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EMISSION ANALYSIS OF DIESEL ENGINE FUELED WITH JATROPHA OIL METHYL ESTER BLENDS

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ABSTRACT

In the present era due to high brake thermal efficiency of modern diesel engines, conventional fuel consumption in agricultural sector has increased to an extreme end which causes drastic depletion of natural resources. Due to good oxidation characteristics and lubricating nature Biodiesel is attracting the world to its side as the alternative fuel. The present paper elaborates about the emission characteristics of an agricultural diesel engine utilizing Jatropha oil methyl ester with diesel blends (B10, B20 and B30). All the emission values were noted and plotted in the graph against loads varying at 0%, 20%, 40%, 60%,80%,100%. The results depict that BD20 is the blend which shows the less tendency towards emissions like CO, CO_2, HC, while there is a slight increment in both NO_x and smoke emission in comparison to other test fuel blends which gives a conclusion that B20 is a best alternative fuel capable of replacing current petroleum diesel fuels to reduce the engine emissions.

1. INTRODUCTION TO JATROPHA

Jatropha plant belongs to the family of "Euphorbiaceous" and genus of Jatropha L"Cultivation of Jatropha is uncomplicated it grows in both subtropical and tropical regions. Jatropha is a good crop that can be obtained with a little effort. This Jatropha plant can grow on terrain, wastelands and it can even grow on sandy, saline soils [1]. Jatropha Cruces is one of the best oil seed plants for the production of biodiesel. Seeds that are produced from Jatropha contain 37% of oil. The oil that is produced can be directly used for combustion without refining. The oil that is produced from Jatropha is highly toxic. Medically Jatropha is used for diseases such as piles, cancer, paralysis, snakebite, dropsy etc. Jatropha is a small shrub or a tree, which exudes whitish colored, latex, watery when cut [2]. Generally Jatropha plant grows between 3-5 meters in height; it can grow up to 8-10meters of height under favorable conditions. The oil seed that is produced by Jatropha plant acts as an energy source in the form of biodiesel. The major advantage of the Jatropha is it can be grown in poor soils, leaving the rich soils in the cultivation of other consumable goods [3]

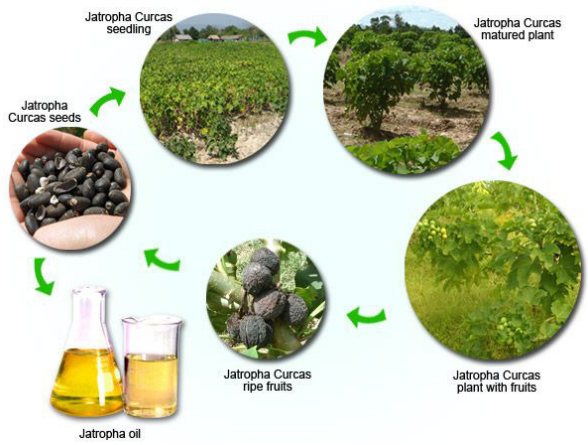

Figure 1

2. CULTIVATION OF JATROPHA

Cultivation of Jatropha is highly profitable, as there is huge demand in the production of biodiesel. Jatropha acts of "Life Fence" for the protection of agricultural crops from being damaged from the cattle as it cannot be consumed. It can be cultivated in all the states in India, as it has the capability of adapting to different climatic conditions.

Table 1 Availability of waste land (ha) and the exploitable potential of Jatropha plantation (Million ha) in various states [4].

S.NO	States	Available Wasteland (million ha.)	Exploitable Potential of Jatropha Plantation (Million ha.)
1	Andhra Pradesh	5.175	4.396
2	Arunachal Pradesh	1.832	0.997
3	Assam	2.001	1.456
4	Bihar / Jharkhand	2.098	1.860
5	Goa	0.062	0.04
6	Gujarat	4.301	2.871
7	Haryana	0.374	0.262
8	Himachal Pradesh	3.164	0
9	Jammu & Kashmir	6.545	0
10	Karnataka	2.083	1.789
11	Kerala	0.146	0.10
12	Madhya Pradesh Chhattisgarh	6.970	6.620
13	Maharashtra	5.350	4.855
14	Manipur	1.294	1.262
15	Meghalaya	0.98	0.937
16	Mizoram	0.409	0.407
17	Nagaland	0.841	0.840
18	Orissa	2.135	1.888
19	Punjab	0.224	0.106
20	Rajasthan	10.563	5.688
21	Sikkim	0.357	0.213
22	Tamil Nadu	2.302	1.795
23	Tripura	0.126	0.128

