Study on the Performance and Emission Characteristics of Diesel Engine with Blends Biodiesel with Diesel as Fuel

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Abstract:

The wide use of petroleum-based lubricants increases concerns about pollution, and the rising of awareness of greenhouse gases has produced a demand for the use of environmentally friendly and biodegradable lubricants for industrial applications. Vegetable oils are one of the bio-oils that is a good choice for the replacement for petroleum products, due to their environmentally friendly characteristics. Many researchers have accomplished bio-lubricants from sunflower oil, corn oil, palm oil and soy oil but few have studied Jatropha, Neem and Pongamia oil, as a lubricant. In this study, performance and emission characteristics of biodiesel on a diesel engine are tested. Experiments were conducted using bio-diesel blends. The results were compared with diesel.

1. INTRODUCTION

The constant increase in the rate of consumption of the fossil fuels, consequent upon the ever-increasing pollution and the urbanization in the present-day world, has made the depletion of these conventional fuel resources shortly a quite inevitable fact. Also, the Greenhouse Gas emissions from these fossil fuels are constantly degrading the planet and causing global warming and other pollutant emission related problem. As such, the situation demands an alternate source of energy that can be used to overcome the forecasted future energy crisis. In addition to this, if the energy source is clean and renewable, it will reduce the environmental issues as well. In this quest for an alternate and renewable energy resource, scientists have come up with a variety of options among which biodiesel-diesel blends as alternative fuels has become a popular option and is gaining the attention of many researchers.

This is because scientists have seen that the properties of biodiesel prepared from vegetable oils are very close to commercial diesel and thus it has a promising future as an alternative fuel for the diesel engine. Biodiesel is renewable, biodegradable and green fuel can reduce our dependence on conventional/non-renewable fossil fuels as well as improve environmental quality in metro cities, urban and rural sectors by reducing obnoxious automotive/vehicular emissions. As such biodiesel has the potential to replace petroleum diesel shortly.

1.1 ADVANTAGES OF BIODIESEL

It is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is renewable, domestic resource with an environmentally friendly emission profile and is readily biodegradable. Biodiesel is non-toxic and biodegradable. It reduces the emission of harmful pollutants from diesel engines (80% less CO2 emissions, 100% less sulphur) but emissions of nitrogen oxides are increased. The use of biodiesel reduces the emission of un-burnt hydrocarbons due to its more complete combustion. Biodiesel is an ester that contains two oxygen atoms in the molecule. The use of biodiesel can extend the life of diesel engines because it is more lubricating and power output is relatively unaffected by biodiesel. It has a low explosion risk. No engine modification is needed to run Biodiesel in trucks and farm types of equipment. Biodiesel is a clean renewable source of energy that will create jobs and income for rural areas. Farmers can produce their fuel. Biodiesel can be used as pure fuel in engines or blended with petro-diesel at any ratio because it is the miscible product.

1.2 DISADVANTAGES OF BIODIESEL

Pure vegetable oil used as biodiesel tends to gum up injectors, so they might need overhauling more often. Biodiesel has a lower energy density than petro-diesel and because it is denser fuel, roughly speaking the reductions are in the vicinity of 10%. Viscosity at low temperatures is important with diesel, sometimes making cold-weather starting difficult; biodiesel can be at a disadvantage in this respect. Biodiesel cleans the dirt from the engine. This dirt then collects in the fuel filter, which can clog it. Clogging occurs most often when biodiesel is first used after a period of operation with petroleum diesel, so filters should be changed after the first several hours of biodiesel use. Quality of biodiesel depends on the blend, this quality can tamper.

1.3. OBJECTIVES

Extraction of non-edible oil and converting it into biodiesel and studying its properties. Study on the suitability of biodiesel by testing its properties on coated and without coated piston engine. Study on performance and emission characteristics of biodiesel and its blends with diesel as fuel with and without coating the engine piston. comparing the results with diesel as fuel. To blend the neat biodiesel with ethyl acetone acetate and obtain the blended fuel samples. To successfully run performance tests and emission tests on compression ignition engine for different blend samples.

