Performance Analysis of Emissions using Bio-Diesels as Fuel for different Compression Ratio (Review)

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Abstract - *The rapidly increasing consumption of fossil fuel and petroleum products has been a matter of concern for the many countries which imports more crude oil. Because it causes huge foreign exchange out-go on the one hand and increasing exhaust emission on the other. Therefore it is necessary for the development of renewable energy sources. Vegetable oils have become more attractive recently because of their environmental benefits and it is made from renewable resources. Bio-diesel commands crucial advantages such as technical feasibility of blending in any ratio with petroleum diesel fuel, use of existing storage facility and infrastructure, superiority from the environment and emission reduction angle, its capacity to provide energy security to remote and rural areas and employment generation. There are more than 350oil bearing crops identified, among which only sun flower, sunflower, soybean, cottonseed, rapeseed, Jatropha curcas and peanut oils are considered as potential alternative fuels for Diesel engines. Smoke reduces as compression ratio increase. When compared with diesel fuel the smoke increases for all blends for lower CR while for higher CR smoke reduces drastically. As compression ratio increases the NOx increases for neat diesel while NOx decreases for lower blends.CO was not changed with compression ratio for all the blend of fuel. Brake specific fuel consumption decreases with the compression ratio increases. Brake thermal efficiency increase with the compression ratio for all fuel. Exhaust gas temperature increases with compression ratio for all blends*.

Key Words: *Jatropha Oil, Mahua Oil, Blends, Compression Ratio, Blends B20, B40, B60*

Literature Review:

The rapidly increasing consumption of fossil fuel and petroleum products has been a matter of concern for the many countries which imports more crude oil. Because it causes huge foreign exchange out-go on the one hand and increasing exhaust emission on the other. Therefore it is necessary for the development of renewable energy sources.
A.S.Ramadhas, S.Jayaraj, C.Muraleedharan, work "Characterization and effect of using rubber seed as fuel in the compression ignition engines", Renewable Energy, 30 (2005). 2005/10/31. Journal Renewable energy Volume 30 Issue12 Pages1789-1800 Publisher Pergamon. In this paper A. Ramadhas successfully ran a Diesel engine with rubber seed oil and stated that a compression ignition engines can be made run on it without a hitch.
Dr. Deshpande NV. "Bio-diesel: An alternative fuel for compression ignition engines, Proceedings on Recent trends in alternative fuels, Nagpur, India, 2002.International Journal of Scientific and Research Publications, Volume 2, Issue 10, October 2012 1 ISSN 2250-3153. Dr. Deshpande advocates "using of bio-diesel as an alternative to diesel.
American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 P-ISSN: 2320-0936 Volume-02, Issue-10, and pp-22-47.The researchers found the following results when Mahua oil was used:_800-850ml of esterified Mahua oil is extracted from 1000ml of Mahua oil during esterification. Percentage increase in esterified Mahua oil increases the viscosity of diesel.ϖ Increase in percentage of Mahua oil increases the cetane number of the blend.ϖ Smooth running of engine is observed with esterified Mahua oil compared with that of diesel.ϖ Slight increase in brake thermal efficiency and decrease in specific fuel consumption is observed in the caseϖ of esterified Mahua oil (all blends especially 75% Mahua oil) compared to that of diesel.
Zeiejerdki K, Pratt K. "Comparative analysis of the long term performance of a diesel engine on vegetable oil", SAE 860301, 1986.Zeiejerdki K, Pratt K in their paper stated that there was no problem in running the engine on Bio-diesel because it won't harm the engine in short runs but in long term performance analysis they found out gradually the efficiency of the engine decreases. Also high viscous oil tends to form wax in the engine which leads to many problems.

