A Experimental Study on Performance and Emission Characteristics of JATROPHA & DIESEL blend

Chandral Pal Singh Inda[1], Ankit Goyal [2], Sunil Kumar Bhati [1] , Dr. Jai Gopal Gupta [3]
1 Guest Faculty Mechanical Engineering, Government Women Engineering College Ajmer
2 M.Tech scholar Malaviya National Institute of Technology, Jaipur
3 Head of Department Mechanical Engineering, Government Women Engineering College Ajmer

Abstract

The objective of this experimental study is to check the performance characteristics of four stroke single cylinder air cooled diesel engine by using different blends of biodiesel (Jatropha). Two different types of emulsion fuels were taken: B5 (95% diesel and 5% bio-diesel by volume) and B10 (90% dieseland 10% bio-diesel by volume) to compare its' performance with the 100 % diesel. Experiments on the engine were conducted with varying loads from 0 watts to 2000 watts with the help of electrical dynamometer by keeping engine speed constant at 1500 rpm. Experimental study shows the effect on fuel consumption, Mechanical efficiency, exhaust gas temperature and CO_2 (carbon dioxide), CO (carbon monoxide), NO_X (Nitrogen Oxides) and HC (hydro carbon) emission etc. with respect to the load on the engine. Emission of smoke, CO, CO_2, HC and NO_X of blend mixture were higher than the diesel but exhaust temperatures were lower than diesel.

Keyword : *Jatropha, Straight vegetable oil, Blend, Mechanical efficiency*

I. INTRODUCTION

Continuous increase in fuel prices and fast depletion of the available petroleum reservoirs has renewed an interest in the field of Alternative fuels. Some popular proposed alternatives include ethanol and gasoline blended fuels, plant based oils blended with or substituted for diesel fuel, waste vegetable oil in diesel engines. Biodiesel refers to a vegetable oil or animal fat-based diesel fuel consisting of long chain alkyl (ethyl, methyl or propyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g. Vegetable oils, animal fat {tallow}) with an alcohol producing fatty acid esters. The national biodiesel board (USA) also has a technical definition of "biodiesel" as a mono alkyl ester. As per the National Biodiesel Policy, 2008 government of India aims that 20% of the diesel consumption from plants. To reach these targets we have to cultivate the biodiesel plants in 140,000 km^2 of land, presently in India fuel yielding plants cover less than 5,000 km^2. Most cultivated plant for biodiesel production in India is "JATROPHA". It was reported that the research on the production of biodiesel has increased significantly in recent years because of the need for an alternative fuel which endows with biodegradability, low toxicity and renewability.

Some other alternate fuels which contain hydrogen and oxygen molecule like alcohol fuels, dimethyl ether and biodiesel fuels etc., have been analyzed. Many researches on biodiesel have been found to employee biodiesel as a fuel for diesel engine without modification in the available design. Biodiesels are one of the most promising alternate fuels for diesel engines because of its biodegradable, oxygenated, sulphur free and renewable characteristics. But the viscosity of biodiesel is higher than the diesel which put restriction over the use of larger volume of biodiesel in a blend mixture. To eliminate the problem of viscosity, Turpentine have been used in many researches as matching blend with Jatropha as it has lower viscosity and greater calorific value than Jatropha. Turpentine contains comparable auto-ignition temperature, boiling point and flash point with that of diesel so as to form a homogeneous mixture having more conducive physical properties. Some other problems such as carbon deposition on cylinder wall, fouling of injector nozzles due to unburned fuel, polymerization and gum formation in the presence of oxygen. The issue of gum arrangement can be mitigated by transesterification of bio-fuel and oxidation can be forestalled through the expansion of greasing up oil to bio-fuel. The advantages of biodiesel also includes as follows:

- Closeness to important diesel properties
- Renewable in nature and local availability
- High miscibility with diesel without a blending agent in any proportion
- Excellent lubricity to reduce wear and to increase life of fuel injection pump
- Safe storability and ease in handling and transport
- Ability to reduce CO_2 emissions compared to fossil diesel or remaining CO_2 neutral

Various emissions ands waste products are released when diesel fuels burn in particular nitrogen oxides (NO_x), suspended particulates matter (PM), sulfur dioxide (SO_2) and hydrocarbons (HC). These unwanted emissions not easily disappear and they can harm the environment for instance by contributing to global warming and acid rain.

