

Emission Characteristics Analysis of Biodiesel from Pongamia Pinnata Using Different Blends

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Abstract

Karanja oil (Pongamia Pinnata) is non-edible in nature and is available abundantly in India. In the present investigation, the oil obtained from the seeds of Karanja is being considered as a potential alternative fuel for CI engine. The Karanja oil extracted from the seeds is converted into Bio-Diesel by the method of esterification. We used different blends such as D100, BD100, BD90 and BD80. The physical properties such as viscosity, calorific value, fire point, flash point and density value are evaluated. Then the performance characteristics like Brake thermal efficiency, Brake specific fuel consumption, Exhaust gas temperature and Emission characteristics like opacity, NOX, carbon-monoxide, carbon-dioxide, unburnt hydrocarbons are also determined. During this investigation standard fuel testing procedure are adopted. A single cylinder diesel engine developing 5.2KW is used for investigation. It is found that engine characteristics with neat Biodiesel are found to be inferior compared to diesel with increase in IOP from 180 bar to 200 bar resulted in improvement in engine characteristics.

Keywords: *Biodiesel, Karanja oil (Pongamia Pinnata), Esterification*

1) INTRODUCTION

Biodiesel is a liquid fuel made up of fatty acid alkyl esters, fatty acid methyl esters, or long-chain mono alkyl esters. It is produced from renewable sources such as new, used vegetable oils animal fats and is a cleaner-burning replacement for petroleum-based diesel fuel. It is nontoxic and biodegradable. Biodiesel has physical properties similar to those of petroleum diesel. In simple terms, biodiesel is a renewable fuel manufactured from methanol and vegetable oil, animal fats, and recycled cooking fats (1).

Due to the uprising crisis of the today world, Vegetable oils have come up as a reliable source of fuel. They are being tested worldwide because of their abundant availability, renewable nature and better performance when used in engines (2). Many Non-edible oils are being used in compression ignition engine by fuel modification or engine modification. The vegetable oils have very high density and viscosity, so we have used methyl ester of the oil to overcome these problems. Their use in form of methyl esters in non modified engines has given encouraging results (3).

2) SCOPE OF PROJECT

Biodiesel has low emission, non toxic and biodegradable therefore it is the perfect alternative that can be utilised to fulfil the future demands of energy consumption. As the nonedible oils are produced in abundance especially in India and have the tendency to with stand harsh climate therefore it is taken up in waste land. Pongmia have short gestation, intercropping tendency, it can be grown in boundaries and extra lands more ever they are less prone to pests, they have longer lifespan and higher seed yield. Moreover it is environmental friendly and safe compared to diesel. During the work, performance and emission characteristics of CI engine at pre set injector opening pressure with diesel and biodiesel of Pongamia oil are investigated. Also engine characteristics with various biodiesel and diesel blends at various IOP are investigated.

3) OBJECTIVES OF PROJECT

- 1) Extraction of crude oil from Pongamia Pinnata.
- 2) Biodiesel production using Pongamia Pinnata by transesterification process.

3) Determining the performance and emission characteristics of Pongamia biodiesel using different blends.

4) The comparative study of emission parameters obtained from the diesel and biodiesel using different blends.

4) MATERIAL AND METHODOLOGY



Figure 4.1 Pongamia Seed

Table-1 Properties of Diesel and Biodiesel

PARAMETERS	DIESEL	BIODIESEL
Viscosity (Cst)	4.25	9.106 .
Density (Kg/m ³)	830	879.66
Fire point (°C)	75	170°C
Flash point (°C)	52°C-60°C	161°C
Calorific value	42000 J/gm	39267 J/gm

4.1 Experimental Set-up

Engine

The engine chosen to carry out experimentation is a single cylinder, four stroke, vertical, water cooler, direct injection computerised kirloskar made CI engine. This engine can withstand higher pressures encountered and it is also used extensively in agriculture and industrial sectors.

Dynamometer

The engine has a DC electrical dynamometer to measure its output. The dynamometer is calibrated statistically before use. The dynamometer is reversible that is it works as monitoring and as well as an absorbing device. The load is controlled by changing the field current. Eddy current dynamometer theory is based on eddy current.

The construction of eddy current dynamometer has a notched disc which is driven by prime mover and magnetic piles are located outside with a gap the coil which excites the magnetic pole is wound in circumferential direction when current runs through exciting coil, the magnetic flux loop is formed around the exciting coil through stators and rotor.