24	Uttar Pradesh Uttaranchal	3.878	1.214
25	West Bengal	0.570	0.258
26	Union Territories	0.057	0.055
	GRAND TOTAL	**63.843**	**40.037**

Table.2 Analysis of the cultivated land for Jatropha in hectors [5]

State	Plantation (ha.)	State	Plantation (ha.)
Andhra Pradesh	355	Mizoram	500
Arunachal Pradesh	185	Meghalaya	113
Bihar	10	Maharashtra	1635
Chhattisgarh	604	Madhya Pradesh	741
Gujarat	1129	Nagaland	442
Haryana	460	Rajasthan	174
Jharkhand	700	Tamil Nadu	463
Karnataka	377	Uttar Pradesh	778
Kerala	50	Uttrakhand	618
Manipur	250	West Bengal	100
Sikkim	100	**Grand Total**	**10083**

3. SCOPE OF JATROPHA CULTIVATION

Due to high demand cultivation of Jatropha is viable and it does not replace traditional crops. This crop is best in the areas where annual rainfall is less and in barren lands, so this crop is best hope for farmers. For agricultural crops, this Jatropha can be used as live fencing as no livestock will eat this Jatropha plant [6]. When it comes to Jatropha, every part of this plant can be used such as a raw material for pharmaceutical and for cosmetic industries; it can also be used as input for traditional medicine [1]. Jatropha provides good economic life to farmers, when it is cultivated in poor soils, barren lands and drought areas.

4. SOIL AND CLIMATE REQUIREMENT FOR CULTIVATION OF JATROPHA.

It is the tropical species; it grows good in subtropical conditions. This crop can grow in extreme temperature but logging of water does not permit to grow [7]. Jatropha can be grown even in acid and alkaline soils, sandy and gravel. It is cultivated in the soils having pH 5.4 to pH 8.5. It can even thrive in poorest soils that are present on stones. It grows even in crevices and cracks of rocks on all types of soils except to water flow. If there is rise in water flow and that water engulf the major root system to some extent of time the plant will die.

Figure 2

5. ADVANTAGES OF JATROPHA

i. Jatropha is mainly used in production of biodiesel.
ii. It can be grown in poor soils, waste lands
iii. Jatropha is suitable for preventing the soil erosion
iv. Fertility of soil increases throughout the lifecycle
v. This plant can also be used for medical purposes

6. DISADVANTAGES OF JATROPHA SEEDS

i. Jatropha compounds are highly toxic
ii. The Jatropha plant cannot produce the nut, if there is too little water.

Figure 3

7. PRODUCTION OF JATROPHA OIL BIODIESEL

7.1 Transesterification

It is a process of manufacturing of Biofuel by adding alcohol. Transesterification is the process of interchanging R' of an ester to the organic group R' of an alcohol [8]. This transesterification process is catalyzed by inclusion of acid or base catalyst [4]. Methanol and Ethanol are the majorly used in the process of transesterification, among these two alcohols methanol is most extensively used because of its low price and physicochemical advantages with triglycerides. 3:1 ratio of alcohol to triglycerides is needed for complete transesterification process [9].

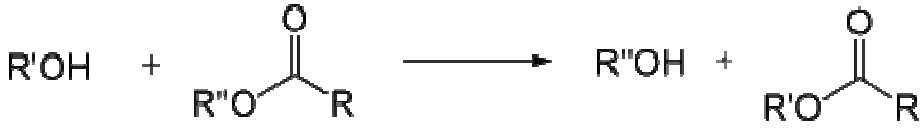

Figure.1 Transesterification Reaction [1]

8. EMISSIONS OF JATROPHA OIL BIODIESEL IN ENGINE

For every action there is an equal and opposite reaction similarly for an engine, if a fuel is injected into the engine then there will be equal and opposite emissions and exhaust gases as the output reaction which is harmful for environment and human life.

