Performance and Emission Studies of Diesel Engine with Biodiesel Blends

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Abstract— The rapid growth in industrialization and motorization of the world has raised the demand of conventional petroleum-based fuels. Conventional fuels obtained from limited recourses. These finite reserves are highly concentrated in certain regions of the world. Therefore, developing countries like India are facing energy crisis day by day, mainly due to the import of crude petroleum. Hence, it is necessary to look for alternative fuels which can be produced from resources available locally within the country such as alcohol, biodiesel, vegetable oils etc. This paper touches biodiesel and its blending with pure diesel as well as the experimental research work carried out in diesel engine with biodiesel. The experimental results showed that the performance of CI engine was improved with the use of the B20 especially in comparison to pure diesel.

Key words — Biodiesel, Diesel engine. Emission

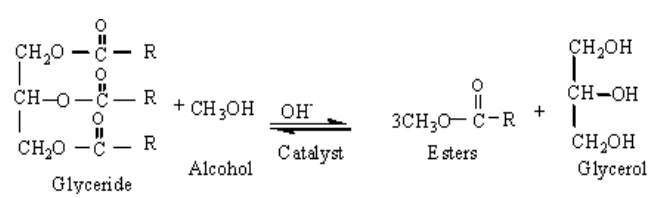
1. INTRODUCTION

The large increase in number of automobiles in recent years has resulted in great demand for petroleum products. With crude oil reserves estimated to last for few decades, there has been an active search for alternate fuels. The depletion of crude oil would cause a major impact on the transportation sector**.** Out of the various alternate fuels under consideration, biodiesel, derived from vegetable oils, is the most promising alternative fuel to diesel engine due to the fact that it can be used in the existing engine without any modifications and can be made entirely from vegetable sources. So far as emission is concerned it emits low CO and HC.

1.1 About the Biodiesel

Biodiesel is also named as fatty acid methyl ester and produced by a process known as transesterification. A byproduct of transesterification is glycerol and has industrial application.

Biodiesel can be prepared either by edible or non edible oil. Use of non edible oil will be beneficial in terms of cost and overcome food scarcity.



Biodiesel can however be effectively used to replace our diesel requirements. Diesel has been the backbone of our economy. Diesel is not only used in the transport sector but also in agriculture and industries for generating electricity, running pumps and tractors etc. The entire use of diesel oil can be substituted with biodiesel. The properties of biodiesel are quite close to that of diesel.

There are various advantages of using biodiesel:

i. It is cost effective.
ii. It acts as a good lubrication to the engine.
iii. Less emission in terms CO, and HC would result in clean environment.
iv. Oil seeds for biodiesel can be grown in wastelands.

However the biggest advantage of using biodiesel is the economic aspect. The dependence on biodiesel would generate large scale employment in rural areas which will increase the average income of the households in village. The government which spends millions of rupees providing subsidies on the petroleum goods can use this huge pool of money in other sectors. Hence it is observed that the use of biodiesel has the potential to solve our energy needs in the future.

Table 1.1 Properties of biodiesel and petroleum diesel

Characteristics	**Biodiesel (Palm)**	**Petroleum diesel**
Type of Source	Renewable	Fosil
Flash point[^{0}C]	174	98^{0}C
Fire point[^{0}C]	256^{0}C	107^{0}C
Pour point[^{0}C]	16^{0}C	15^{0}C
Cloud point[^{0}C]	16^{0}C	18^{0}C
Viscosity at 40^{0}C[cST]	4.5	4
Density at 40^{0}C[kg/l]	0.855	0.823
Calorific value[MJ/KG]	41.3	46.8(MJ/KG)
Cetane level	65	53
Sulphur content[wt.%]	0.04	0.10
Carbon residue[wt.%]	0.02	0.14

2. Methodology

4 Stroke single cylinder diesel engine (fig2.1) is tested and performance is obtained for pure diesel and blended diesel.

Fig 2.1 Four-stroke compression ignition engine

2.1.1 **Specification of Engine:**

4 Stroke diesel engine having a loading system, a rope brake arrangement, water cooling system, engine base to minimize the vibration, a manometer, thermocouples for temperature measurement.