Pressure sensor

A piezoelectric pressure transducer is mounted on the cylinder head through an adopter to measure the pressure in the cylinder, in the combustion chamber. Temperature sensor is mounted on the engine at various locations to measure the temperature of the cooling water as well as those of exhaust gases.

Computerized setup

A computerized engine setup consisting of a computer loaded with the engine compatible software (ENGINE SOFT) is connected to the engine electronically to different units like the dynamometer. Pressure sensor, temperature sensor Rota meters, fuel and air level indicators etc. If is used to analyse all the data accumulated during the process of experimentation.

Exhaust gas analyser

Use of five gas exhaust analyser can be helpful in troubleshooting both emission and drivability concerns. Presently short grade analyzers are capable of measuring as few as two exhaust gases HC and CO. The five gases measured by the latest technology exhaust analyser(AVL Digas analyser) are HC, CO, CO₂, O₂ and NO_x all five of these gases especially O₂ and CO₂ are excellent troubleshooting tools.



Figure 4.2: Exhaust gas analyser machine

5) RESULT AND DISCUSSION

5.1 Brake thermal efficiency:

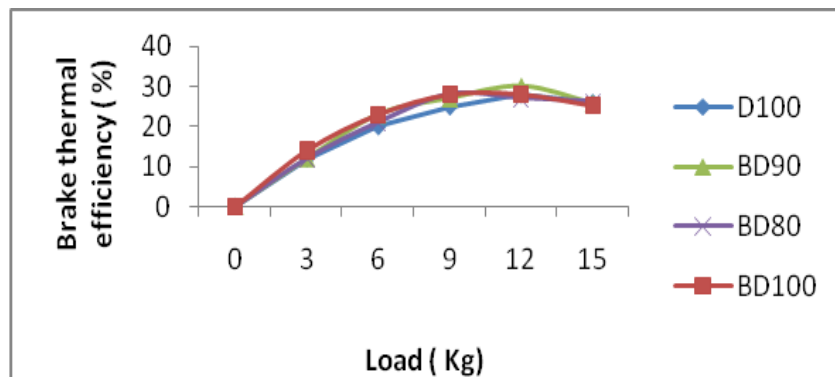


Figure 5.1: Break thermal efficiency v/s Load

It is observed that break thermal efficiency with neat biodiesel is lower than diesel due to its higher viscosity. With BD90 and BD80 thermal efficiency is higher than as compared to biodiesel due to reduction in viscosity and better combustion process.

5.2 Brake specific fuel consumption

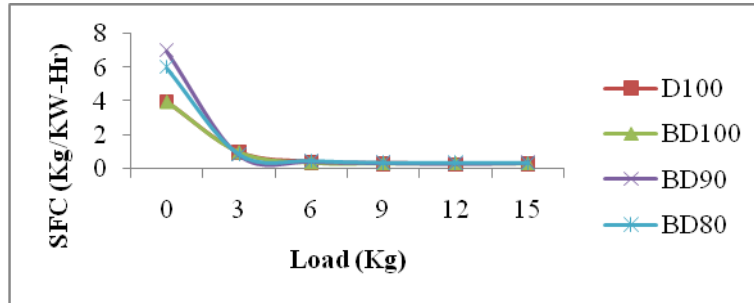


Figure 5.2: SFC v/s Load

Above figure indicates variation in specific fuel consumption with brake power. Higher BSFC with bio diesel and its blends with diesel are observed due to their calorific value and their higher density. This indicates more fuel is required to develop same power.

5.3 Exhaust Gas Temperature:

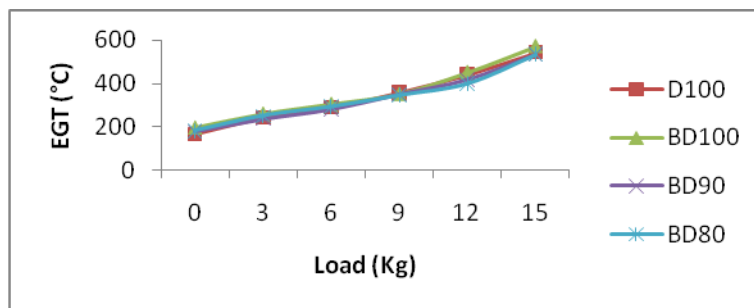


Figure 5.3: EGT v/s Load

Figure 5.3 indicates variation in EGT for biodiesel and its blends with diesel. Higher exhaust gas temperature is observed with bio diesel as compared to diesel due to sluggish combustion and late release of heat. Reduction in exhaust gas temperature is observed with blends due to better combustion

