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RESEARCH ARTICLE

Performance and Emission Analysis of Bio Fuel in Diesel Engine

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Abstract

Biodiesel, a promising substitute as an alternative fuel has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. The utilization of liquid fuels such as biodiesel produced from Jatropha oil by transesterification process represents one of the most promising options for the use of conventional fossil fuels. The physical properties such as density, flash point, Kinematic viscosity, Cloud point and Pour point were found out for Jatropha oil and Jatropha methyl ester. The same characteristics study was also carried out for the diesel fuel for obtaining the base line data for analysis. The values obtained from the Jatropha methyl ester is closely matched with the values of conventional diesel and can be used in the existing diesel engine without any modification. There are concerns ranging from environmental degradation as a result of tremendous noxious tail pipe emissions CO_2, HC to global warming due to emission of green house gases from petrol & diesel driven vehicles. Various blends of Jatropha oil methyl ester was to test in diesel. Engine and engine performance results obtained were compared with data obtained from pure diesel. With biodiesel blends, significant reduction in emissions of CO_2 emissions measurement using exhaust gas analyzer. Finally, we are conclude that JB 10 gives better performance and less emission rate than the other blending ratio with compared to diesel for all load conditions

INTRODUCTION

India is one of the fastest developing countries with a stable economic growth, which multiplies the demand for transportation in many folds. Fuel consumption is directly proportionate to this demand. India depends mainly on imported fuels due to lack of fossil fuel reserves and it has a great impact on economy. India has to look for an alternative to sustain the growth rate. Bio-diesel is a promising alternative for our Diesel needs. With vast vegetation and land availability, certainly bio-diesel is a viable source of fuel for Indian conditions. Recent studies and research have made it possible to extract bio-diesel at economical costs and quantities. The blend of Bio-diesel with fossil diesel has many benefits like reduction in emissions, increase in efficiency of engine, higher Cetane rating, lower engine wear, low fuel consumption, reduction in oil consumption etc. It can be seen that the efficiency of the engine increases by the utilization of Bio-diesel. This will have a great impact on Indian economy.

Energy is a major need for the development of country and the increase in population needs more energy for both economic and social development. The petroleum products and fossil fuels are a predominant source of energy, but the scarcity of those items and the environmental pollution caused by petroleum fuels are the major uncertainties in the challenging world. The diesel and petrol causes more emission of carbon dioxide (CO_2), hydrocarbons add in environmental so we are considered biodiesel as a alternative fuel to petroleum-based fuel resulting in numerous environmental, economic, and social benefits. Biodiesel benefits include bio-degradable, non-toxic, and 60% less net carbon dioxide emissions. Biodiesel causes less emission of carbon dioxide (CO_2), hydrocarbon (HC), and particulate matter (PM), which are the dominant factors while compared with diesel.

DMC (Dimethyl Carbonate) is an additive with the oxygen content of 53.3%, which is used as an oxygenated additive to blend with diesel fuel for the improvement of combustion and to reduce emissions of the diesel engines. Normally additives are used to boost the combustion hence improves fuel economy at lower emission rates from the engine. Blends of diesel and biodiesel usually require additives to improve the lubricity, stability and combustion efficiency by increasing the Cetane number. Blends of diesel and ethanol usually require additives to improve miscibility and reduce knock.

What is Biodiesel?

Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feedstock, such as, vegetable oils or animal’s fats, for use in compression ignition engines.

The oil produce from the non-edible plants, edible plants, chicken fats, beef tallow and waste cooking oils, these oil properties is approximately same to diesel so it is known as biodiesel.

Project Jatropha aims to demonstrate the commitment of the youth in developed countries to environmental issues that affect the developing nation’s as well. This is where Project Jatropha comes in. Jatropha curcas is a carbon sink, taking carbon dioxide out of the air and putting it into the ground. The bio fuel produced by the seeds provides a clean, alternative source of energy that not only helps reduce emissions, but also is able to be used in diesel engines to power vehicles and irrigation pumps. In addition, by providing an alternative crop to tobacco for rural farmers, the burning of large quantities of firewood.

Objective: The participation speeds and the output torque for representative operating conditions and maximum output torques measured in service conditions The use of biodiesel is rapidly expanding around the world, making it imperative to fully understand the impacts of biodiesel on the diesel engine combustion process and pollutant formation.