Table 2.1 The specification of diesel engine in which experiment is performed

Type	VRC-1
Power	3.7 KW
Maker	KIRLOSKAR
BHP	5
Speed	1500 RPM
Compression Ratio	16.5:1
Bore	80 mm
Stroke	110 mm
Type of Ignition	Compression
Method of Loading	Rope Brake
Type of Governor	Centrifugal

In this paper blending of Diesel with Bio diesel is done in different proportion. The proportions are as follows:

I. B00 fuel (Pure Diesel)
II. B10 fuel (90% Diesel + 10% Biodiesel)
III. B15 fuel (85% Diesel + 15% Biodiesel)
IV. B20 fuel (80% Diesel + 20% Biodiesel)
V. B25 fuel (75% Diesel + 25% Biodiesel)
VI. B30 fuel (70% Diesel + 30% Biodiesel)

3. Results and Discussion

The following performance curves shows the comparision between pure diesel and diesel blend B0, B10, B15, B20, B25 & B30

From the fig3.1 we can see that all the blendings are showing linear deviation of brake power w.r.t. load. Brake power doesn't get affected much by using different blends.

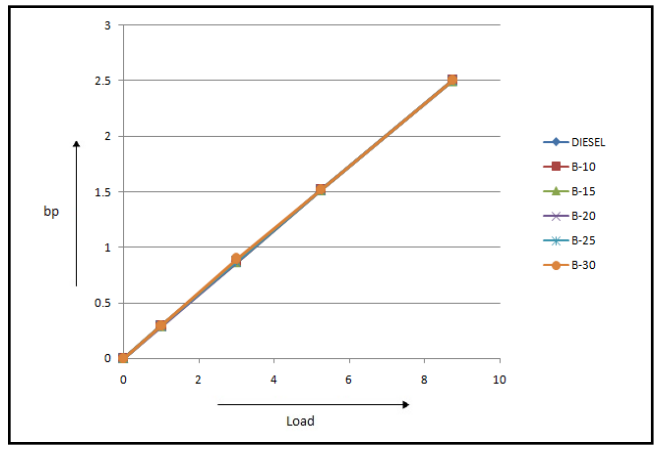


Fig 3.1 Load v/s bp comparison

The fig3.2 is showing that B10 has lowest brake specific fuel consumption, pure diesel is just above the B10 and the rest of blending are above B00 with B25 the highest value. Bio-diesels having slightly higher values than pure diesel because of lower C.V of bio-diesel.

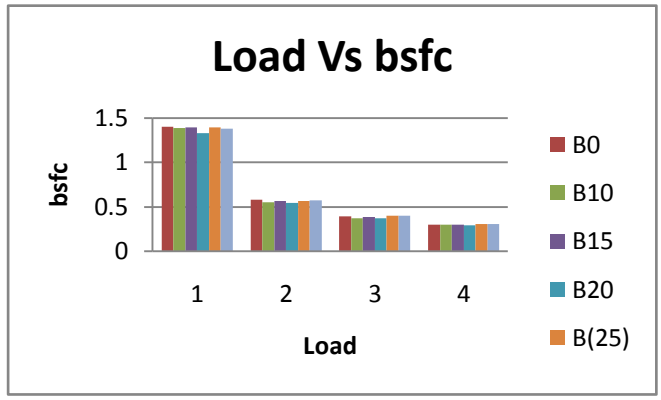


Fig 3.2 Load v/s bsfc comparision

The fig3.3 shows the bio-diesel blended fuels have greater brake thermal efficiency as compared to pure diesel fuel. Researches say that addition of oxygen atoms with increase in bio-diesel blending results in complete combustion of fuel.

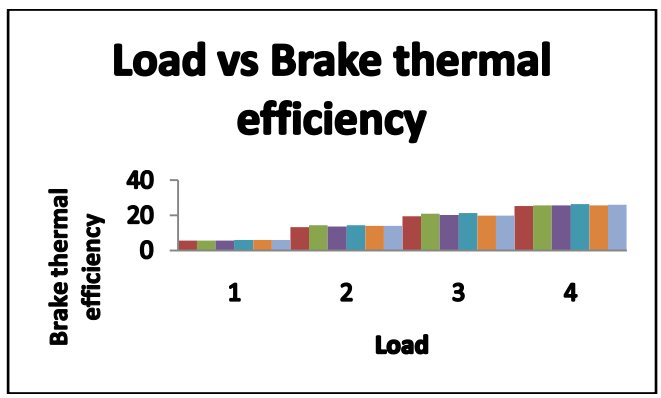


Fig 3.3 Load v/s brake thermal efficiency comparison

4. Emission studies

Emission studies shows that emission of CO and HC components are very less comparative to convention diesel fuel because oxygen content in biodiesel is more that leads to complete combustion. The only penalty in terms of emission is NOx which is quite higher than convention diesel fuel due to the fact that complete combustion of biodiesel raises the temperature inside engine cylinder which in turn increases NOx emission.