5.4 Carbon Monoxide Emission:

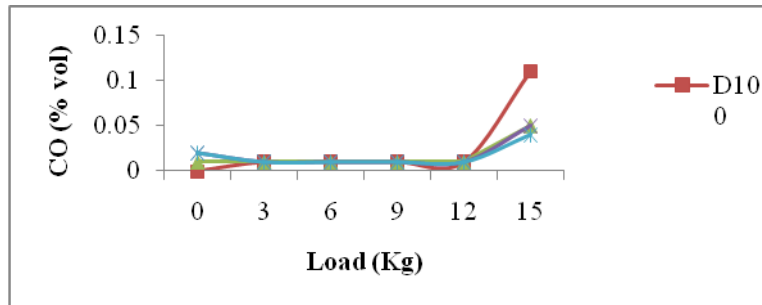


Figure 5.4: CO v/s Load

Figure shows variation in CO emission with different fuels. With bio diesel and its blends with diesel reduction in carbon monoxide emissions are observed due to inherent oxygen present in these fuels.

5.5 Carbon Dioxide Emission:

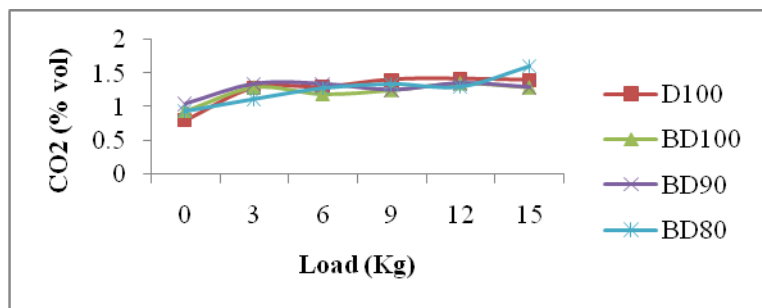


Figure 5.5: CO2 v/s Load

Marginal increase in CO₂ emission with blends is observed with blends as compared to neat bio diesel due to better combustion. BD-80 shows highest CO₂ emission as compared to other blends due to better combustion.

5.6 Unburnt Hydrocarbon Emission:

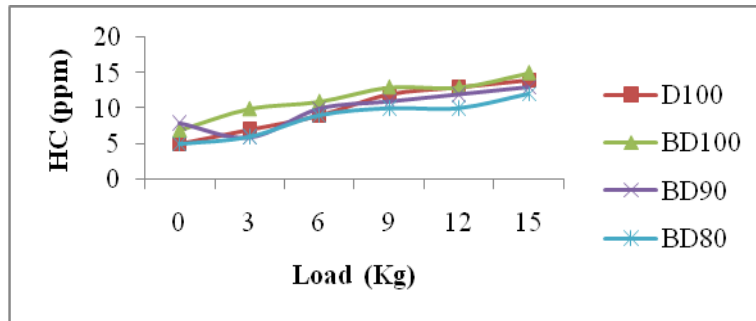


Figure 5.6: HC v/s Load

Figure shows variation in unburnt hydrocarbon emission for blends. Higher UBHC emission is observed with bio diesel due to improper combustion. Reduction in UBHC emission with blends in blend is observed due to better combustion.

5.7 Oxides of Nitrogen Emission:

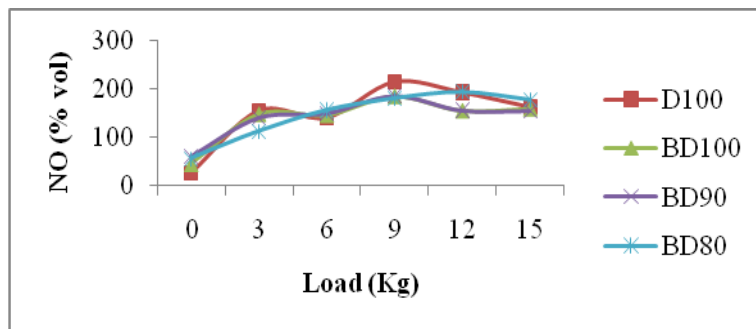


Figure 5.7: NO v/s Load

Figure shows variation in oxides of nitrogen emission with blends. As combustion with bio diesel is slightly inferior with diesel, reduction in NOX emissions is observed. Slight increase in NOX emission is observed with blends. Highest NOX emission is observed with BD-80.

