Effect of Jatropha Biodiesel Blend on Performance and Emission of four Stroke Single Cylinder Diesel Engine

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***Abstract*: Day by day population and air pollution increase in the world. A country like India it is a very serious matter to control vehicle exhaust emission and control the cost of fuel. To achieve above concept by improvement of engine performance with generate the air swirl inside a diesel engine combustion chamber. This attempt is made by blending of biodiesel to reduce engine emission. Here effort requires to experimental work on Single cylinder four stroke water cooled diesel engine of 5.2 kW attached with 7 HP Eddy current dynamometer and speed is 1500 rpm and the 1st phase was taken with no modification on engine for 0.5 kW to 3.5 kW load condition with Diesel and JB20 and all the performance and emission results was taken. Through above experiment it is found that Brake power and Mechanical efficiency was slightly decrease but 3 % Brake thermal efficiency and 3.90% SFC, 10.34% CO, 7.14 % HC and 10.90 % Smoke is decrease but 8.81 % NOx is increase with JB20.**

***Keywords*: Jatropha Biodiesel, Diesel engine.**

Introduction

Diesel engines are mostly internal combustion engines and efficient prime movers that are run on fossil fuel. The rapid increase in the consumption of fossil fuel is resulting in climate change, which is considered to be the most important environmental problem of the present century [3-4].

Bio-diesel, which can be used as an alternative diesel fuel, is made from renewable biological sources such as vegetable oil and animal fats. It is biodegradable, nontoxic and possesses low emission profiles [6]. Also, the uses of bio-fuels are environmentally beneficial. Use of conventional diesel fuel causes serious problem of air pollution and effects on the environment leading to effect like green house, some factors in diesel fuel results in high emission in diesel engine[1-2]. The stringent emission norms have been an important driving force to develop the CI engines more environment friendly. The main pollutants from diesel engines are carbon monoxide, hydrocarbons, nitrogen oxides and Smoke intensity. The problem of increasing demand for high brake power and the fast depletion of the fuels demand severe controls on power and a high level of fuel economy. That's Many innovative technologies are developed to tackle these problems [11].

The presented work here is aimed to explore the technical feasibility of jatropha biodiesel in compression ignition engines. jatropha curcas plant can thrive under adverse conditions. It is a drought-resistant, perennial plant, living up to fifty years and has capability to grow on marginal soils. It requires very little irrigation and grows in all types of soils [12-13].

Jatropha curcas is unusual among tree crops is a renewable non-edible plant. From jatropha seeds jatropha oil can be extracted which have similar properties as diesel but some properties such as kinematic viscosity, solidifying point, flash point and ignition point is very high in jatropha oil. By some chemical reactions, Jatropha oil can be converted into biodiesel. Jatropha oil can also be used directly by blending with diesel [5]. The purpose of this research work is to investigate the fuel properties of Jatropha oil and investigate the performance test of single cylinder diesel engine by using jatropha biodiesel blending with diesel fuel [14].

Biodiesel Blending

Biodiesel is a liquid biofuel obtained by chemical processes from vegetable oils or animal fats and an alcohol that can be used in diesel engines, alone or blended with diesel oil. Biodiesel fuel can be used in any mixture with petro diesel fuel as it has very similar characteristics but it has lower exhaust emissions [8]. Biodiesel contains virtually no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. ASTM International (originally known as the American Society for Testing and Materials) defines biodiesel as a mixture of long-chain monoalkylic esters from fatty acids obtained from renewable resources, to be used in diesel engines [9-10].

Straight vegetable oils (SVO) even though projected as an engine friendly fuel by many researchers have recently lost its attraction. Being highly viscous and less volatile, SVO's will result in poor spray atomization, vaporization, and pose serious threat to the engine health in the long run. More over many SVO's are edible oils whose continuous supply cannot be ensured in our country [15]. Measures like blending, micro emulsification, transesterification have turned out to be effective methods of viscosity reduction in vegetable oils, thus making their usage in DI diesel engines feasible. Blending refers to the mixing of vegetable oil with other low viscosity fuels like diesel and alcohol. It results in reducing the viscosity of the blends and increasing the cetane number. The blends can be directly used in diesel engines for better results. The use of 100% vegetable oil was found to be possible with some minor modifications in the fuel system. In this experiment JBD20: A blend of 20 % raw Jatropha biodiesel and 80 %diesel fuel by volume is used [7].

