An Experimental study of Diesel Engine Using Bio-diesel as A Fuel

Mr. Hardik H. Makwana[1], Mr. Gosai Hiralgiri G.[2], Mr. Yash Mahuwagara[3], Mr. Jayesh D. Vaghmashi[4]

[1,2,3] BE Student, Dept. Of Automobile Engineering, ITM Universe Vadodara, Gujarat, India
[4]Asst. Professor, Dept. of Automobile Engineering, ITM Universe Vadodara, Gujarat, India

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Abstract - *As we know that the diesel engine are more favorable and demanded type of I.C. Engine because of the many major and important use of it like transport, construction, agricultural and power generation. Hence the demand of fossil fuel in also increases significantly. That directly affects on the economy of that country which import the fossil fuels to fulfill the need. And the main factor which affects to all equally is the increase in pollution (CO, HC, PM Etc.) and performance issues by conventional fossil fuels. Considering all above explained factors, we have to use alternative fuels & recent studies shows the biodiesel is the best possible and promising choice of alternative fuel for the diesel engine. The reason behind the selection of biodiesel in diesel engine is its characteristics like biodegradable, oxygenated, sulphur free & renewable. We can use the biodiesel with conventional diesel fuel as a blend to take the advantages like reduced emission from harmful gases, lower engine wear resulting longer life expectancy of the engine, improved performance and lesser engine oil consumption. This review is attempted to use of important performance & emission characteristic of biodiesel in diesel engine.*

Key Words: Bio-diesel, C.I. Engine, Alternative Fuel, Blending, Diesel Fuel, Automobile

1. INTRODUCTION

As we know that the increasing industrialization & motorization the demand of petroleum products increasing rapidly. These fossil fuels are limited and the consumption rate is very high. Also it creates harmful gases while using it in the system, and one of the main responsible factors for global warming. Due to this scenario need of alternative fuel is increasing. Diesel engine releases the harmful contents and it affects the nature, therefore use of alternative fuel in diesel engine is the best way to rectify all the problems. Use the biodiesel in diesel engine because, it has biodegradable, sulphur free, renewable, oxygenated characteristics. Using the blends of biodiesel with diesel fuel to get advantage like reduction in emission, lower engine wear and easy to use in existing system.

The main producing sources for bio-diesel in India can be edible oils and non-edible oils like plant species such as Jatropha, karanj, neem, palm, and canola. Bio-diesel contains no petroleum, but it can be blended with petroleum diesel to create a bio-diesel blend or sometimes can be used in its pure form [1].

Just like petroleum diesel, bio-diesel operates in CI engine as we know; which essentially require very little or no engine modifications because bio-diesel has properties similar like petroleum diesel fuel. Also it can be stored like conventional diesel fuel and does not require separate storage facility.

Bio-diesel has been used not only as an alternative for fossil diesel. Bio-diesel is considered to be a candidate alternative to diesel in order to decrease the use of conventional diesel. It is expected that the use of ethanol as a gasoline-blending component can reduce the amount of petroleum-fuel imports by up to 20-30% [5].

So, considering all above study and research we conduct an experimental study and research study on Bio-diesel blends in diesel engine.

2. Production of Bio-diesel from Canola Oil

Canola oil is produced from rapeseeds of canola plants. Most of the Canola crop producing nations is India, China, Canada, France and Germany. The oil has golden yellow in color and prepared from the seeds of the canola. We are using vegetable canola oil as a base ingredient in making of bio-diesel with methanol, NaOH and other needed substances.

Following flow chart describes the method of production of Bio-diesel. The method known as transesterification for producing bio-diesel that we followed with the use of all gears and apparatus. Used materials and method for producing canola bio-diesel is explained in below chart and table.

Materials used in making of bio-diesel:

1. Canola oil
2. Methanol
3. Sodium Hydroxide (NaOH)
4. Transesterification process
5. Glass beakers
6. Thermometer
7. Water bath heating apparatus
8. Stirrer for mixing
9. C.I. Engine Test Rig
10. Safety Gears (eye glasses, gloves etc.)

The Bio-diesel production process is explained by below flow chart.

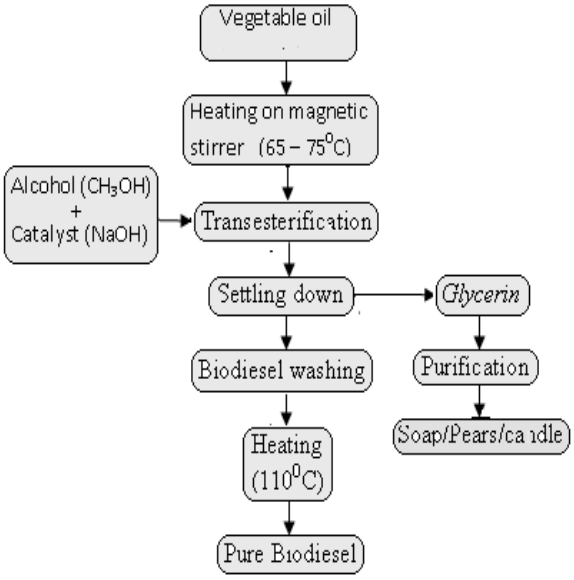

Fig. – 1: Flow chart of Bio-diesel Production

The production of bio-diesel starts with the producing the selected oil or collecting from market, in our case of bio-diesel production we brought the canola oil from market and use as a base oil after preparing and measuring the canola oil heating process is undergone using water bath heating apparatus on 65° C. On the other hand the methanol is processed with sodium hydroxide as par the measurement and mixing together and making a dissolved mixture of methanol and sodium hydroxide.