1. INTRODUCTION:

With the Modernization and industrial growth in the world, the consumption of the petroleum resources is increasing day by day but these resources are limited, it is widely acceptable that these natural petroleum resources are likely to be depleted in 100 years from now. Thus in the favor of this experimental data there is a requirement of alternative sources to replace these petroleum resources without a wider change in the conventional engines and which are renewable and easily achievable in the nature and Also should be available at low cost.
Biodiesel will be the best alternative over the diesel because it is renewable, environment friendly and easily produced in rural area. It can produce same power as the conventional

diesel fuel in the conventional diesel engine. It is non toxic and produced less CO2 and CO on the combustion. Biodiesel is derived from the vegetables like Sunflower, Neem, Jatropha, Mahua, curcas, corn and canola etc. In recent years many efforts have been taken by the several researchers in making the Biodiesel suitable. There is Number of Countries which are working on different aspect of producing Biodiesel, for example in Philippines research on coconut oil, USA research on the soybeans oil. Europeans country research on sunflower oil. In the all non-edible Tree Bearing Oil (TBO) seeds, Jatropha is considered as most favorable plant for the production of biodiesel, because it can be harvest in the non agricultural land and also in the area of low rain fall (~27 cm) as well as heavy rain fall. It can be used directly after the extraction (without refining) in the conventional diesel engine. Jatropha curcas can grow in the variety of agro-climatic conditions. Thus it ensures the reasonable production at the low input. Jatropha Biodiesel can be used or mixed in any ratio with the diesel. But preferred ratio is between 5 to 20%.

Two species of the genus madhuca indica and madhuca longifolia are found in India. Mahua is known as *Illupai maram* in Tamil and *Hippi* in Kannada, which can be successfully grown in the wastelands and dry lands. The seeds of the tree popularly known as `Indian butter tree. The specific gravity of mahua oil was 9.11% higher than that of diesel. The kinematic viscosity of mahua oil was 15.23 times more than that of diesel at temperature of 40c. The kinematic viscosity of mahua oil reduced considerably with increase in temperature to 80c and by increasing the proportion of diesel in fuel blends.

Table -1: Comparison of properties of Jatropha Oil and Mahua Oil

Properties	Diesel	Jatropha Oil	Mahua Oil
Density gm/cc	0.840	0.918	0.918
Calorific Value MJ/KW-hr	42.39	39.774	38.863
Cetane Number	45.55	45	38
Viscosity @ 44^0C	4.59	49.9	68.51
Flash Point ^{0}C	75	240	238
Carbon Residue	0.1	0.44	0.4215
Fire Point ^{0}C	78	244	244

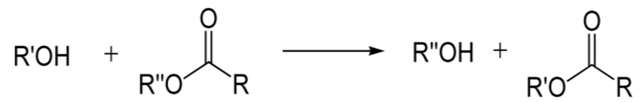
1.2 Modification: The problems associated with viscosity can be reduced by heating the oil before entering into the engine.

1. Further the fuel injection problem can be increasing the injection pressure.
2. The problems associated with late/slow burning can be avoided by advancing fuel injection and preheating the fuel.
3. All the above problems can be eliminated up to certain extent by blending vegetable oils with diesel (Transesterification).
4. Low problems can be eliminated by winterization (popular technique for reducing high melting point by freezing them over a prescribed time period and drawing the liquid portion off separately)

1.2 Biodiesel production: The process of producing the bio fuel, biodiesel, through the chemical reactions transesterification and esterification. This involves vegetable or animal fats and oils being reacted with short-chain alcohols (typically methanol or ethanol). The alcohols used should be of low molecular weight, ethanol being one of the most used for its low cost. However, greater conversions into biodiesel can be reached using methanol. Although the transesterification reaction can be catalyzed by either acids or bases the most common means of production is base-catalyzed transesterification. This path has lower reaction times and catalyst cost than those posed by acid catalysis. However, alkaline catalysis has the disadvantage of its high sensitivity to both water and free fatty acids present in the oils.

1.3 Transesterification:

In organic chemistry, **transesterification** is the process of exchanging the organic group R″ of an ester with the organic group R′ of an alcohol. These reactions are often catalyzed by the addition of an acid or base catalyst. The reaction can also be accomplished with the help of enzymes (biocatalysts) particularly lipases (E.C.3.1.1.3).



