IJARSCT ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252 Volume 2, Issue 8, June 2022

Test on CRDI Diesel Engine Using Biodiesel as an Alternative Fuel

Prof. R.A. Solunke[1], Mr. Abhishek Shekde[2], Mr. Shubham Mane[3], Mr. ShriKrishna Kadam[4], Mr. Suraj Lokhande[5]

Assistant Professor, Mechanical Engineering, NBNSSOE, Pune, India[1]

UG Student, Mechanical Engineering, NBNSSOE, Pune, India[2,3,4,5]

Abstract: *In this research work an experimental investigation of biodiesel blends on combustion, performance and emission characteristics of a direct injection (DI) CRDI Diesel Engine is carried out. The blends are prepared at different proportions and fuel properties such as calorific value, viscosity, flash point and fire point, cloud point, pour point of biodiesel (B), diesel (D), biodiesel-diesel (BD) blends are determined. The engine test is conducted at different speeds and loads. From the results obtained for fuel properties we can observe that the flash, fire and pour point, mechanical efficiency and thermal efficiency are decreasing by increasing the percentage of sunflower biodiesel in BBD blends. It is also observed that the performance parameters such as brake thermal efficiency (BTE) and exhaust gas temperature increases with increase in the proportion of butanol in BBD blend. However, the brake power (BP) decreases with increase in the proportion of sunflower and waste cooking oil in BBD blend. The increase of butanol in BBD blends also influences emission characteristics such as carbon monoxide (CO), hydrocarbon (HC) and oxides of nitrogen (NOx). The use of biodiesel as an alternative to petroleum diesel has become prevalent in the past two decades due to the depletion of fossil fuels. It is a renewable source of energy as edible and non-edible plants can be grown at will. But taking into consideration the ever-growing population the use of vegetable oil in excess could result in starvation.*

Keywords: Diesel Engine, Butanol, Biodiesel, BBD Blends, Emission Characteristics Alternative, Edible, Non-edible, Lubrication, Mechanical Efficiency. Diesel, Ethanol, etc.

I. INTRODUCTION

We find out what are the outcomes of using Biodiesel as an alternative fuel on a DIESEL Engine. Our aim is to carry out an experimental investigation of biodiesel blends on combustion, performance and emission characteristics of a direct injection (DI) engine. Our aim in this project is to conduct trail on CRDI Diesel Engine using Biodiesel as an alternative fuel and map out its characteristics.

Biodiesel:

Biodiesel which is propelled as substitute to diesel fuel though attractive is not viable at present state because of its high production cost with the major concern of finding a permanent resource. As basically biodiesel is a assortment of fatty acid methyl ester it can also be produced from non-glyceride sources like acid oil which is non-edible, easily obtainable in significant amounts at the majority of the vegetable oil processing plants. This project mainly focuses on the utilization of Acid Oil Methyl Ester (AOME) and its combinations with diesel and ethanol in different proportions in a modified CRDI Diesel Engine fitted with Common Rail Direct Injection (DIESEL) facilities.

Properties of Biodiesel:

The properties of a biodiesel fuel that are determined by the structure of its component fatty esters include ignition quality. It is also a renewable source of energy and a clean burning stable fuel. Properties of biodiesel such as oxygen content, cetane number. viscosity and density are greatly dependent the sources (soybean. rapeseed or animal fats) of biodiesel.

Advantages of Biodiesel:

- Lowered viscosity
- Complete removal of the glycerides
- Lowered boiling point
- Lowered flash point

Disadvantages Of Biodiesel:

- Variation in Quality of Biodiesel.
- Not Suitable for Use in Low Temperatures.
- Food Shortage.
- Increased use of Fertilizers.
- Clogging in Engine.

II. LITERATURE REVIEW

D.B. Hulwan et.al., concluded that the blend prepared on diesel, ethanol and biodiesel on volume basis, the smoke and CO emissions are reduced at all the speeds and loads and the NOX, CO2 and UBHC emissions are increased. Vinod kotebavi et.al., revealed in their experimental results that CO and HC emissions reduced with increasing the waste cooking oil percentage in the blends because of high oxygen content in the oil.