Experiment setup

The final product of biodiesel from Jatropha oil blending (JBD) with diesel is used as an alternative fuel to operate diesel. The Performance test are conducted on a computerized single cylinder, four stroke, direct injection, water cooled diesel engine test rig. The engine directly connected to eddy current dynamometer for variable loading. The schematic photograph of experimental setup is as shown in 1.1 figure. And the tested engine specification is shown in Table below. The engine has been run using biodiesel and required data are collected to calculate the engine performance parameters.

Table1.1: Diesel engine specification

ENGINE:	HIMALAYA
No of Cylinder:	1
Engine HP	5.2 KW (7HP)
Cooling	Water cooling
Bore:	87.5mm
Stroke:	110mm
Compression Ratio:	17.5:01
Speed:	1500 rpm

Fig1.1: Experimental setup

Results and Discussion

Brake thermal efficiency:

The variation of brake thermal efficiency of the engine with jatropha biodiesel is shown in Fig. 1.2 and compared with the brake thermal efficiency obtained with diesel. From the test results it was observed that initially with increasing load the brake thermal efficiencies of the jatropha biodiesel blends and the diesel were increased 3 % and the maximum thermal efficiencies were obtained and then tended to decrease with further increase in load, but the brake thermal efficiencies of the jatropha blends were higher than that with diesel fuel. The maximum values of thermal efficiencies for 20% Blend jatropha biodiesel diesel at 70% load. This mainly happens due to oxygen molecules present in the jatropha blend improves the combustion characteristics.

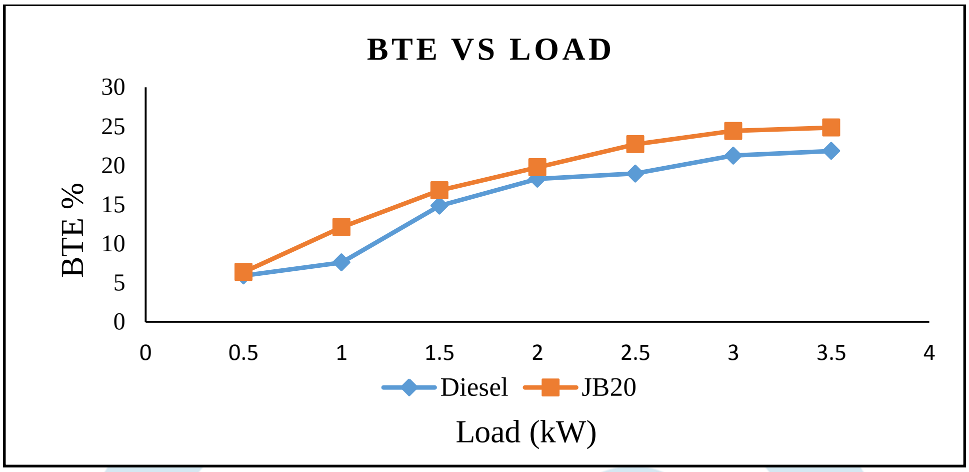

Fig1.2: Load. Vs brake Thermal Efficiency for Diesel and JB20

Brake specific fuel consumption:
Fig. 1.3 compares the specific fuel consumption of diesel and various blends of Jatropha and diesel. The Graph below shows the relation between Load and Specific Fuel Consumption. As Load Increases Specific Fuel Consumption decreases 3.90% up to rated condition and then it increases. This is mainly due to the combined effects of the relative fuel density, viscosity and heating value of the blends.