Strong acids catalyze the reaction by donating a proton to the carbonyl group, thus making it a more potent electrophile, whereas bases catalyze the reaction by removing a proton from the alcohol, thus making it more nucleophilic. Esters with larger alkoxy groups can be made from methyl or ethyl esters in high purity by heating the mixture of ester, acid/base, and large alcohol and evaporating the small alcohol to drive equilibrium.

1.4 Experimental Setup and Specification:

Sr. No.	**Engine Parameters**	**Constant Values**
01	Fuel Density	830 kg/m³
02	Fuel Calorific Value	42000 KJ/Kg
03	Compression Ratio	12-18

04	Cylinder Dia.	0.0875 m
05	Stroke length	0.11 m
06	No. Of Cylinder	1
07	Specific Heat Of Exhaust	1.542 KJ/Kg-K
08	Rated power	5bhp at 1500rpm
09	Dynamometer Type	Eddy current, water cooled, with loading unit
10	Piezo sensor	Range 5000 PSI, with low noise cable
11	Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse

2 EXPERIMENTAL RESULTS:

2.1 Emission Analysis: CO

As shown in graphs that CO emissions for the Diesel is higher than that of the blends of Jatropha biodiesel. The increase of CO emission as load decrease was an indication of improve combustion efficiency was in correlation to the change in brake thermal efficiency BTE under change in load. But at the 80% load CO emission rapidly increase it is due to that at higher load fuel consumption is high and combustion process also high this increase incomplete combustion, resulting in rapid increase in the CO emission. The emissions of CO increase with increasing load. Higher the load, richer fuel air mixture is burned, and thus more CO is produced due to lack of oxygen. As we discussed above that co emission in the blends of the biodiesel is lower than that of the diesel due to the less carbon content in to the biodiesel blends, but as in graph that CO emission for the B80 is slightly higher than that of the B40. Its reason may be the improper atomization and high viscosity of the Biodiesel blend, which leads to the improper combustion and lead to increase emission of CO. In the this is case of preheated Jatropha oil the CO emission is less in comparison to all blends this is due to the pure biodiesel which have less carbon content and also due to preheating of the biodiesel, leads to decrease it viscosity and improve atomization and proper combustion and resulting in the less CO emission.

2.2 CO_2 Emission:

The carbon dioxide emission from the diesel engine with different blends is shown in graphs. The CO2 increased with increase in load conditions for diesel and for biodiesel blended fuels. The carbon dioxide emission from the diesel engine with different blends is shown in graph. The CO2 increased with increase in load conditions for diesel and for biodiesel blended fuels. The Jatropha biodiesel followed the same trend of CO2 emission which was higher than in case of diesel. Since biodiesel is produced from plant oils or animal fats, it has been promoted as means for reducing emissions of carbon dioxide that would otherwise be produced from the combustion of petroleum-based fuels. Carbon dioxide is considered by many to be an important component in global warming, though other pollutants can also play a role. The total impact that biodiesel could have on global warming would be a function not just of its combustion products, but also of the emissions associated with the full biodiesel production and consumption lifecycle. We perform the experiment for the B40 and
B80 blends of the biodiesel and compare it with Diesel in the diesel engine. Thus we can see in the graphs that CO2 emission for the diesel is higher than that of the any blends of the biodiesel this is due to that diesel contain carbon content in high quantity in comparison of biodiesel. And also emission of CO2 for the blends is nearly same, but that for preheated biodiesel is lower than the blends, this may be because pure biodiesel with any mixing of the Diesel very low carbon content.

2.3 HC Emission:

HC exhaust emissions are shown in the graphs. For all of blends, the HC emissions were less than that of the diesel fuel. Biodiesel contains oxygen in its structure. When biodiesel is added to diesel fuel, the oxygen content of fuel blend is increased and thus less oxygen is needed for combustion. However oxygen content of fuel is main reason for better combustion and reduction in to the HC emission. On the other hand, the reduction of HC is due to the oxygenated fuel of biodiesel, it leads to a more complete combustion. The higher cetane number of biodiesel fuel reduces delay period leading to lower HC emissions. Thus, the higher oxygen content and cetane number of biodiesel-diesel fuel blends tend to reduce HC emissions when compared to conventional diesel. Diesel engine performance showed that the biodiesel blend offered lower engine power output, higher specific fuel consumption, and lower mechanical efficiency. Consequently, the biodiesel producing cleaner emission with the significant drop in CO, and HC emissions compares to the conventional diesel.