Edward Antwi et.al., experimentally studied the performance characteristic of CI engine with diesel and different proportions of biodiesel blend. They found that the BSFC, BTE and BP did not change significantly by using biodiesel in place of diesel. Substituting biodiesel with diesel the BTE and brake power did not differ from that obtained with diesel. F. Halek et.al., examined the CRDI Diesel Engine operated on biodiesel- fatty acid methyl ester (FAME) and concluded that the engine when operated on FAME fuel have lower emissions of CO, HC, particulate matter and air toxics then when operated on diesel fuel.

NOx:

The use of pure biodiesel causes the increase in NOx emissions. For example, a maximum of 15% increase in NOx emissions for B100 was observed at high load condition as the results of 12% oxygen content of the B100 and higher gas temperature in combustion chamber. The WPOME and COME on a 6-cylinder WC, NA, DI, and CRDI Diesel Engine and found that the NOx emissions of the WPOME and COME increased by 22.13% and 6.48%, respectively.

CO:

According to table 1it is common trend that CO emissions reduce when diesel is replaced by pure biodiesel. About 50% reduction in CO emissions for biodiesel from rapeseed oil compared to low and ultralow sulfur diesel. A higher reduction in emissions was observed that the reducing range of CO was 73–94% for the Karanja methyl ester (B100) and its blends (B20, B40, B60 and B80) compared to diesel, showed that CO emissions decreased by 86.89% and 72.68% for WPOME and COME, respectively.

HC:

That HC emissions reduce when pure biodiesel is used instead of PD. The properties of biodiesel are related to HC emissions. Increase in chain length or saturation level of several biodiesels led to a higher reduction in THC emissions on an 11.1 L engine. THC emissions reduced with the increasing in chain length when they tested lauric (C12:0), palmitic (C16:0) and oleic (C18:1) methyl esters on a 6-cylinder engine, and THC reduced by 50% for pure biodiesel instead of diesel.

III. METHODOLOGY

Engine Specification

No. of Cylinder	1
No. of Strokes	4
Cylinder Diameter	87.5mm
Stroke Length	110mm
Connecting rod Length	234mm
Orifice Diameter	20mm
Dynamometer A.L.	185mm
Fuel	Diesel

Sample Calculations

Brake Power

BP = 2.π. N. T / 60000 = 2 x 3.14 x 1543 x (0.185 x 3 x 9.81) / 60000 = 0.879859 kW

Break Thermal Efficiency

BTE = (BP x 1000 x Time for 10ml) / (10 ml. ρ. Calorific value) = ((0.879859 x 1000 x 45.45) / (10 x 830 x 42 x 106 x 10-6)) x 100 = 11.47148%

Figure 1: CRDI Diesel Engine

IJARSCT
ISSN (Online) 2581-9429
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Volume 2, Issue 8, June 2022
Impact Factor: 6.252

1. Pure Diesel:

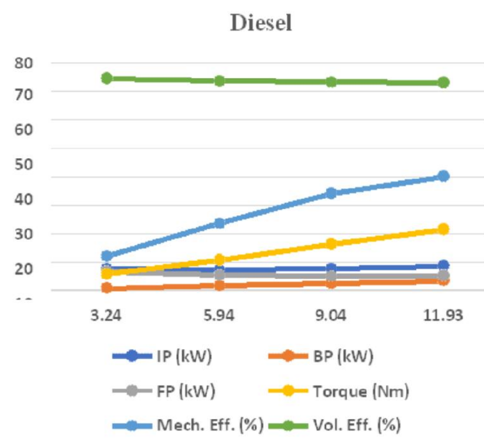

Figure 2: Diesel VS Load

Conclusion

- We get at the load of 12 kg and speed at 1528 rpm then B. P. (Brake Power) = 3.46kW is maximum in pure diesel.
- Load is increased that is also Torque will be increased at 12kg load applied is on speed 1528 rpm then Torque is 21.64Nm maximum in pure diesel.

