesu. The potential of using vegetable oil fuels as fuel for diesel engines. Energy Conversion and Management, 2001.
9. W.Christopher. The practical implementation of bio-diesel as an alternative fuel in service motor oaches. SAE, 973201, 1997.
10. X.Montague. Introduction of rapeseed methyl ester in Diesel fuel-the French National Program. SAE, 962065, 1996.
11. G.H.Hohl. Rape oil methyl ester and used cooking oil methyl ester as alternative fuels. SAE, 952755, 1995.
12. Norbert Hemmerlein, Volker Korte and Herwig Richter. Performance, exhaust emission and durability of modem diesel engines running on rapeseed oil. SAE, 910848, 1991.
13. M.Jose', Desantes, Jean Arregle and Santiago Ruiz. Characterization of the injection combustion process in a DI Diesel engine running with Rape seed oil methyl ester. SAE, 1999-01-1497, 1999.
14. Tadashi and Young. Low carbon build up, low smoke and efficient diesel operation with vegetable oil by conversion to monoesters and blending with diesel oil or alcohols. SAE, 841161, 1984.
15. A.Senatore. A comparative analysis of combust ion process in D. I. diesel engine fueled with biodiesel and diesel fuel. SAE, 2000-01-0691, 2000.
16. C.Y.Choi. Effect of bio-diesel blended fuels and multiple injections on D.I. diesel engines. SAE, 970218, 1997.
17. Peter Klee. Characterization of different vegetable oil fuel with regard to their suitability as diesel fuel substitutes under special consideration of their physical and chemical properties. SAE, VDI Nr.375, 1983.
18. Y.Zhang. Combustion analysis ofesters of Soya bean oil in a diesel engine. SAE, 960765, 1996.
19. T.K.Ghormade and N.V.Deshpande. Soya bean oil as an alternative fuels for I. C. engines. Proceedings of Recent Trends in Automotive Fuels, Nagpur, India, 2002.
20. D.R.Pangavhane and P.B.Kushare. Bio-diesel need of India. Proceedings of Recent Trends in Automotive Fuels, Nagpur, India, 2002.
21. M.J.Jacobus and S.M.Geyer. Single cylinder diesel engine study on four vegetable oils. SAE, 831743, 1983.
22. Mariusz Ziejwski and J.Goettler. Design modifications for durability improvements of diesel engines operating on plant oil fuels. SAE, 921630, 1992.
23. B.S.Samaga. Vegetable oil as alternative fuels for C.I. engines. 8th National Conference on I. C. Engines, Trivandrum, India, 1983.
24. Kelvin Schimidt and Jonvan Gerpan. The effect of bio-diesel fuel composition on diesel combustion & emission. SAE, 961086, 1996.
25. N.J.Barsic and H.Humke. Performance and emission characteristics of a naturally aspirated diesel engine with vegetable oil. SAE, 810262, 1981.
26. Rosa Radu. The use of sunflower oil in diesel engines. SAE, 972979, 1997.
27. K.Zeiejerdki and K.Pratt. Comparative analysis of the long term performance of a diesel engine on vegetable oil. SAE, 860301, 1986.
28. A.Salvatore and A.Maddaleena. The effect of methyl ester of rapeseed oil on combustion and emissions of D.I. diesel engines. SAE, 932801, 1993.
29. Yasufumi Yoshimoto, Masayuki Onodera and Hiroya Tamaki. Reduction of NOx, smoke, B S F C in a diesel fueled bio-diesel emulsion used frying oil. SAE, 1999-013598, 1999.
30. Yu CW, S.Ban and A.Ameen. A comparison of combust ion characteristics of waste cooling oils as fuel in a D. 1. Diesel engines. Part B, 216D3, 1. Mech. E., 2002.
31. H.H.Masjuki, M.A.Kakm, M.A.Maleque, A.Kubo and T.Nonaka. Performance, emissions and wear characteristics of a 1.D.I. diesel engine using coconut blended oil. Part D 215, 1. Mech. E., 2001.
32. M.Senthil Kumar, A.Ramesh and B.Nagalingam. Experimental investigation on Jatropha oil— Methonal dual fuel engines.SAE, 2001-01-0153, 2001.
33. N.V.Deshpande. Bio-diesel - An alternative fuel for compression ignition engines. Proceedings on Recent trends in alternative fuels, Nagpur, India, 2002.
34. H.Masjuki and Abdulmin. Investigation on preheated palm oil-methyl ester in diesel engine, SAE, 15-Z10-A2-131.
35. M.V.Prasasd and M.Krishna. Performance evaluation of non-edible vegetable oil as substitute fuel in LHR engine. SAE, 18- 214-D2-181.
36. M.K.Abbas and I.L.Davis. The composition of organic fraction of particulate emission of a diesel engine operated on vegetable oil. SAE, 901563, 1990.
37. The Hindu, Daily Newspaper dated 4.1.2003.
38. S.Dhinagar and B.Nagalingam. Experimental investigation on non-edible vegetable oil operation in a LHR diesel engine for improved performance. SAE, 932846, 1993.