5. Conclusion

Biodiesel is an environmentally friend renewable diesel fuel alternative. The performance characteristics of the engine with pure diesel and blended diesel fuel have been compared. From the results obtained, it is understood that the thermal efficiency is slightly less with biodiesel when compared with pure Diesel. This is due to addition of oxygen atoms with increase in value of blending. And specific fuel consumption is slightly higher with bio-diesel when compared with pure diesel due to the lower calorific value of the biodiesel. It is concluded that the biodiesel can be used as alternative fuel in the Diesel engine without any engine modifications.

REFERENCES

[1] N.Janardhana Rao, M.R.CH.Sastry , Dr. P.Nageshwar Reddy , 2007 **,**"Comparative Analysis Of Performance And Emissions Of An Engine WithBiodiesel Biodiesel Blends With Diesel".

[2] G Lakshmi Narayana Rao, S Sampath, K Rajagopal , 2008 , "Experimental Studies on the Combustion and Emission Characteristics of a Diesel Engine Fuelled with UsedBiodiesel and its Diesel Blends".

[3] Edward Antwi ,2006 , "Experimental Analysis OfBiodiesel Blend in a Compression Ignition (CI) Engine".

[4] Soni S.Wirawan, Armansyah H. Tambunan, Martin Djamin, Hiroshi Nabetani , "The Effect of Palm Biodiesel Fuel on the Performance and Emission of the Automotive Diesel Engine".

[5] B. Deepanraj, C. Dhanesh, R. Senthil, M. Kannan, A. Santhoshkumar , 2011, "Use ofBiodiesel Biodiesel Blends as a Fuel for Compression Ignition Engine".

[6]Azhar Abdul Aziz; Mohd Farid Said and Mohamad Afiq Awang, "Performance ofBiodiesel-Based Biodiesel Fuels in a Single Cylinder Direct Injection Engine".

[6] Palm Biodiesel an Alternative Green Renewable Energy for the Energy Demands of the Future : *ICCBT 2008 - F - (07) – pp79-94*

[7] Sendzikiene, E., Makareviciene, V. and Janulis, P. 2006. Influence of fuel oxygen content on diesel engine exhaust emissions. Renewable Energy 31(2006) 2505-2512.

[8] Kalligeros, S., Zannikos, F., Stournas, S., Lois, E., Anastopoulos, G., Teas, C. and Sakellaropoulos, F. 2003. An investigation of using biodiesel/marine diesel blends on the performance of a stationary diesel engine. Biomass and Bioenergy 24 (2003) 141 – 149

[9] Canakci, M. and VanGerpen, J.H. 2003. Comparison of engine performance and emission for petroleum diesel, yellow grease biodiesel & soybean oil biodiesel. Transaction Of ASAE 46 (4): 937-943.

[10] S. Jindal,2009," Effect of engine parameters on NOx emissions with Jatropha biodiesel as fuel" International Journal of Energy and Environment, Volume 1, Issue 2, 2010 pp.343-350.

[11] Kalam, M.A. and Masjuki, H.H. 2002. Biodiesel from palmoil—an analysis of its properties and potential. Biomass and Bioenergy 23 (2002) 471 – 479

[12] Ramadhas, A.S., Jayaraj, S. and Muraleedharan, C. 2005. Biodiesel production from high FFA rubber seed oil. Fuel 84 (2005) 335–340.

[13] Sahoo, P.K., Das, L.M., Babu, M.K.G. and Naik, S.N. 2007. Biodiesel development from high acid value polanga seed oil and performance evaluation in a CI engine. Fuel 86 (2007) 448–454.

[14] Agarwal, A.K., Bijwe, J. and Das, L.M. 2003. Effect of biodiesel utilization of wear of vital parts in compression ignition engine. Journal of Engineering for Gas Turbine and Power, Transactions of the ASME 125(2003) 604-611.

[15] Forson, F.K., Oduro, E.K. and Donkoh, E.H. 2004. Performance of Jatropha oil blends in a diesel engine. Renewable Energy 29 (2004) 1135-1145.