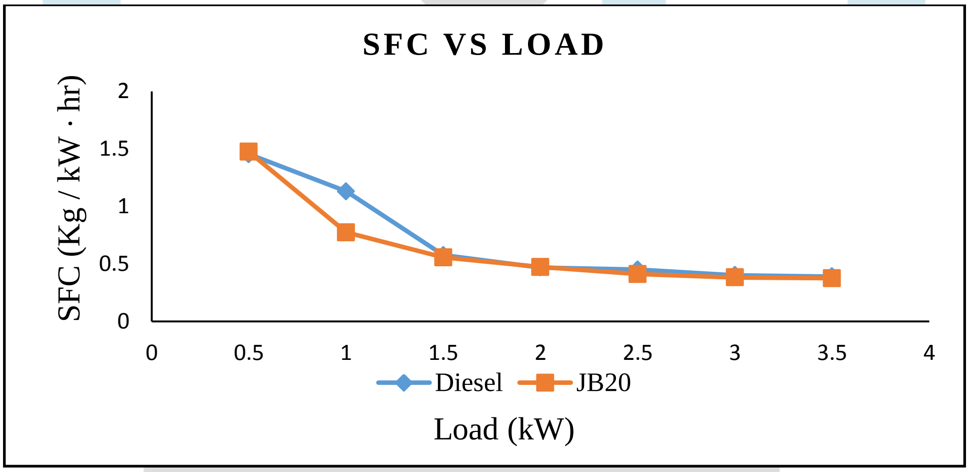

Fig1.3: B.P. vs S.F.C. For Diesel and JB20

CO Emission:
Fig 1.4 show that the variation of CO emission with Load. It is observed that the engine emits more CO for diesel at part load conditions when compared to the blends. It has been found that CO reduces 10.34% in engine exhaust as load increases up to 70% of rated load beyond that it further increases. It may be due to improper combustion in higher range of load. As the Jatropha biodiesel content increases in fuel sample, it reduces up to JB20, after that it further increases.

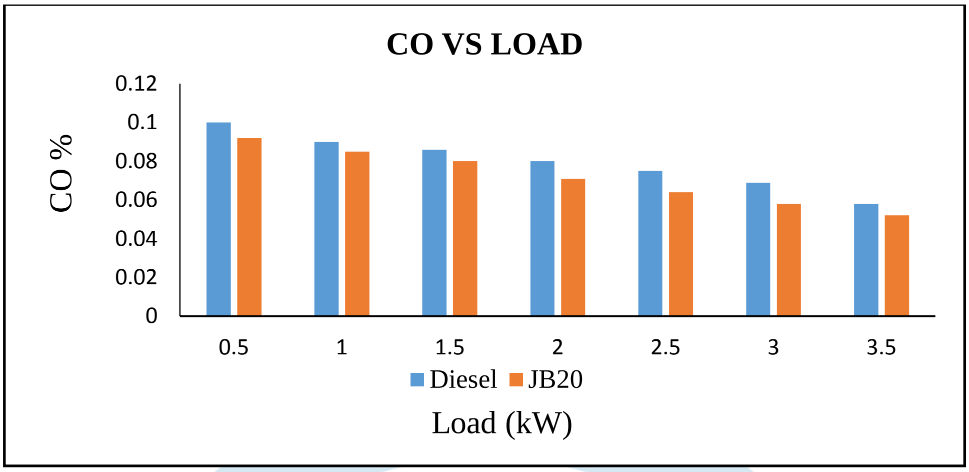

Fig1.4: CO vs Load. For Diesel and JB20

NOx Emission:

Fig 1.5 shows the variation of nitrogen oxides (NOx) in exhaust gas with brake load for 20% blends of jatropha bio-diesel and conventional diesel in the test engine. It has been observed that as load increases, NOx increases 8.81% till 70% of rated load, beyond that it further reduces for most of the samples of fuel tested. It may be due to improper combustion at higher load due to less calorific value and viscosity of fuel..

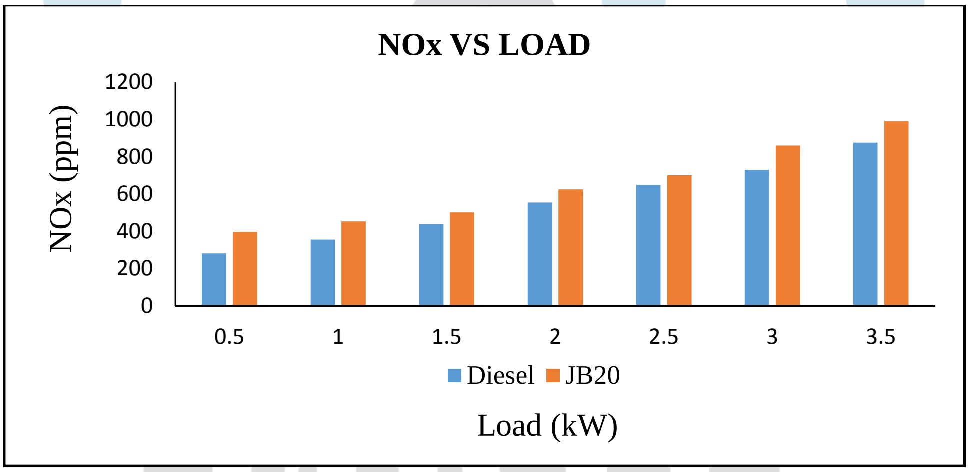

Fig1.5: NOx vs Load. For Diesel and JB20

HC Emission:

Fig 1.6 shows the variation of un-burnt hydrocarbon in exhaust gas with brake load for different blends of bio-diesel and conventional diesel in the test engine. It has been observed that for all the samples of fuel tested on engine, un-burnt hydrocarbon reduces 7.14% with increase of load up to 70% of engine load and, after that it further increases. It may be due to poor combustion at higher load.