To measure the performance parameters of engine and also measure emission of bio diesel with blends like as CO_2 and HC by exhaust gas analyzer.

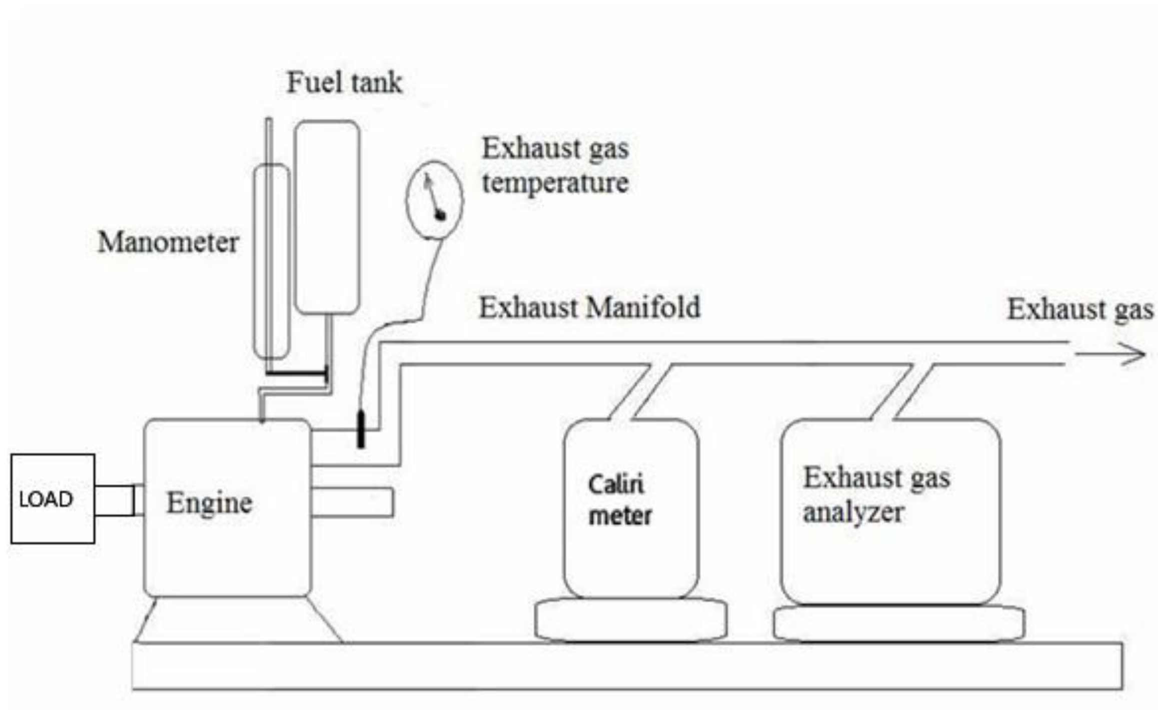
Table 1 properties of diesel, jatropha biodiesel,JB 10,JB 20 & JB 30

	JATROPHA BIO-DIESEL	**DIESEL**	**JB10**	**JB20**	**JB30**
Density	0.92	0.84	0.8474	0.8512	0.8552
Kinematic Viscocity	55	4	2.58	2.62	2.74
Calorific Value(MJ/KG)	39.5	45	44	43.750	43.220
Cetane Number	43	47	47.48	48.01	48.54
Flash Point(^{0}C)	214	65	69	72	76
Fire Point (^{0}C)	256	78	80	80	85
Pour Point(^{0}C)	6	-6	3	-3	-6

Tabl-2 Engine Specification

SR.NO	**ENGINE SPECATION**	**REMARK**
1.	Type	Kirloskar oil engine
2.	Stroke	4-stroke
3.	Cylinder	Single cylinder
4.	Fuel oil	Diesel
5.	Lubricant oil	SAE 30 / SAE 40
6.	R.P.M	1500 rpm
7.	Bhp	5 KW
8.	SFC	245 g/kw-h
9.	Torque	2.4 k-gm
10.	Excitation Max	80v
11.	Insulation	Class ‘F’

Exprimental Setup:



Engine Parameter Calculate

Brake Power:

The horsepower available at the crankshaft (for onward transmission to drive the vehicle) is cold Brake horsepower. Rating of automotive engine is done in terms of BHP. Brake horsepower can be measured dynamometer.