The mixture of methanol and sodium hydroxide is then mixed with heated oil and the second mixture is also stirred for well homogenous state. After this the mixture is stored in the separating funnel for settle down for at least 24 hours without any internal or external disturbance. After the given time for settling down process there were two different layer had been clearly seen, upper one is the Bio-diesel and the lower layer define as the by-product glycerin that can after used as making of soap and other related stuff.

The produced bio-diesel is then undergoes washing process, in washing the bio-diesel is mixed with distilled water and after some time the bio-diesel is again separate from the water. Washing removes the extra alcohol content and other impurities. After the washing procedure is done the final product known as bio-diesel can be used as fuel in diesel engine or can be used as measured blends with conventional diesel fuel and bio-diesel.

2.1 Test Results and Comparisons of Bio-diesel

Table – 1: Properties of Diesel and various Bio-diesels

Fuel type	Calorific Value (MJ/Kg)	Specific gravity	Viscosity at 40° C (cSt)	Cetane No.
Canola	38.179	0.91	4.3	56
Diesel	43	0.815	3.522	47
Jatropha[1]	45	0.8636	4.78	63
Corn[1]	40	0.89	3.39	59
Palm[1]	34	0.9	4.42	62
Waste Cooking Oil[1]	35.40	0.89	2.72	41

Currently, more than 350 oil-bearing crops have been identified for the production of biodiesel. Due to the different type of feed stocks that are used for producing the biodiesel fuels, they have various compositions of methyl esters and chemical structures. This necessitates a critical analysis of their physical and chemical properties and Suitability to qualify as alternate fuels for diesel engines [1].

Above mentioned bio-diesel oil is mostly used oil for making of bio-diesel and as we use the canola oil for making of bio-diesel, all the properties of the canola bio-diesel oil enlisted in the table with suitable comparison against the some of the most used oil in bio-diesel production.

3. Experimental Study on Diesel Engine

3.1 Experimental Set-up

The engine used for this experimental investigation was a single cylinder 4-Stroke naturally aspirated water cooled diesel engine having 5 BHP as rated power at 1500 r/min. The engine was coupled to a brake drum dynamometer to measure the output. Fuel flow rates were timed with calibrated burette.

Table – 2: Engine Specifications

Model	AV1 (Kirloskar)
No. of Cylinders	1
Rated Speed	1500 RPM
Rated Output	3.7 (5); kW (BHP)
Torque	24 Nm
Cubic Capacity	0.553 ltr
SFC (Specific Fuel Consumption)	245 g/kW-h
Bore X Stroke	80 X 110 mm
Lubrication Oil	SAE 30/ SAE 40
Engine Weight (dry)	130 kg
Governing	Class B1
Type of Fuel Injection	Direct Injection
Fuel Tank Capacity	6.5 ltr

3.2 Experimental Procedure

Experimental is carried out on a diesel engine. The diesel engine first run on the conventional diesel fuel and take all the performance data and then the diesel engine is runs on the various bio-diesel blends includes B10, B15, B20 as a fuel

and again takes all the performance parameters and data to compare with the conventional diesel fuel results. The Experimental set-up or test rig is shown in fig. – 2.

Fig. – 2: Experimental Set-up/Test Rig

3.3 Results

Firstly the results are carried out on the diesel fuel and then on the bio-diesel blends.

Table – 3: 100% Diesel Combustion Parameters

Load (kg) (W)	Difference of Manometer (cm) (H)	Time for 10 ml fuel consumption (sec)	BP (kW)	FC (kg/hr)	BSFC (kg/kWhr)	Thermal Efficiency (%)
0	10.5	89	0	0.3397	-	-
3	10.8	57	0.7091	0.5305	0.7481	11.45
5	11	50	1.1257	0.6048	0.5372	15.95
7	11.3	44	1.4281	0.5872	0.4811	17.81

Table – 4: 90% Diesel + 10% BD Combustion Parameters

Load (kg) (W)	Difference of Manometer (cm) (H)	Time for 10 ml fuel consumption (sec)	BP (kW)	FC (kg/hr)	BSFC (kg/kWhr)	Thermal Efficiency (%)
0	8.5	90	0	0.3368	-	-
3	8.5	58	0.7091	0.5226	0.7369	11.73
5	9.0	52	1.1176	0.5829	0.5215	16.58
7	9.3	46	1.4281	0.6589	0.4613	18.74