2. EXPERIMENTAL STEPS IN PRODUCTION OF BIO-DIESEL

1. Measure 1.5 liters of waste cooking oil and transfer this oil to the 3-neck flask.
2. Next place the 3-neck flask on a magnetic stirrer with heater and magnetic pellet or Teflon bead add to the 3-neck flask for continuous stirring during heating.
3. The central neck of the 3-neck flask fitted with a reflux condenser for the recovery of methanol. For Condenser cooling purpose through tap cold-water circulating line adopted and periodically observing the water circulation.
4. Start the heater and maintain temperature to 60^0C constantly for reaction carryout.
5. Switch on the stirrer and adjust the speed in between 650 to 1000 rpm for clear agitation of the oil during heating.
6. To check the temperature, insert the thermometer to side of the 3-neck flask and observe the temperature periodically during operation.
7. For 1.5 litre of waste cooking oil, nearly 200 ml of methanol take and add in 500ml beaker.
8. Based on calculated FFA percentage the required KOH weighed, mixed with methanol, and stir it well until the mixer is a clear mix. The obtained mixture is known as the "methoxide mixture."
9. The oil temperature is kept between 60 c to 63 c. The next methoxide mixture adds to the 3 neck flask and maintains a constant speed. The reason behind to maintain between 60 c to 63 c is methoxide mixture contain methanol whose boiling temperature is 64.07 c if temperature more that will evaporate suddenly then the reaction goes incomplete.
10. The reaction maintains for 120 minutes.
11. After 30 minutes, observe the change of color and drain one sample allow it to cool and settle, next check whether the reaction is following the right direction what we expected. Check neatly.
12. After 90 minutes drain another sample and observe glycerine separation.
13. If the reaction is perfect, transfer the mixture into separating funnel and allow it cool for 5 hours.
14. After the time of 5 hours, glycerine separated and the biodiesel sets at the top.
15. Remove the glycerine layer from separating funnel and store it carefully.
16. Collect the biodiesel and again add to separating funnel allow for another 45 minutes for observe the further glycerine content to settle in case if there remove as mentioned above.

2.1 ESTIMATION OF FFA

Free Fatty acid Formula = 28.2 (Normality of KOH) (Titration value) / (weight of the oil)

For Normal Pongamia oil $= \frac{28.2 \times (0.1) \times (2.7)}{1} = 7.61$

2.2. TRANSESTERIFICATION

The term transesterification is used as synonymous for alcoholises of carboxylic esters, in agreement with most publications in this field. The transesterification is an equilibrium reaction and the transformation occurs essentially by mixing the reactants. However, the presence of a catalyst (typically a strong acid or base) accelerates considerably the adjustment of the equilibrium. To achieve a high yield of the ester, the alcohol has to be used in excess.



Pongamia oil Magnetic stirrer with an electric heater separation funnel

2.3 WATER WASH

The biodiesel obtained is washed 3 times with warm water at 50-60 degree centigrade to remove the catalyst and any soap contents. If clear water is got back, it indicates that the catalyst is not present in the biodiesel.

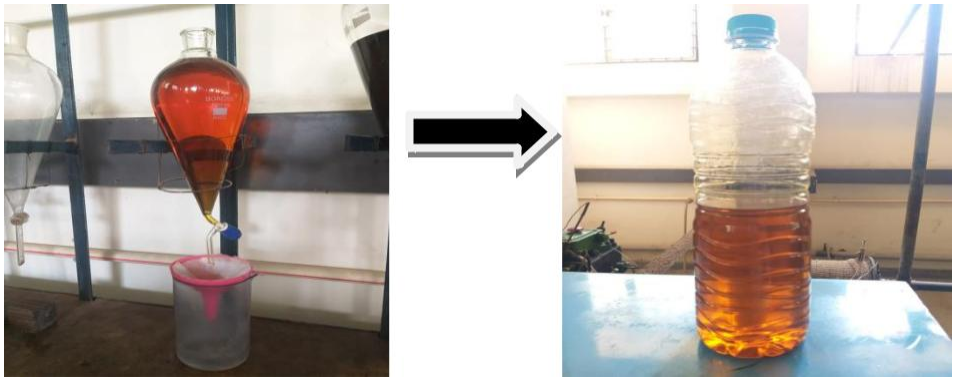


First water wash second water wash third water wash

Water wash process

2.4 FILTERING AND COLLECTING BIO-DIESEL

The neat and dry biodiesel obtained after heating is filtered through filter papers to make it ultra-pure and then it is collected in bottles for further blending and testing purpose



2.5 PREPARATION OF BLENDS AND EXPERIMENTAL SETUP

2.6 SPECIFICATION OF THE EXPERIMENTAL SETUP

Four Stroke Single Cylinder Diesel Engine		
SL.NO	Make	Kirloskar
1	Capacity	3.7 kW
2	Compression ratio	16.5:1
3	Cylinder	80mm
4	Stroke	110mm

3. RESULT AND DISCUSSION

Table 3.1 B0 Blend Reading

Fuel Type:-B0									
SL NO	Load in N/m	Time for 10cc of oil in sec	T in C exhaust	CO % vol	HC ppm	CO_2 % vol	O_2 % vol	NOx ppm	Speed
1	0	53.67	239	0.24	89	2.6	17.17	30	1412
2	5	48.38	275	0.21	73	4.2	14.91	98	1404
3	10	36.31	348	0.14	82	6.3	11.97	191	1396
4	15	29.02	415	0.22	129	9.4	7.59	358	1382
5	18	20.7	575	2.32	173	11.3	2.9	390	1366