Load of dynamometer = $\frac{V \times I}{1000}$ KW

Where, V = voltmeter

I = Current in Amps.

Assuming dynamometer efficiency 70% brake power of the engine

$$B.P = \frac{\text{Load on dynamometer}}{0.7}$$

Fuel Consumption:

$$Fc = \frac{100}{tf} \times \frac{3600}{1000} \times 0.84$$

$$= \frac{149400}{tf} Kg / hr$$

Where, tf = Time required for 100 ml fuel (sec.)

Specific Fuel consumption:

$$SFC = \frac{Fc}{B.P.} Kg / KW.hr$$

Heat Supply by Fuel:

$Hf = Fc \times$ Calorific value of Diesel

Indicated Power:

The power developed inside the cylinder by combustion of gases is called indicated horsepower

IP = BP + FP KW

Heat Equivalent to BP:

$H_{bp} = BP \times 3600 KJ/hr$

Heat Equivalent to IP:

Hip = $IP \times 3600 KJ/hr$

Efficiency:

Everyone desires that the power produced by should be fully (100%) utilized. But it is not possible as power losses are inevitable. It is due to losses of two kids viz

1. Mechanical losses due to friction
2. Thermal losses

Hence power produced inside the cylinder is not fully transferred to the crankshaft. The relationship between power produced and the power utilized, is therefore, expressed in terms of efficiency.

Mechanical Efficiency:

Mechanical efficiency relates the power produced inside the cylinder (ihp) and the power actually available at the crankshaft (bhp).

$$\eta_m = \frac{BP}{IP} \times 100\%$$

Brake Thermal Efficiency:

$$\eta th = \frac{\text{heat equivalent to power output per unit time}}{\text{Heat enegy supplied by fuel per unit time}}$$

Indicated Thermal Efficiency:

$$\eta ith = \frac{3600}{m_i \times CV}$$

Where, m_i = indicated specific fuel consumption

$= \frac{\text{Fuel consumption}}{\text{Indicated Power}}$

Result Table for Diesel:

Sr. No	1	2	3	4	5
BP(kw)	0	1.50	2.66	4.13	5.25
Fuel consumed(kg/hr)	0.903	1.00	1.209	1.25	1.493
SFC(kg/kw-hr)	-	0.664	0.408	0.288	0.280
IP(kw)	3.24	4.74	5.92	7.11	8.50
Mechanical efficiency (%)	-	31.79	45.27	56.27	62.11
Brake thermal efficiency (%)	-	11.43	19.54	27.86	29.57
Indicated thermal efficiency (%)	27.87	38.48	39.75	48.15	46.07

Result Table for JB 10

Sr. No	1	2	3	4	5
BP(kw)	0	1.50	2.66	4.13	5.25
Fuel consumed(kg/hr)	0.916	0.982	1.209	1.265	1.512
SFC(kg/kw-hr)	-	0.652	0.454	0.306	0.288
IP(kw)	3.22	4.72	5.95	7.33	8.5
Mechanical efficiency (%)	-	30.71	43.89	54.85	60.69
Brake thermal efficiency (%)	-	12.25	18.10	26.47	28.42
Indicated thermal efficiency (%)	28.42	39.47	40.94	48.51	47.56

Result table for JB 20

Sr. No	**1**	**2**	**3**	**4**	**5**
BP(kw)	0	1.50	2.66	4.13	5.25
Fuel consumed(kg/hr)	0.95	1.032	1.209	1.326	1.591
SFC(kg/kw-hr)	-	0.686	0.454	0.321	0.303
IP(kw)	3.22	4.72	5.95	7.33	8.5
Mechanical efficiency (%)	-	31.8	45.09	56.07	60.82
Brake thermal efficiency (%)	-	11.55	18.22	25.46	27.27
Indicated thermal efficiency (%)	27.31	36.27	40.44	45.41	43.90