This paper focuses on investigating the emulsion characteristics, engine performance and exhaust emissions of air cooled, four strokes, single cylinder and diesel engine when using the diesel and biodiesel blend fuels. The effects of different biodiesel ratio content in the blend fuels were investigated. The experimental results were then compared with the conventional diesel operation. In our experiment we are tested the engine with different blends, i.e. 5% and 10% blends of Jatropha oil.

II. EXPERIMENTAL SETUP

Experimentation were carried out on the single cylinder, four stroke, air cooled diesel engine coupled with electrical dynamometer (see Fig. 1 & Fig. 2). Technical specifications of an engine are shown in Table 1 and technical specifications of electrical dynamometer are shown in Table 2. Load on the engine can be varied with the help of electrical dynamometer by switch ON/OFF of different bulbs. Burette was attached to fuel tank to measure the fuel consumption with the help of stop watch. U- Tube manometer was used to measure the flow rate of air.

Table 1: Technical Specifications of Engine

PARAMETER	UNIT/TYPE	SPECIFICATION
Rated output	kW (HP)	4.4 (6)
No of cylinders		1
Bore x Stroke	mm×mm	102 x 116
Compression Ratio		22
Aspiration		Natural
Type of engine		Compression Ignition
Injection type		Direct injection
Speed	Rpm	1500 (Constant)
Governor	Mechanical	Class B-1
Lubrication	Wet Sump	SAE 30/SAE 40
SFC	gms/kWhr	338
Fuel		High speed diesel

Table 2 Technical Specification of Electrical Dynamometer

PARAMETER	UNIT/TYPE	SPECIFICATION
Type		Slip ring type
No of poles		4
Speed	RPM	1500
Max output	kVA	5
Frequency	Hz	50±5
Insulation class	H	180^0 C
Phase		Single
Power Factor(P.F)		1
Efficiency	%	79 @ full load

Figure 1: Kirloskar Single Cylinder Four Stroke Air Cooled C.I. Engine with Electrical Dynamometer

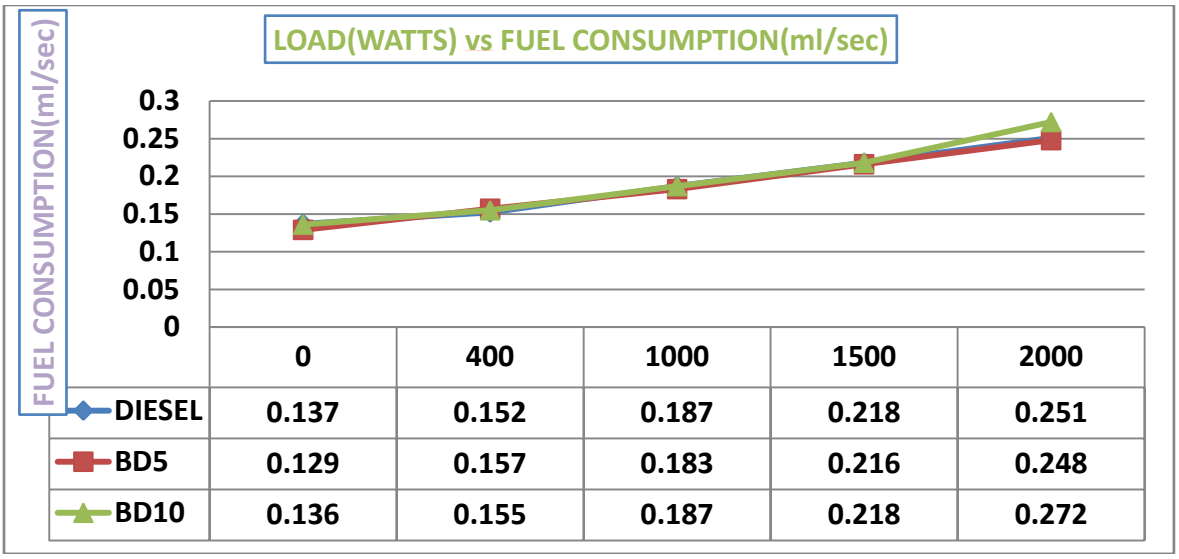
Figure 2. Engine coupled with electrical dynamometer