After manufacturing of Jatropha Bio Oil then it is blended in different ratios as, JOBD10,JOBD20,JOBD30.All these blends including pure standard diesel Oil(PD) is injected into the engine to experiment on the emission that are caused by Jatropha Oil Bio Diesel [10].

8.1 Co vs BP

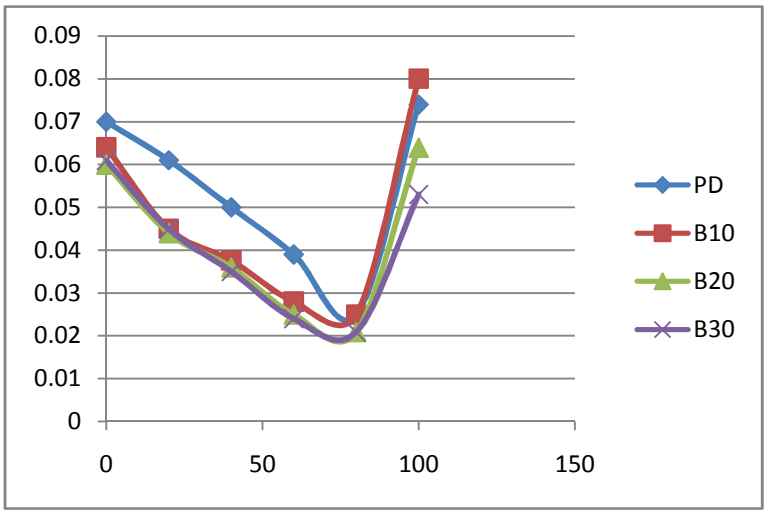

Figure 4

Due to incomplete combustion in the engine Carbon monoxide (CO) was formed in the engine which is colorless, odorless, poisonous gas. In the engine if there is poor atomization or uneven distribution of fuel in the combustion chamber, then some fuels are left un burned and some carbons atoms ends up with CO. At 0 load of an engine, the emission of CO is 0.06ppm for JOBD20, 0.0609ppm for JOBD30, 0.064ppm for JOBD10, 0.07ppm for Pure Diesel. Similarly at 100% load of an engine, the emission of CO is 0.053ppm for JOBD30, 0.0639ppm for JOBD20, 0.074ppm for Pure Diesel, 0.08ppm for JOBD10 [11]. We can observe that Initially CO emissions are almost constant. As the engine load was increasing emission also continued to increase, after 80% of engine load there exists some incomplete combustion of the excess fuel that is injected into the combustion chamber because of lower air fuel ratio because of that the CO emissions have started increasing at high loads [12].