2.4 O_2 Emission:

As we seen in the graphs that O2 emission for the blends of biodiesel is higher than that of the Diesel. This is due to because Biodiesel is an oxygenated fuel and it contains oxygen of about 11% by weight. High oxygen content leading to complete combustion. The presence of oxygen in biodiesel fuel results in higher heat release during the premixed phase combustion. As we seen in the graphs that O2 emission is maximum for the preheated biodiesel is maximum and then for the biodiesel blends and lowest for the mixture the emission of the O2 will be increase. Emission of the O2 decrease with the increase in the load. And it is minimum at 80% load, because at this load the brake power is maximum thus mean increase in the combustion rate and consumption of the oxygen of the fuel for the combustion process.

2.5 Smoke Emission:

The graph was plotted between smoke emission and varying load (%). The smoke emission found to increase continuously with the increase in load. It is clear from the graph that smoke emission for the diesel is maximum and minimum for the preheated Jatropha oil, Blends of Jatropha biodiesel shows intermediate performance for the smoke emission, the lies between the Diesel and Preheated Jatropha oil in the smoke emission characteristics. At the zero load smoke emission is high but as the load increase it value decrease till 60% load, but at 80% load it value suddenly increase. Smoke emission for the diesel is minimum at the 60% load approximate 20 % 18CR, and for the B40 and B80 blends also minimum at 60% load, this also continue in the case of preheated biodiesel. Thus from the this experimental data it is clear that Diesel, all blends of Jatropha Biodiesel and preheated Jatropha oil shows good smoke emission characteristics for the 60% load and 18 compression ratio.

3. CONCLUSIONS

The studies executed in the scope of both analysis and experimentation of title has revealed the followings:

- Use of Bio-Diesels in Compression ignition engine is possible.
- The main problem is that the output gets changed drastically depending upon the fuel we use.
- Also the compression ratio plays a significant role in output and performance. Compression ratio should always be raised and should not be lower, as lower compression ratio leads to incomplete combustion of fuel.
- Above mentioned statement leads to generation harmful exhaust gases and sometimes even dangerous exhaust gases can be formed.
- Also it should be noted that high viscous fuel should be avoided as they leads to formation of wax within the engine.
- Formation of wax in engines leads to rise in temp. of engine and lowering of and power generation drops.
- To avoid above problems transesterification process is used to break down the high viscous oil into esters and alcohol respective to the oil used.
- Jatropha oil is only oil in the list of selected bio-diesel which can be directly used in engine without any pre-processing.
- In Blending 20:80 proportion is used i.e. 20% vegetable oil and 80% of Diesel.

- Smoke reduces as compression ratio increase. When compared with diesel fuel the smoke increases for all blends for lower CR while for higher CR smoke reduces drastically. As compression ratio increases the NOx increases for neat diesel while NOx decreases for lower blends.CO was not changed with compression ratio for all the blend of fuel. Brake specific fuel consumption decreases with the compression ratio increases. Brake thermal efficiency increase with the compression ratio for all fuel. Exhaust gas temperature increases with compression ratio for all blends.

- In general, increasing the compression ratio improved the performance and cylinder pressure of the engine and had more benefits with biodiesel than with high pure diesel.

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REFERENCES

[1] Saurabh Sharma, Rohit Singh, Mayank Mishra, Gaurav Kumar Mitra and Rakesh
Kumar Gangwar, "Performance and Emission Analysis of Diesel Engine using Biodiesel and
Preheated Jatropha Oil", International Journal of Current Research and Academic Review, ISSN: 2347-3215 Volume 2 Number 6 (June-2014) pp. 229-239

[2] Sudheer Nandi, "Performance of C.I Engine by Using Biodiesel-Mahua Oil", American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-02, Issue-10, pp-22-47

[3] A.S.Ramadhas*, S.Jayaraj, C.Muraleedharan, "Characterization and effect of using rubber seed as fuel in the compression ignition engines" Renewable Energy, 30 (2005) 2005/10/31Journal Renewable energy Volume 30 Issue12 Pages1789-1800 Publisher Pergamon.