Table – 5: 85% Diesel + 15% BD Combustion Parameters

Load (kg) (W)	Difference of Manometer (cm) (H)	Time for 10 ml fuel consumption (sec)	BP (kW)	FC (kg/hr)	BSFC (kg/kWhr)	Thermal Efficiency (%)
0	9	92	0	0.3302	-	-
3	9	59	0.7042	0.5149	0.7311	11.79
5	9.3	53	1.1176	0.5732	0.5128	16.94
7	9.5	48	1.4281	0.633	0.4432	19.60

Table – 6: 80% Diesel + 20% BD Combustion Parameters

Load (kg) (W)	Difference of Manometer (cm) (H)	Time for 10 ml fuel consumption (sec)	BP (kW)	FC (kg/hr)	BSFC (kg/kWhr)	Thermal Efficiency (%)
0	9.5	93	0	0.3274	-	-
3	9	59	0.7091	0.5162	0.7279	11.99
5	9	56	1.1176	0.5438	0.4865	17.94
7	9.5	47	1.4166	0.648	0.4574	19.09

3.4 Comparative Analysis

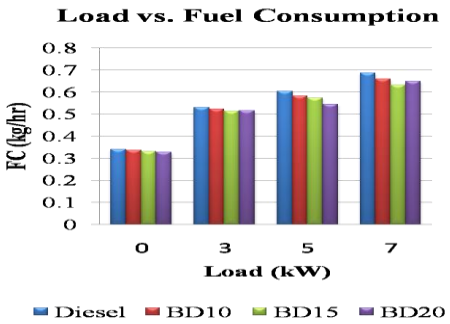

Fig. – 3: Variation of Load with FC

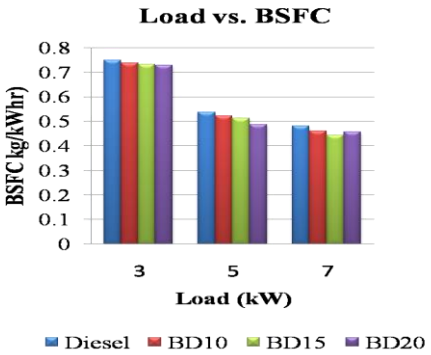

Fig. – 4: Variation of Load with BSFC

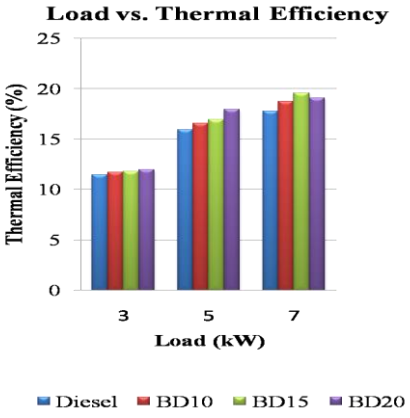

Fig. – 5: Variation of Load with Thermal Efficiency

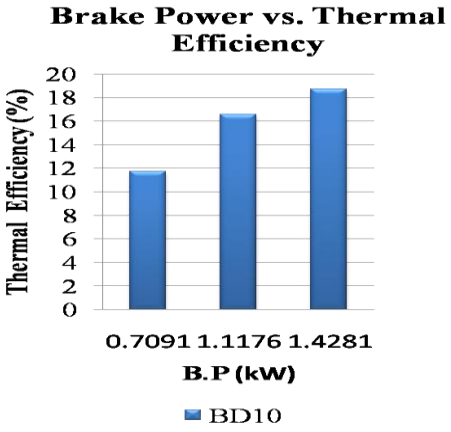

Fig. – 6: Variation of BP with Thermal Efficiency (BD10)

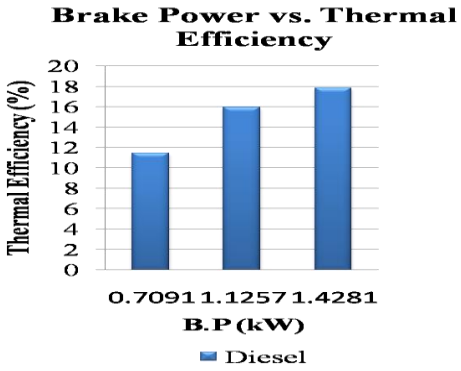

Fig. – 7: Variation of Load with Thermal Efficiency (Diesel)

4. CONCLUSIONS

This paper provides a comprehensive study and research on the performance and combustion characteristics of diesel engine fuelled with diesel fuel as well as different blendes of bio-diesel. Also a very good effort is made to provide qualitative and quantitative comparisons of performance and combustion parameters between diesel and bio-diesel fuels. The following conclusions are drawn from this research paper:

A single cylinder C.I. Engine was operated successfully using methyl ester of Canola oil as blends with diesel fuel.

Blends of Bio-diesel can be used without any engine modification.

From Canola oil, Bio-diesel can be produce using transesterification process.

Laboratory Report parameters are within the standard limits, thus it permits to use Bio-diesel in Conventional Diesel Engine.

Blends of Bio-diesel (BD10, BD15, BD20) was used in Diesel Engine.

Engine works smoothly on Bio-diesel & Diesel blends with performance comparable to Diesel operation.

Blends of Bio-diesel results in a increased Thermal Efficiency as compared to that of Diesel.

Blends of Bio-diesel results in overall reduction in Fuel Consumption as compared to that of Diesel.

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