III. RESULTS AND DISCUSSION

The following table gives the properties of the fuel and the calculated results were plotted in the form of graphs to facilitate easy understanding of the parameters involved in the study

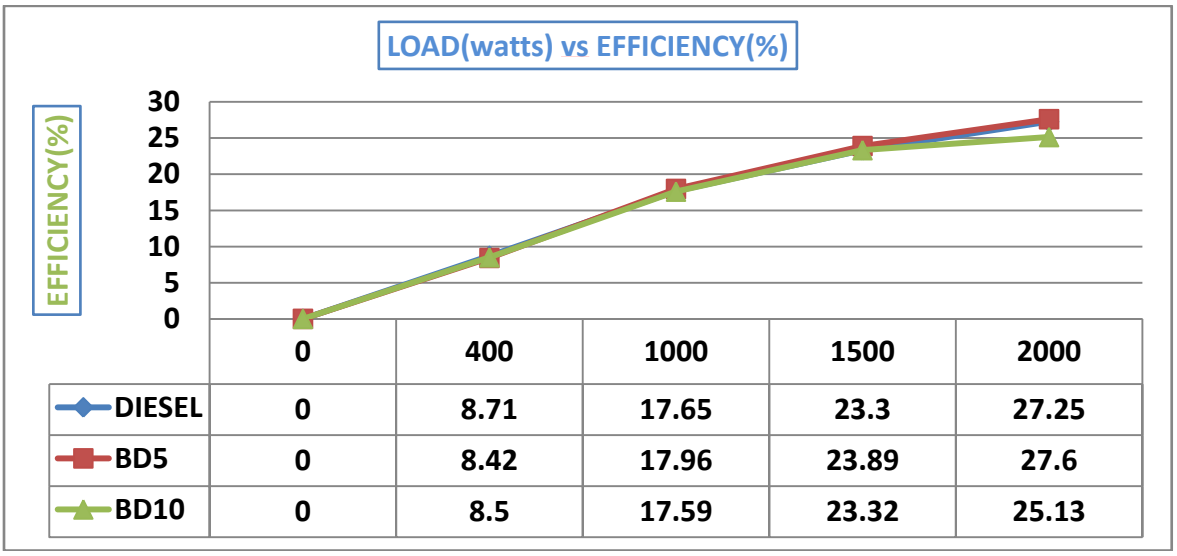
Table 3: Properties of Fuel

Property	Diesel	Jatropha oil	B5	B10
Density (kg/l) At 30^{0}C	0.838	0.944	0.8433	0.8486
Kinematic Viscosity at 30^{0}C [x10^(-2) strokes]	4-8	52.76	8.333	10.676
Cetane number	40-45	38	42.275	42.05
Flash point in ^{0}C	45-60	210	60.375	68.25
Calorific value (kJ/kg)	43400	39340	43197	42994



	0	400	1000	1500	2000
DIESEL	0.137	0.152	0.187	0.218	0.251
BD5	0.129	0.157	0.183	0.216	0.248
BD10	0.136	0.155	0.187	0.218	0.272