Table 3.2 B10 Blend Reading

Fuel Type:- B10									
SL NO	Load in N/m	Time for 10cc of oil in sec	T in C exhaust	CO % vol	HC ppm	CO_2 % vol	O_2 % vol	NOx ppm	Speed
1	0	56.12	265	0.23	79	2.5	17.41	35	1410
2	5	45.57	275	0.07	32	1.5	18.95	38	1408
3	10	41.1	315	0.01	16	1.1	19.02	61	1398
4	15	33.3	488	0.13	75	8	9.94	315	1383
5	18	21.25	580	0.74	132	10.9	4.46	351	1365

Table 3.3 B20 Blend Reading

Fuel Type:- B20									
SL NO	Load in N/m	Time for 10cc of oil in sec	T in C exhaust	CO % vol	HC ppm	CO_2 % vol	O_2 % vol	NOx ppm	Speed
1	0	52.72	304	0.25	104	2.7	16.96	36	1415
2	5	46.6	285	0.2	83	4	15.16	100	1410
3	10	40.12	340	0.12	63	5.6	13.04	221	1399
4	15	32.26	425	0.13	103	8	9.65	369	1386
5	18	22.37	520	1.42	140	10.6	4.95	378	1370

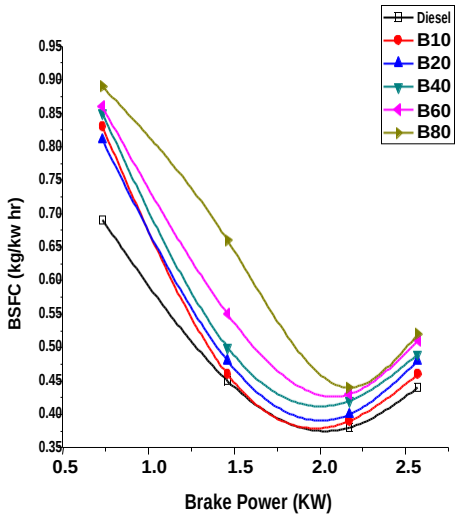
3.4 GRAPHS

3.4.1 Graph of Brake Power vs BSFC

BSFC vs BP - The experiment is conducted on a single-cylinder DI engine using different blends of biofuel with diesel. In general, BSFC decreases with Brake Power up to 80-90% loading and thereafter it decreases. The results for the blend B10 and B20 follow the same trend and are almost close to Diesel at higher loads this is because of better combustion.

3.4.2 Graph of Brake Power vs BTE

BP vs BTE - The engine was run at different blends of biodiesel at different loads. Brake thermal efficiency increases with an increase in load as well as Brake power up to 80% loading and thereafter it follows downtrend. As that B10 at highest BTE as compared to other biodiesel blends. The lowest BTE was found to be of diesel at B80 blend at 18 N-m loads.



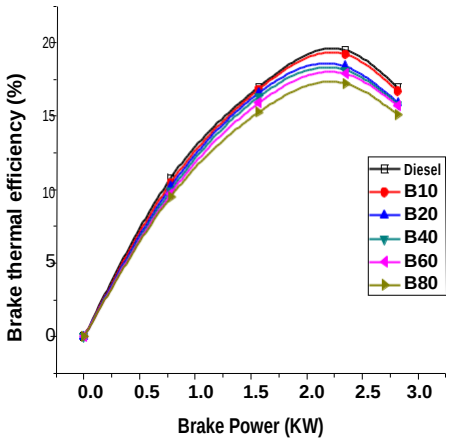


Table 3.5 Result table of BSFC

Parameter	Load-in N-m	BP	B0	B10	B20	B40	B60	B80
Brake Specific Fuel Consumption (BSFC) kg/kW hr	0	0	0	0	0	0	0	0
	5	0.73	0.83	0.96	0.94	0.97	0.96	0.97
	10	1.46	0.55	0.54	0.58	0.51	0.63	0.59
	15	2.17	0.47	0.47	0.53	0.48	0.51	0.5
	18	2.57	0.55	0.58	0.55	0.52	0.6	0.59

Table 3.6 Result table of BTE

Parameter	load n-m	BP	B0	B10	B20	B40	B60	B80
Brake Thermal Efficiency in %	0	0	0	0	0	0	0	0
	5	0.73	10.01	9.37	9.37	9.25	9.2	8.84
	10	1.46	15.46	15.22	15.32	14.89	14.47	14.4
	15	2.17	18.01	17.73	16.51	15.96	15.9	15.81
	18	2.57	15.44	15.21	15.11	15.02	14.48	14.41

CONCLUSION

After conducting the test we can draw the following conclusions

1. The transesterification of straight vegetable oil reduces the viscosity of oil to 3.6 cost
2. The properties of biodiesel produced have similar properties as diesel
3. The calorific value of biodiesel is now nearing diesel
4. Biodiesel produced now can be directly used as fuel for diesel engine
5. The performance of the engine at B10 is matching with the performance with diesel as fuel
6. It is also observed that the BTE increases with increase in load 80 as a result of better combustion.

SCOPE OF FUTURE WORK

A performance study can be conducted on a variable compression ratio engine. Tests can also be conducted on heavy-duty diesel engine with biodiesel as a fuel

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