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An Experimental Approach to the Performance Analysis of Diesel Engine Using Karanja Oil As Bio-Diesel

Deepu T[1],Jithin P[2], Ajith Kumar C Y[2], Akhil S[2], Biswajith V[2], Kailasnath K U[2]
[1]Asst.Professor, Department of mechanical engineering, Ammini College of engineering Palakkad Kerala, India
[2]Students, Department of mechanical engineering, Ammini College of engineering Palakkad Kerala, India

ABSTRACT

This paper explains about the performance analysis on diesel engine by using Karanja oil as biodiesel. The use of biodiesel is increasing day by day because the fossil fuels are depleting. In the proposed work, Karanja oil is used as biodiesel and is derived from the seeds of the Millettia Pinnata tree. It is prepared by alkali catalyzed transesterification method. The karanja oil is widely available in the southern parts of India and it seems to be a good additive to the diesel. After preparing the blend (B20) the Performance tests were conducted with single cylinder water cooled diesel engine.
Keywords: Karanja Biodiesel, FFA, Esterification, Transesterification

I. INTRODUCTION

The main problem the society is facing is the depletion of the fossil fuels that is required for the daily purposes, so we need to find a solution. So we decided to use non edible oils as biodiesel which are produced in large amounts. The main non edible oils used are Jatropha, Karanja, Mahua and etc. The use of biodiesel helps to control pollution as it is sulphur free, non-toxic, oxygenated. It has many environmental benefits and is renewable.

Biofuels can be classified into three categories. They are first generation, second generation and third generation. The first generation is made largely from edible sugars and starches. The second generation is made from non-edible oils. The third generation is made from the algae and bacteria.

II. KARANJA OIL

Karanja oil is commonly known as *Pongamia Pinnata*. The size of the tree is maximum and grows upto 15-20 meters. This is one among the trees in India which is nitrogen fixing. This is even called as pongam or honge oil. The leaves are soft. The Karanja tree is well suited to intense heat and sunlight. The karanja is commonly used as fuel. The proper mixture of Neem and Karanja oil is used for skin problems in animals.

Figure 1: Seed of Karanja

III. KARANJA BIODIESEL PRODUCTION

The Karanja Oil for the production of the biodiesel is collected. At first prepare 0.1N NaoH solution. For that, take 4 grams of NaoH in a conical flask containing 1 liter of water. After sometime, we get the 0.1N NaoH solution. Then take 25ml of the above solution in burette. Take 10g of karanja oil in the conical flask and take 50ml of Isopropyl alcohol in the oil. Then add 5 to 6 drops of Phenolphthalein as indicator and shake well. Titrate this solution under 0.1N NaoH. When the colour of the oil changes to pink colour stop titrating. Note the reading on the burette and find the FFA by using the equaton

$$\text{FFA Content} = \frac{28.2 \times Normality\ of\ NaOH \times Titration\ value}{weight\ of\ the\ oil}$$

If the value of the FFA is less than 2% we can directly go to transesterification or we need to do esterification and then reduce the FFA content till it lower than 2%.

Esterification is process is used to remove the extra free fatty acid in the oil.

$$\underset{(FFA)}{R-COOH} + \underset{(METHANOL)}{CH_3OH} \xrightarrow{H_2SO_4\,(CATALYST)} \underset{(FATTY\ ACID\ ESTER)}{R-CO-OCH_3} + \underset{(WATER)}{H_2O}$$

In esterification process, 75ml of methanol and 0.75ml of H_2SO_4 is added to the 500ml oil. After settling it for 3-4 hours. We will get acid layer on the top and esterified layer on the bottom which can be removed separately.

Figure 2.: Esterified Oil

Now check the FFA of the esterified oil. If the FFA is less than 2% we can do transesterification. If not, we need to do esterfication till FFA reaches less than 2%. Transesterification process is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis, except that an alcohol is employed instead of water. In this process, 75ml of methanol and 2.76g of NaoH is added to the 500ml of esterified oil. After settling it for 3-4 hours, we get separate layers of Karanja biodiesel and glycerine in top and bottom respectively.

Figure 3: Transesterified Biodiesel

IV. EXPERIMENTAL SETUP

After preparing the Karanja Biodiesel, prepare the blend B20. It means 200ml of Karanja biodiesel and 800ml diesel. Then we choose single cylinder water cooled engine for testing the performance of B20 karanja biodiesel. The specification of the diesel engine is shown in the table 1.

Figure 4: Pensky–Martens closed cup apparatus.