2. Brake Power:

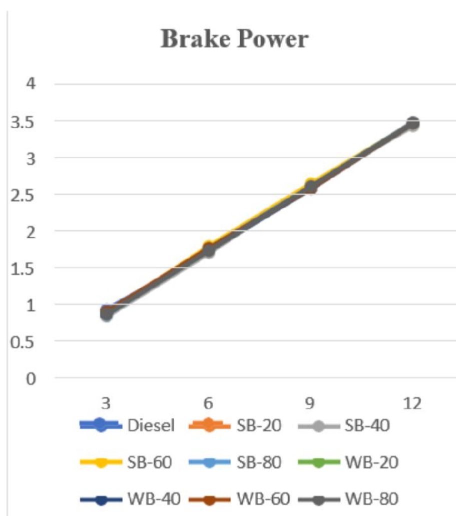

Figure 3: Brake power VS Load

Conclusion

- The brake power increase can be observed at the loads of 9 and 12 kg respectively. Here the values of brake power increases more than the diesel brake- power.
- Evidently it is clear from the graph that as the load and the biodiesel percentage increases the break power increases.

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3. Indicated Power

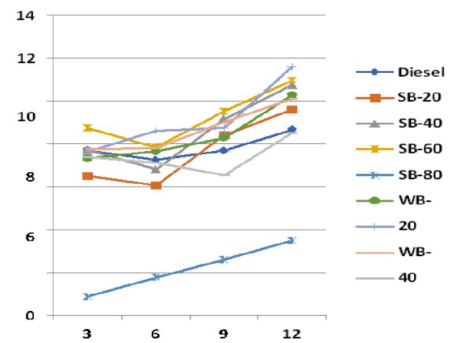

Figure 4: Indicated Power VS Load

Conclusion:

- The Indicated power increase can be observed at the loads of 9 and 12 kg respectively. Here the values of brake power increases more than the diesel power.
- Evidently it is clear from the graph that as the load and the biodiesel percentage increases the Indicated power increases.

4. Thermal Efficiency:

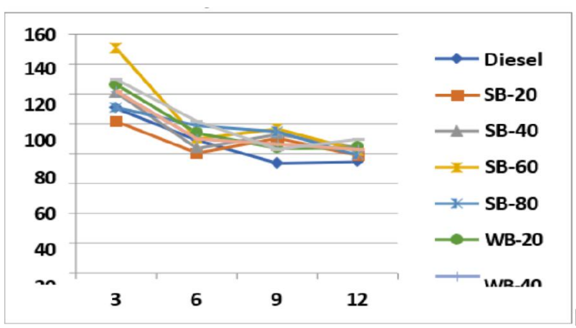

Figure 5: Thermal Efficiency VS Load

Conclusion:

- The Thermal Efficiency decreases can be observed at the loads of 3kg. 9kg and 12 kg respectively. Here the values of Thermal Efficiency decreases.

5. Mechanical Efficiency:

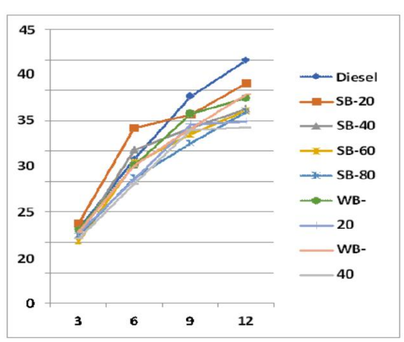

Figure 6: Mechanical Efficiency VS Load

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Conclusion:

- Evidently it is clear from the graph that as the load and the biodiesel percentage increases the Mechanical Efficiency increases.

6. Volumetric Efficiency

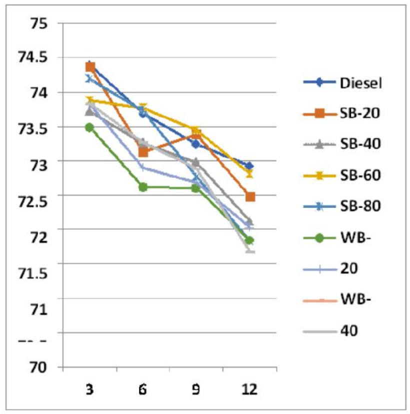

Figure 7: Volumetric Efficiency VS Load

Conclusion:

- The Volumetric Efficiency decreases can be observed at the loads of 3kg, 9kg and 12 kg respectively. Here the values of Thermal Efficiency decreases.
- Evidently it is clear from the graph that as the load and the biodiesel percentage decreases the Volumetric Efficiency decreases.