Figure 3: Load vs Fuel Consumption



	0	400	1000	1500	2000
DIESEL	0	8.71	17.65	23.3	27.25
BD5	0	8.42	17.96	23.89	27.6
BD10	0	8.5	17.59	23.32	25.13

Fig. 4: Load V/S Efficiency

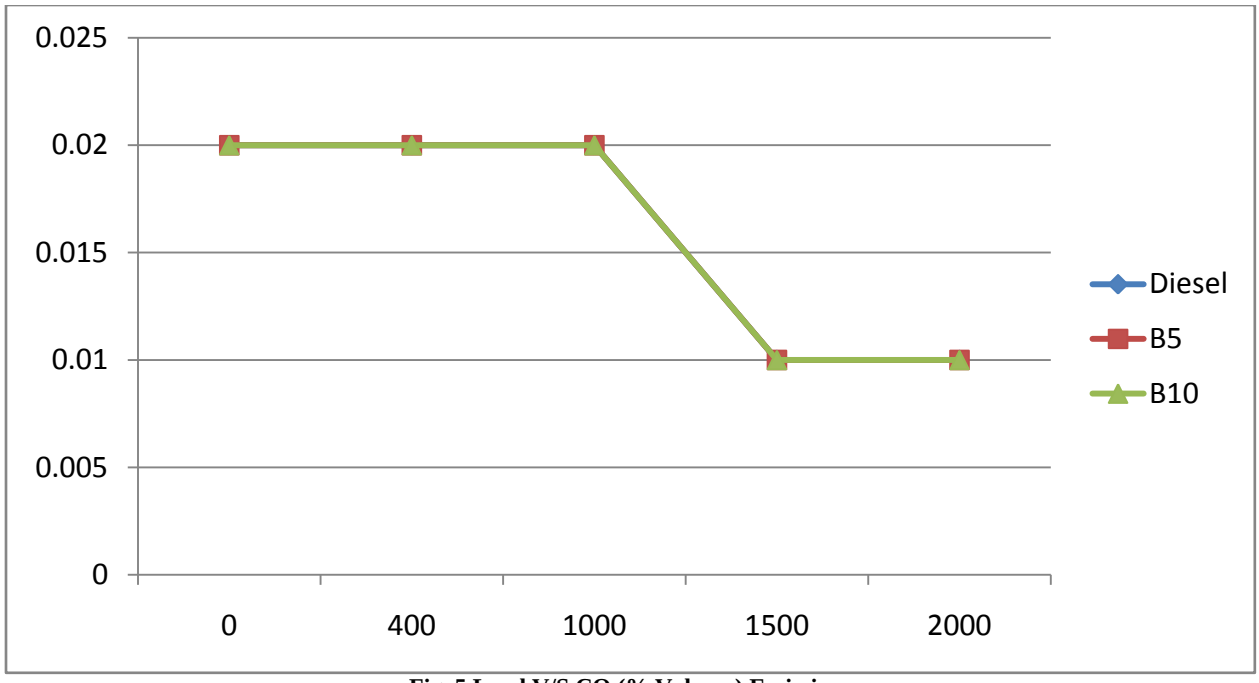


Fig. 5 Load V/S CO (% Volume) Emission

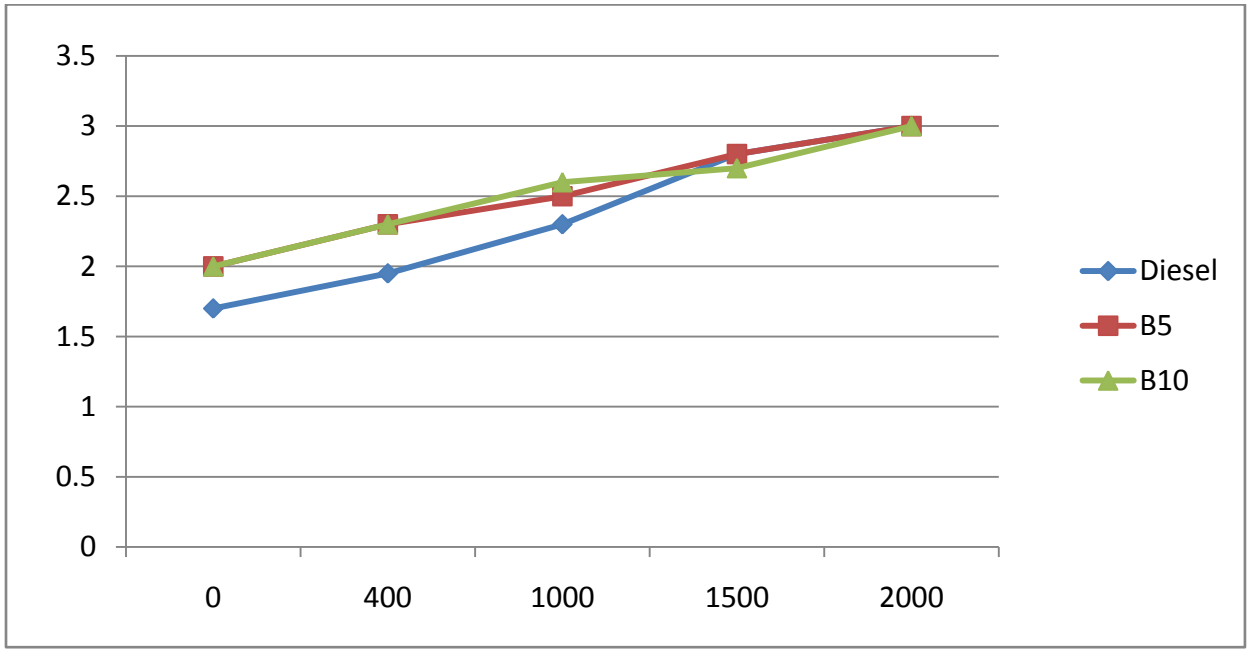


Fig. 6 Load v/s CO_2 (% volume) emission

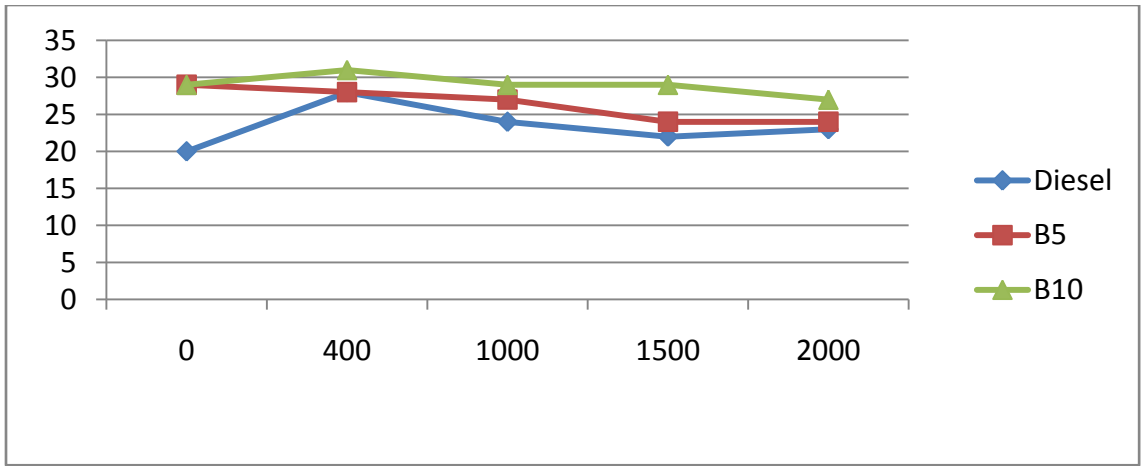


Fig.7: Load v/s HC (ppm of hexane) emission

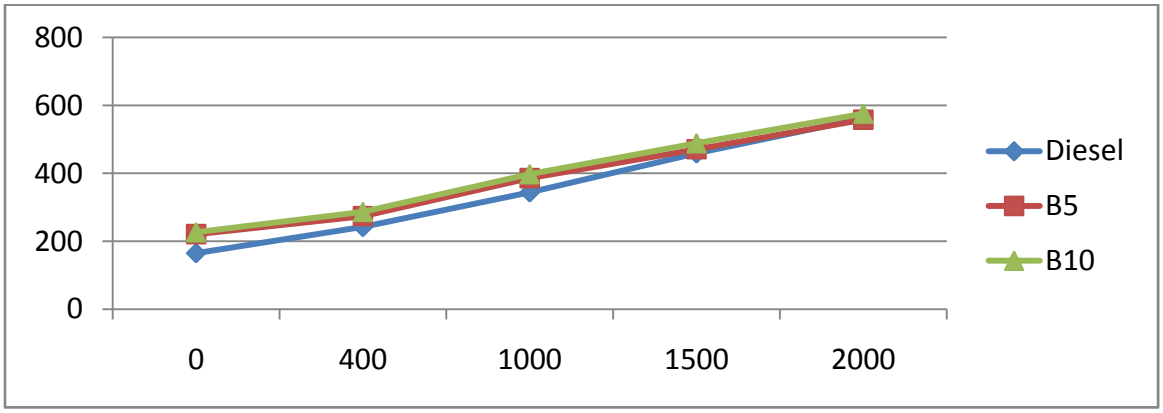


Fig. 8: Load v/s NO_x (ppm) Emission

IV. CONCLUSION

Efficiency curve of 5% blend and 10% blend runs very close to the diesel efficiency curve. Fuel consumption and emission parameters also have same values with usage of the 5% and 10% blends. Hence existing engine can be used for 5% and 10% blends of jatropha oil without any major changes in the equipment which can save the fossil fuel (diesel) up to certain extent.

REFERENCES