8.2 NOx vs. BP

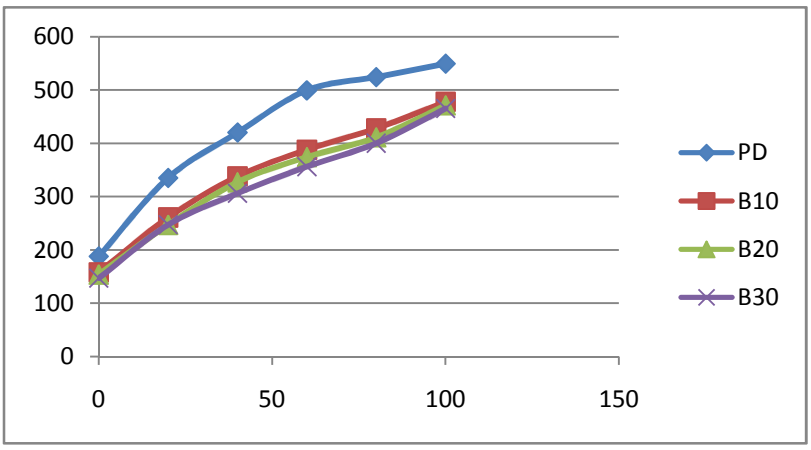

Figure 5

When different blends of Jatropha oil biodiesel is used in engine then the emission of NOx mainly depends on Availability of oxygen and higher temperatures these are the two important factors which facilitate the production of NOx because at higher temperature nitrogen becomes reactive where at lower temperatures, nitrogen exists as a stable diatomic molecule hence it is not the main facilitator for the production of NOx [6]. At 0 load of an engine, the emission of NOx is 147ppm for JOBD30 154ppm for JOBD20, 158ppm for JOBD10, 188ppm for Pure Diesel. Similarly at 100% load of an engine, the emission of NOx is 465ppm for JOBD30, 471ppm for JOBD20, 478ppm for JOBD10, 549ppm for Pure Diesel [8]. Since there is presence of oxygen molecules in biodiesel, an unrivaled effectiveness and efficiency of combustion was obtained due to temperature of higher peak combustion chamber. It can be seen from the figure, as the engine load is increasing NOx concentration in emission is increasing. This had led to produce higher NOx emissions at higher loads.

8.3 HC vs. BP

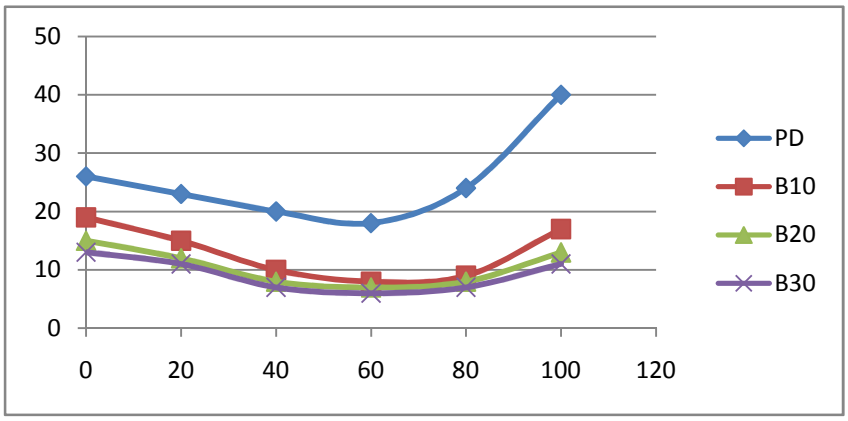

Figure 6

When different blends of Jatropha oil biodiesel is used in engine then the emission of HC from CI engine act as Odorants, irritant and some are carcinogenic because of non-homogeneity [2]. At 0 load of an engine, the emission of HC is 13ppm for JOBD30, 15ppm for JOBD20, 19ppm for JOBD10, 26ppm for Pure Diesel. Similarly at 100% load of an engine, the emission of HC is 11ppm for JOBD30; 13ppm for JOBD20, 17ppmfor JOBD10, 40ppm for Pure Diesel, As incomplete combustion occurs in the chamber due to non-homogeneity of air fuel mixture, this mixture is lean in some spots and too rich in some other spots of the combustion chamber [11]. This incomplete combustion produces more HC emission or unburned fuel emissions. HC emissions are mainly increased as the load is increasing because of heat liberation (that occurs as the load is increased)We can observe that the emissions of HC are increasing as the percentage of blend decreases and emissions of HC are decreasing as the percentage of blend ratio increases.