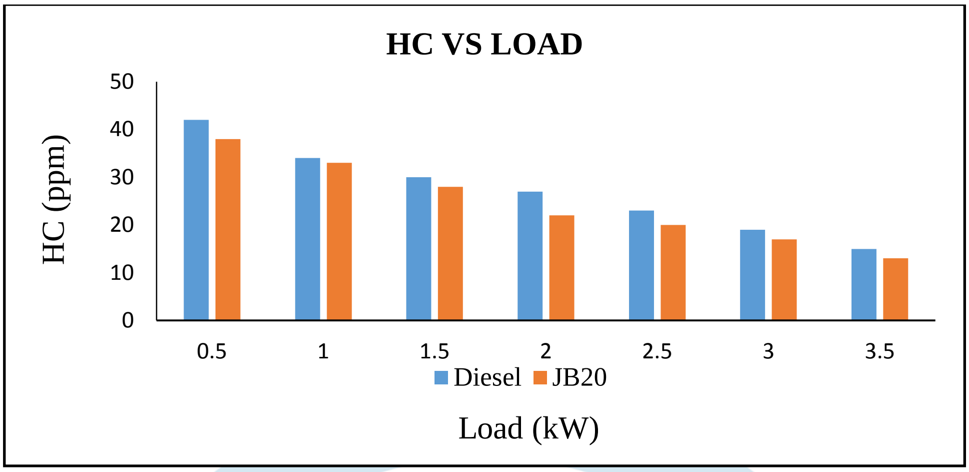

Fig1.6: HC vs Load. For Diesel and JB20

Smoke Emission:

Fig 1.7 shows the variation of smoke percentage in exhaust gas with brake load for different blends of jatropha bio-diesel and conventional diesel in the test engine. It clearly shows that the smoke percentage increases as load increases for all the blends tested. It may be due to supply of more quantity of fuel and improper combustion of fuel at higher loads. The smoke percentage in exhaust has been found to be higher at full load for JB20 fuel which is 10.90 % lower than diesel sample. It may be due to the availability of oxygen molecules in biodiesel blended fuel which enhances combustion quality.

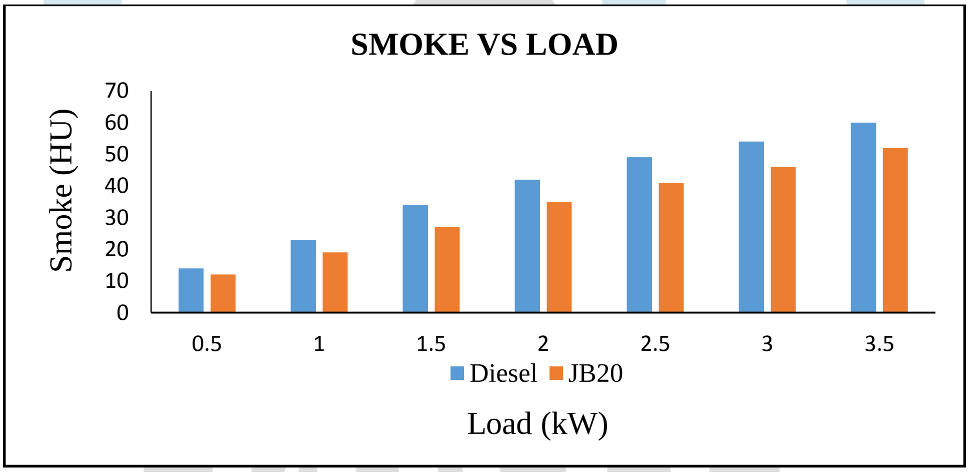

Fig1.7: Smoke vs Load. For Diesel and JB20

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.

- The main aim of the present investigation was to make blending of diesel fuel with jatropha biodiesel and to make it suitable fuel for use in a C.I. engine and to evaluate the performance of the engine with the modified Blending fuel with diesel fuel. Significant improvement in break thermal efficiency and specific fuel consumption was achieved by mixing 20% of vegetable oil with 80% of diesel.

- Diesel fuel with20% blending with jatropha biodiesel increases break thermal efficiency by 3 % as compared to diesel fuel.