[1] Dubey P., Gupta R., Effects of dual bio-fuel (Jatropha biodiesel and turpentine oil) on a single cylinder naturally aspirated diesel engine without EGR, Appl. Therm. Eng. 115 (2017) 1137-1147.

[2] Agarwal A.K., Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines, Prog. Energy Combust. Sci. 33 (2007) 233-271.

[3] E. Dobrucali, R.U. Ozcumalı, S. Ergin, The effect of biodiesel on exhaust emission characteristics of a diesel engine, Marit. Ind. Ocean Eng. Coast.Resour. 1 (2008) 345-350.

[4] P. Tamilselvan, N. Nallusamy, S. Rajkumar, A comprehensive review on performance, combustion and emission characteristics of bio diesel fuelled diesel engine, Renewable and sustainable energy reviews 29,2017 1134-1159

[5] Chauhan B. S., Kumar N., HaengMuk Cho, A study on the performance and emission of a diesel engine fuelled with Jatropha biodiesel oil and its blends, Energy 37 (2012) 616-622.

[6] M. Satyanarayana, C. Muraleedharan, Investigations on performance and emission characteristics of vegetable oil biodiesels as fuels in a single cylinder direct injection diesel engine, Energy Sour, Part A Recov, Util. Environ. Eff. 34 (2011) 177-186.

[7] Kumar, M.S., Ramesh, A., Nagalingam, B., An experimental comparison of methods to use methanol and jatropha oil in a compression ignition engine. Biomass Bioenergy 25 (2003) 309–318.

[8] Deepanraj, B., Dhanesh, C., Senthil, R., et al, Use of palm oil biodiesel blends as a fuel for compression ignition engine. Am. J. Appl. Sci. 8 (2011) 1154–1158.

[9] Forson, F.K., Oduro, E.K., Hammond-Donkoh, E., Performance of jatropha oil blends in a diesel engine. Renew. Energy 29 (2004) 1135–1145.

[10] J. Xue, Combustion characteristics, engine performances and emissions of waste edible oil biodiesel in diesel engine, Renew. Sustain. Energy Rev. 23 (2013) 350-365

[11] N. Yilmaz, Performance and emission characteristics of a diesel .engine fuelled with biodieseleethanol and biodieselemethanol blends at elevated air temperatures, Fuel 94 (2012) 440-443