Table 1: Engine Specification

Sl No.	Parameter	Details
1	Make	Kirloskar
2	Type of engine	Single cylinder, 4 Stroke
3	No. of cylinders	1
4	Power	6 HP (6×736 watts)
5	Rated speed	650 rpm
6	Bore Diameter	114 mm
7	Stroke length	140
8	Starting	Cranking
9	Type of Loading	Rope Brake Loading
10	Type of Cooling	Water Cooling
11	Type of Ignition	Compression Ignition
12	Dia. of Drum	382 mm
13	Belt Thickness	6 mm

Figure 5: Test Engine

The flash and fire point of the B20 Karanja Biodiesel blend is tested on Pensky–Martens closed cup apparatus.

V. RESULTS AND DISCUSSION

The flash and fire point of diesel is 60^0c and 70^0c respectively. The obtained flash and fire point of B20 Karanja Biodiesel by using Pensky–Martens closed cup apparatus is 73^0c and 79^0c respectively. The density of the B20 blend is 844.9 kg/m^3.

Table 2: Performance of Diesel

Sl. No	Load in kg W1 (Kg)	W2 (Kg)	Net load (Kg)	Time for 5cc Fuel Consumption t(sec)	Brake Power (W)	Total Fuel Consumption (kg/hr)	Specific Fuel Consumption (kg/hr)	Brake Mean Effective Pressure (N/m^2)	Indicated Power (W)	Brake Thermal Efficiency η(%)	Mechanical Efficiency η(%)	Indicated Thermal Efficiency η(%)
1	0	0	0	57.32	0	0.26	0	0	1000	0	0	32.2
2	2	0	2	41	263.09	0.363	0.001379	34233	1263.09	6.06	20.8	29.13
3	5	1	4	38.2	526.18	0.39	0.000741	68467	1526.18	11.29	34.47	32.76
4	8	2	6	37.19	789.24	0.401	0.000508	102695	1789.24	16.47	44.11	37.35
5	12	3	9	31.75	1183.86	0.47	0.000397	154043	2183.86	21.08	54.2	38.9
6	16	4	12	28.31	1578.48	0.527	0.00033	2053944	2678.48	25.07	61.2	40.9
7	20	5	15	24.16	1973.1	0.607	0.000307	256743	2973.1	27.2	66.36	41.48

The above Table 2 explains about the performance test conducted on diesel engine by using diesel. The table 3 gives the performance result of B20 Karanja Biodiesel.

Table 3: Performance of B20 Karanja Biodiesel

Sl. No	Load in kg W1 (Kg)	W2 (Kg)	Net load (Kg)	Time for 5cc Fuel Consumption t(sec)	Brake Power (W)	Total Fuel Consumption (kg/hr)	Specific Fuel Consumption (kg/hr)	Brake Mean Effective Pressure (N/m²)	Indicated Power (W)	Brake Thermal Efficiency η(%)	Mechanical Efficiency η(%)	Indicated Thermal Efficiency η(%)
1	0	0	0	70.81	0	0.214	0	0	900	0	0	39.55
2	2	0	2	50.04	263.09	0.303	0.00151	34233	1163.09	8.16	22.6	36.09
3	5	1	4	43	526.18	0.353	0.00067	68467	1426.18	14.01	36.89	37.99
4	8	2	6	36.69	789.24	0.414	0.000524	102695	1689.24	17.92	46.72	38.37
5	12	3	9	31.71	1183.86	0.479	0.000404	154043	2083.86	23.24	56.81	40.92
6	16	4	12	27.74	1578.48	0.55	0.000347	2053944	2478.48	27.08	63.68	42.33
7	20	5	15	23.89	1973.1	0.636	0.000322	256743	2873.1	28.37	68.67	42.4

After tabulating the performance of both the diesel and B20 Karanja Biodiesel, we compared the different parameters like TFC, SFC, Mechanical Efficiency, Indicated Thermal Efficiency and Brake Thermal Efficiency of B20 to diesel.