Result table for JB 30

Sr. No	**1**	**2**	**3**	**4**	**5**
BP(kw)	0	1.50	2.66	4.13	5.25
Fuel consumed(kg/hr)	0.96	1.046	1.20	1.344	1.55
SFC(kg/kw-hr)	-	0.695	0.451	0.325	0.295
IP(kw)	3.22	4.72	5.95	7.33	8.5
Mechanical efficiency (%)	-	31.8	45.19	56.07	62.11
Brake thermal efficiency (%)	-	11.84	18.29	25.17	27.83
Indicated thermal efficiency (%)	27.36	37.23	40.28	45.90	44.81

Emission Test Results for Diesel:

Sr. No.	**Load (kw)**	**Smoke density %**	**CO %**	**CO_2 %**	**O_2 %**	**HC PPM**
1	0	12.4	0.09	2.1	20.89	42
2	1	13.1	0.08	2.8	20.89	48
3	1.5	20.9	0.07	3.2	20.90	52
4	2.5	35.6	0.06	3.5	20.90	66
5	3.5	41.5	0.07	4.4	20.90	81

Emission test results for JB 10

Sr. No.	**Load (kw)**	**Smoke density %**	**CO %**	**CO_2 %**	**O_2 %**	**HC Ppm**
1	0	11.4	0.08	2.0	20.89	44
2	1.0	13.2	0.06	2.4	20.89	46
3	1.5	19.8	0.05	3.2	20.90	53
4	2.5	32.4	0.05	3.4	20.90	60
5	3.5	39.6	0.05	4.3	20.90	65

Emission Test Results for JB 20

Sr.No.	**Load (kw)**	**Smoke density %**	**CO %**	**CO_2 %**	**O_2 %**	**HC Ppm**
1	0	9.2	0.07	2.0	20.89	42
2	1.0	13.5	0.05	2.4	20.89	46
3	1.5	22.3	0.05	3.1	20.90	43
4	2.5	34.5	0.05	3.4	20.90	60
5	3.5	47.3	0.05	4.15	20.90	72

Emission Test Results for JB 30

Sr.No.	Load (kw)	Smoke density %	CO %	CO_2 %	O_2 %	HC Ppm
1	0	10.3	0.06	2.0	20.89	33
2	1.0	14.0	0.06	2.4	20.89	42
3	1.5	22.9	0.06	2.9	20.90	65
4	2.5	35.0	0.05	3.8	20.90	60
5	3.5	51.8	0.05	4.6	20.90	88

Conclusion

- FC for JB 10 nearer to the neat diesel. FC is increases with increase the blending ratio.
- Specific fuel consumption for JB 10 is lower compare to the other blending ratio.
- The brake thermal efficiency and indicated thermal efficiency for all blending ratio nearer to the neat diesel.
- The exhaust gas temperature increases with brake power. The exhaust gas temperature increases with increases the blending ratio.
- JB 10 have less smoke density compare to the neat diesel.
- CO reduced with increasing the load for all blending ratio.
- JB 10 and JB 20 have less CO_2 emission at higher load.
- JB 20 has produce less HC emission compare to other blending ratio.
- If we change the intake system of the engine than JB20 is most suitable and economic fuel.

Result Table for Performance Parameter of Diesel, JB 10, JB 20 And JB 30.

Fuel name	BP (KW)	Fuel Consumed Kg/hr	SFC Kg/kw.hr	IP (kw)	Mechanical Efficiency %	Brake Thermal Efficiency %	Indicated Thermal %
DIESEL	4.17	1.215	0.291	7.41	56.27	27.86	48.12
JB 10	4.17	1.270	0.307	7.33	57.66	26.47	48.51
JB 20	4.11	1.328	0.323	7.33	56.07	25.46	45.41
JB 30	4.11	1.360	0.331	7.33	56.07	25.17	45.90

Result table for emission analysis of diesel, JB 10, JB 20 & JB 30.

Fuel name	Smoke density %	CO %	CO_2 %	O_2 %	HC PPM
Diesel	35.6	0.06	3.5	20.9	66
JB 10	32.4	0.05	3.4	20.9	60
JB 20	34.5	0.05	3.4	20.9	60
JB 30	35.0	0.05	3.8	20.9	60

Finally, we are conclude that JB 10 gives better performance and less emission rate than the other blending ratio with compared to diesel for all load conditions of engine.

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