7. Exhaust Gas Analysis:

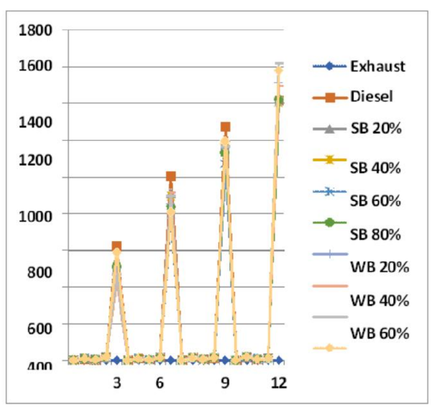

Figure 8: Combine Exhaust Gas

Conclusion:

- The exhaust gas of pure diesel is low at 3, 6, 9, and 12kg respectively for carbon monoxide and CO is high at waste cooking oil bio diesel for 80% blend load of 12kg.
- At pure diesel the loads of 3, 6, 9, and 12 kg respectively. The HC (hydro carbon \) is low at all incident and at blend of 60% waste cooking oil bio diesel the HC is all time high.
- In the blend of 40% waste cooking oil bio diesel the NO (Nitrogen monoxide) is low at 3 kg and blend of 60% waste cooking oil bio diesel is high on 12kg load applied.

IV. CONCLUSION

1. In the all testing on CRDI Diesel engine the fuel can be useful over the petroleum fuel. In that testing the mechanical efficiency increased but other two efficiency thermal and volumetric respectively is decreased.
2. The brake power increases can be observed at the loads of 3, 6, 9, and 12 kg respectively.
3. In the bio-diesel 20% and 80% blend brake power at high and the blend of 40% sunflower biodiesel brake power is low.
4. The Indicated Power increases can be observed at the loads of 3, 6 9, and 12kg respectively.
5. The blend of 40% waste cooking oil bio diesel the indicated power at high and the blend of 80% sunflower bio diesel the indicated power is low as compared to other.
6. The thermal efficiency decreases can be observed at the loads of 3, 6, 9, and 12kg respectively.
7. The blend of 20% and 80% waste cooking oil bio diesel at that time load on 3kg then thermal efficiency is high but after load apply 6, 9, and 12kg respectively thermal efficiency is decreased.
8. The Mechanical efficiency increases can be applied the load of 3, 6, 9, and 12kg respectively.
9. At blend of 60% and 80% of sunflower biodiesel and waste cooking oil bio diesel respectively at that time Mechanical efficiency is low on load of 3 kg.
10. At the load of and. Respectively sunflower bio diesel and waste cooking oil biodiesel respectively that time Mechanical efficiency is high on load at 12kg.
11. The exhaust gas of pure diesel is low at 3, 6, 9, and 12kg respectively for carbon monoxide and CO is high at waste cooking oil bio diesel for 80% blend load of 12kg.
12. At pure diesel the loads of 3, 6, 9, and 12 kg respectively. The HC (hydro carbon) is low at all incident and at blend of 60% waste cooking oil bio diesel the HC is all time high.
13. The CO_2 (Carbon dioxide) gas is high at and low of sunflower 20% blend and waste cooking oil bio diesel 40% respectively at 3 kg load and gas is high and low of sunflower biodiesel 80% and 60% respectively at 12kg load.
14. Exhaust of gas of O_2 (oxygen) is low at waste cooking oil bio diesel 60% and waste cooking oil bio diesel 80% at the load of 12kg and the blend of 40% waste cooking oil bio diesel the level of gas is high.
15. In the blend of 40% waste cooking oil bio diesel the NO (Nitrogen monoxide) is low at 3 kg and blend of 60% waste cooking oil bio diesel is high on 12kg load applied.

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