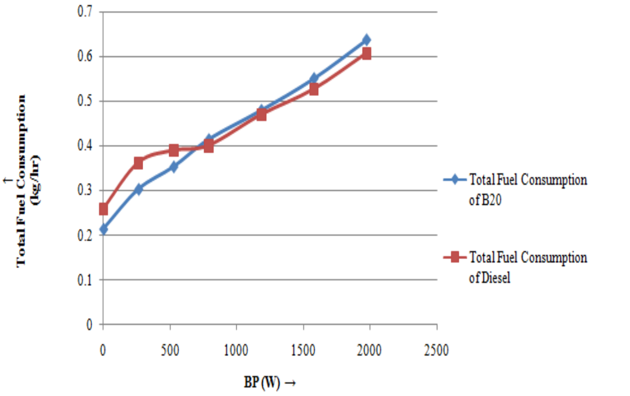

Figure 6: TFC vs. BP

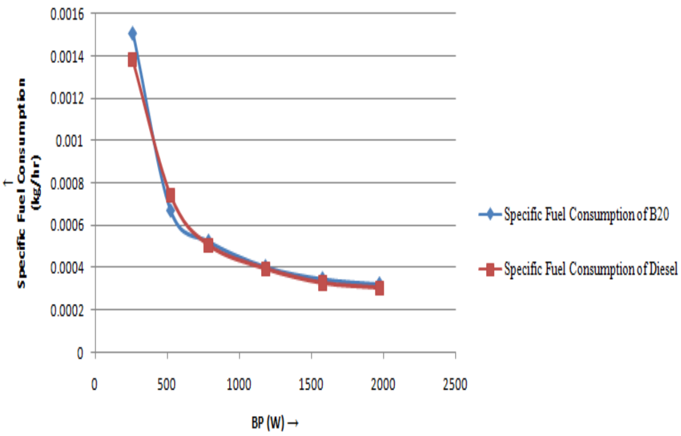

Figure 7: SFC vs. BP

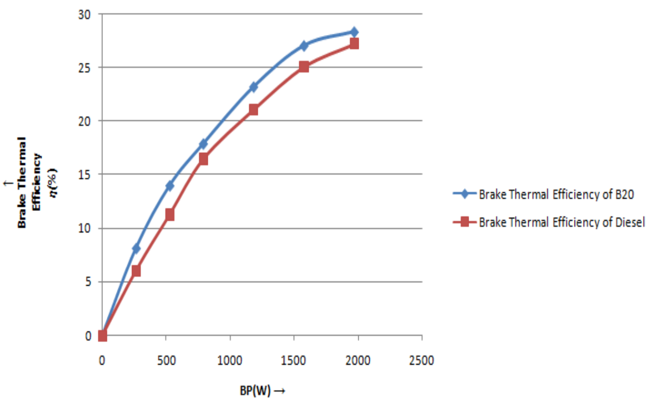

Figure 8: Brake Thermal Efficiency vs. BP

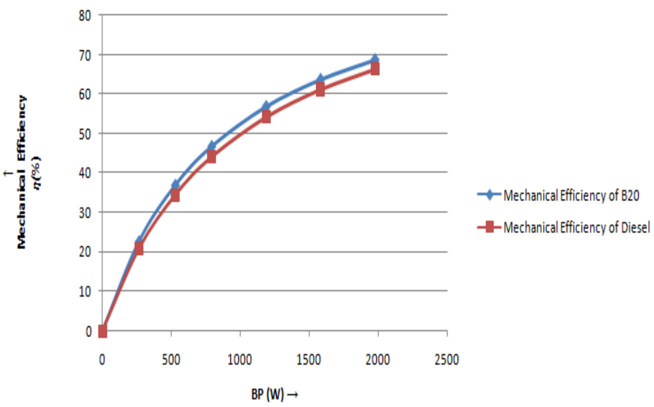

Figure 9: Mechanical Efficiency vs. BP

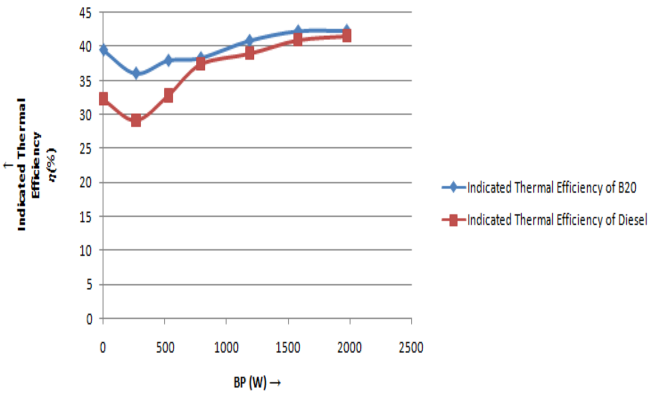

Figure 10: Indicated Thermal Efficiency vs. BP

VI. CONCLUSION

In this work, the Karanja Biodiesel represent as a good additive to diesel. The existing diesel engine performs satisfactorily on biodiesel fuel without any significant engine modifications. There is a little increase in fuel consumption which is often due to the lower calorific value of the biodiesel than diesel. The Brake Thermal Efficiency for B20 is increased due to reduced heat loss with increase in load. Thus we can conclude that the Karanja Biodiesel is a good additive to diesel.

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