8.4 Opacity vs. BP

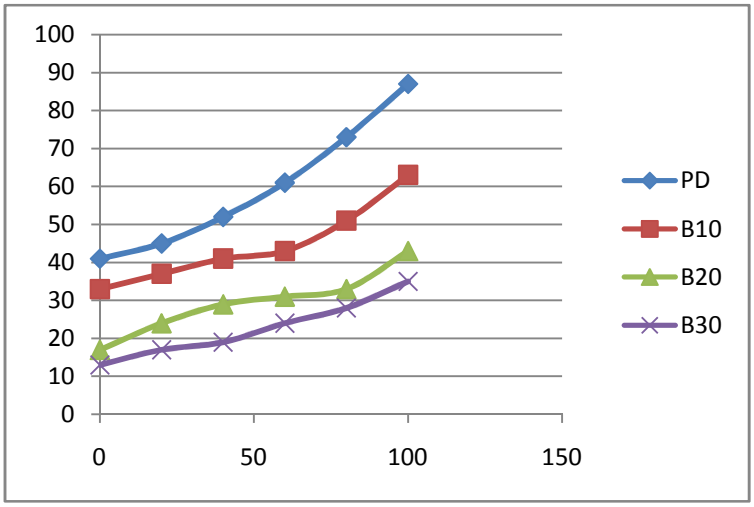

Figure 7

When different blends of Jatropha oil biodiesel is used in engine then the emission of Smoke opacity is mainly formed due to the complete combustion, as there is availability of excess oxygen that is present in the fuel itself. At 0 load of an engine, the emission of opacity is 13ppm for JOBD30, 17ppm for JOBD20, 33ppm for JOBD10, 41ppm for Pure Diesel. Similarly at 100% load of an engine, the emission of opacity is 35ppm for JOBD30, 43ppm for JOBD20, 63ppm for JOBD10, 87ppm for Pure Diesel [7]. Emission of smoke opacity is increased with increase in engine load. This is due to poor atomization of Jatropha oil (Poor atomization is due to heavier fuel molecules, higher viscosity, and low volatility) [6].

8.5 Co2 vs. BP

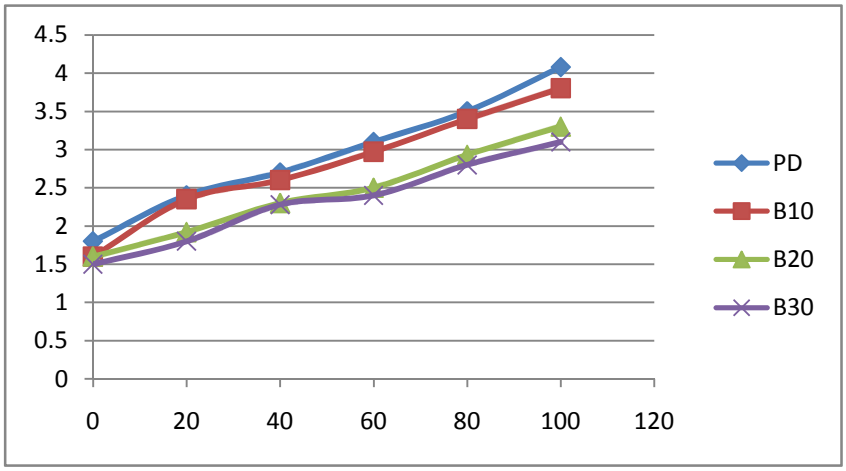

Figure 8

When different blends of Jatropha oil biodiesel is used in engine then the emission of CO2 is as follows. At 0 load of an engine, the emission of CO2 is 1.5ppm for JOBD30, 1.6ppm for JOBD20, 1.6ppm for JOBD10, 1.8ppm for Pure Diesel. Similarly at 100% load of an engine, the emission of CO2 is 3.1ppm for JOBD30, 3.3ppm for JOBD20, 3.8ppm for JOBD10, 4.08ppm for Pure Diesel [9]. We can observe that the emissions of CO2 are increasing with increase in engine load. As the engine load is increasing, the amount of fuel that is entering for combustion in combustion chamber also increases, the measure of fuel that is entering into

the combustion chamber for complete combustion also increases by producing an increase in temperature inside the cylinder. At higher temperature the combustion in the cylinder gets better and this burning of fuel results in higher CO2 emissions

9. CONCLUSION

When different blends of Jatropha biodiesel oil is experimented on the engine at different loads then it was concluded that JOBD30 is less emissive in CO, NOx , HC , Opacity , CO2 when compared to other blends of Jatropha Oil Biodiesel [12]. Hence we can conclude that JOBD30 is less emissive so we can use this in commercial purposes to save our environment. By using biodiesel the sooth particles, which cause damage to humans is greatly reduced.

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