[4] Dr. Deshpande NV. "Bio-diesel: An alternative fuel for compression ignition engines, Proceedings on Recent trends

in alternative fuels," Nagpur, India, 2002 International Journal of Scientific and Research Publications, Volume 2, Issue 10, October 2012 1 ISSN 2250-3153

[5] Barsic, N. and Humke, A., "Performance and Emissions Characteristics of a Naturally Aspirated Diesel Engine with vegetable Oil Fuels," SAE Technical Paper 810262, 1981, Paper #:810262 Published: 1981-02-01 DOI: 10.4271/810262

[6] Zeiejerdki K, Pratt K. "Comparative analysis of the long term performance of a diesel engine on vegetable oil, "SAE 860301, 1986. VOL.7, NO. 4, APRIL 2012 ISSN 1819-6608 ARPN Journal of Engineering and Applied Sciences

[7] American Journal of Engineering Research (AJER) e-ISSN: 2320- 0847 p-ISSN: 2320-0936 Volume-02, Issue-10, pp-22-47.

[8] IC Engine by V. Ganesan.

[9] Introduction to Bio fuels (Mechanical and Aerospace Engineering Series) by David Mousdale

[10] K. Schmidt, J. Van Gerpen, The effect of biodiesel fuel Composition on diesel combustion and emissions, Soc. Automat. Eng. SP1181 (1996) 113–124.

[11] D.Y. Chang, J.H. Van Gerpen, I. Lee, L.A. Johnson, E. Hammond, S.J. Marley, Fuel properties and emissions of soybean oil esters as diesel fuel, J. Am. Oil. Chem. Soc. 73 (1996) 1549–1555.

[12] M.P. Dorado, E. Ballesteros, J.M. Arnal, J. Gomez, F.J. Lopez, Exhaust emissions from a diesel engine fuelled with Transesterified waste olive oil, Fuel 82 (2003) 1311–1315.

[13] J. Kahn, H. Rang, J. Kriis, Advance in biodiesel fuel research, Proc. Estonian Acad. Sci. Chem. 51 (2002) 75–117.

[14] M. Edlund, H. Visser, P. Heitland, Analysis of biodiesel by Argon – oxygen mixed-gas inductively coupled plasma optical emission spectrometry, J. Anal At. Spectrum. 17 (2002) 232–
235.

[15] J.B. Williams, Production of biodiesel in Europe – the markets, Eur. J. Lipid. Sci. Technol. 104 (2002) 361–362.

[16] S. Kalligeros, F. Zannikos, S. Stournas, E. Lois, G. Anastopoulos, Ch. Teas, An investigation of using biodiesel/ marine diesel blends on the performance of a stationary diesel engine, Biomass Bio-energy 24 (2003) 141–149.

[17] G. Labeckas, S. Slavinskas The effect of rapeseed oil methyl ester on direct injection diesel engine performance and exhaust emissions, Energy Convers. Manage 47 (2006) 1954–1967.

[18] L.G. Schumacher, S.C. Borgelt, D. Fosseen, W. Goetz, W.G. Hires, Heavy-duty engine exhaust emission tests using methyl ester soybean oil/diesel fuel blends, Bio-resource Technol. 57
(1996) 31–36.

[19] H. Raheman, A.G. Phadatare, Diesel engine emissions and performance from blends of karanji methyl ester and diesel, Biomass Bio-energy 27 (2004) 393–397.

[20] M. Canakci, J.H.V Gerpen, The performance and emissions of a diesel engine fuelled with biodiesel from yellow grease and soybean oil. in: An ASAE Annual International Meeting Presentation, Paper Number: 01–6050, Sacramento, CA, USA, 30 July–01August, 2001, p. 17.