- As load increases the break specific fuel consumption decreases and for both fuel, however the 20% jatropha biodiesel blend shows 3.90 % reduction in break specific fuel consumption compared to diesel fuel.

- As load increases the exhaust emission like CO, HC and Smoke is 10.34%,7.14% and 10.90% decreases but NOx 8.81% increase and for both fuel, however the 20% jatropha biodiesel blend shows 3.90 % reduction in break specific fuel consumption compared to diesel fuel.

- However, the properties of the blends may be further improved to make use of higher percentage of jatropha oil in the blend using jatropha oil of purer grade which may be obtained by pretreatment of the oil. Moreover, the long term durability of the engine using bio-diesel as fuel requires further study.

Reference

[1] Antarkar, K.A. and Salunke, J.J., 2015. Use of Jatropha Biodiesel in CI Engines-A review. *International Journal of Engineering Research and Applications*, *5*(11), pp.17-24.

[2] Chauhan, B.S., Kumar, N. and Cho, H.M., 2012. A study on the performance and emission of a diesel engine fueled with Jatropha biodiesel oil and its blends. *Energy*, *37*(1), pp.616-622.

[3] Chukwuezie, O.C., Nwaigwe, K.N., Asoegwu, S.N. and Anyanwu, E.E., 2014. Diesel engine performance of jatropha biodiesel: a review. *Biofuels*, *5*(4), pp.415-430.

[4] Tamilselvan, P., Nallusamy, N. and Rajkumar, S., 2017. A comprehensive review on performance, combustion and emission characteristics of biodiesel fuelled diesel engines. *Renewable and Sustainable Energy Reviews*, *79*, pp.1134-1159.

[5] Mahmudul, H.M., Hagos, F.Y., Mamat, R., Adam, A.A., Ishak, W.F.W. and Alenezi, R., 2017. Production, characterization and performance of biodiesel as an alternative fuel in diesel engines–A review. *Renewable and Sustainable Energy Reviews*, *72*, pp.497-509.

[6] Kathirvelu, B., Subramanian, S., Govindan, N. and Santhanam, S., 2017. Emission characteristics of biodiesel obtained from jatropha seeds and fish wastes in a diesel engine. *Sustainable Environment Research*, *27*(6), pp.283-290.

[7] Dubey, P. and Gupta, R., 2017. Effects of dual bio-fuel (Jatropha biodiesel and turpentine oil) on a single cylinder naturally aspirated diesel engine without EGR. *Applied Thermal Engineering*, *115*, pp.1137-1147.

[8] S. D. Romano and P.A. Sorichetti, "Dielectric spectroscopy in biodiesel production and characterization", *Green energy Technology*, 2011**,** *vol. 29*, pp. 8-27.

[9] J Benajes, S Molina, J M Garcia and J M Riesco, "The effect of swirl on combustion in heavy- duty diesel engine'', *Journal of automobile engineers*, 2004, *vol. 218*, pp. 1141-1148.

[10] P.K. Sahoo, L.M. Das,"Combustion analysis of Jatropha, Karanja and Polanga based biodiesel as fuel in a diesel engine", *Fuel*, 2008, *vol. 88*, pp. 994-999.

[11] Magin Lapuerta, Octavio Armas, Jose Rodriguez-Fernandez,"Effect of biodiesel fuels on diesel engine emission", *Elsevier*, 2008, *vol. 34*, pp. 198-223.

[12] J. Narayana Reddy, A. Ramesh,"Parametric studies for improving the performance of a Jatropha oil fuelled Compression ignition engine", *Elsevier*, 2005, *vol. 31*, pp. 1994-2016.

[13] Venkateswarlu Chintala, Suresh Kumar, Jitendra K. Pandey,"Assessment of Performance, Combustion and Emission Characteristics of a direct injection diesel engine with solar driven Jatropha biomass pyrolysed oil", *Elsevier*, 2017, *vol. 148*, pp. 611-622.

[14] M.U. Kaisan , F.O. Anafi , J. Nuszkowski , D.M. Kulla , S. Umaru,"Exhaust emissions of biodiesel bimary and multi-blends from Cotton, Jatropha and Neem oil from stationary multi-cylinder CI engine", *Elsevier*, 2017, *vol.53*, pp. 403-414.

[15] Ankur Nalgundwar, Biswajit Paul, Sunil Kumar Sharma, "Comparision of performance and emission characteristics of DI CI engine fueled with dual biodiesel blends of Plam and Jatropha", *Elsevier*, 2016, *vol. 30*, pp. 1-8.