5.8 Smoke Opacity:

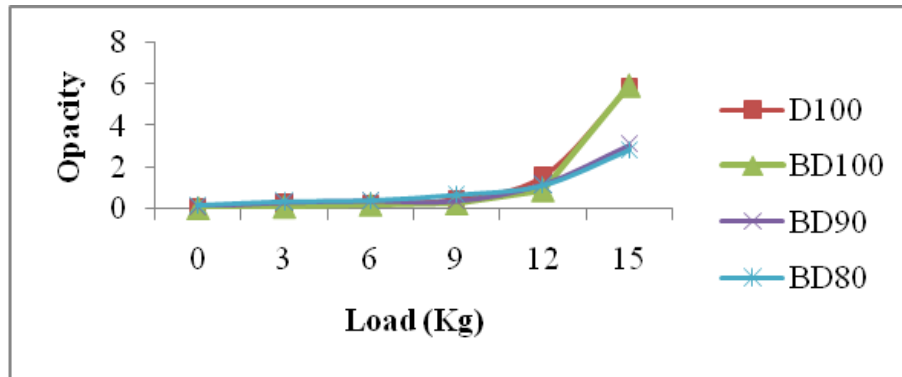


Figure 5.8: Smoke Opacity v/s Load

Figure shows SO for different blends. Higher smoke opacity is observed with neat bio diesel, while reduction in smoke opacity is observed with Blends. This indicates better combustion.

5.9 Effect Of Injector Opening Pressure On Engine Characteristics

The engine characteristics mainly depend on the viscosity of the fuel. If the viscosity is high, larger droplets will be injected and spray will not disperse properly as it comes out of the injector. This leads to lower engine performance and higher emissions. Increase in injector opening pressure improves the atomization and dispersion of fuel spray and rate of evaporation thereby improving the engine characteristics.

Hence, in present investigation an effort is made to reduce the droplet size by increasing the injector opening pressure.

5.9.1 Brake Thermal Efficiency:

Figure 5.9.1 shows the variation of brake thermal efficiency for BD-80 at different injector opening pressure. The brake thermal efficiency at IOP of 180 bar is lowest among all IOPs. . Increase in IOP causes improvement in BTE over entire load range due to improvement in atomization, better air- fuel mixing and improvement in combustion process.

However, increase in IOP to 200 bar and 220 bar resulted in lower thermal efficiency as compared to 200 bar IOP. This may be due to fact that, at very high injector opening pressure, injection of very fine

droplets having less momentum and low penetration in air adversely effects the fuel distribution which causes partial suffocation

of droplets by its own products of combustion leading to incomplete combustion.

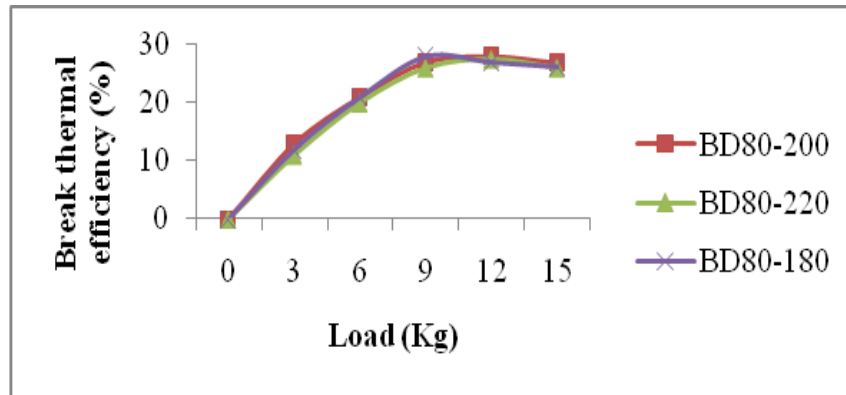


Figure 5.9.1: Break thermal efficiency v/s Load

5.9.2 Brake Specific Fuel Consumption:

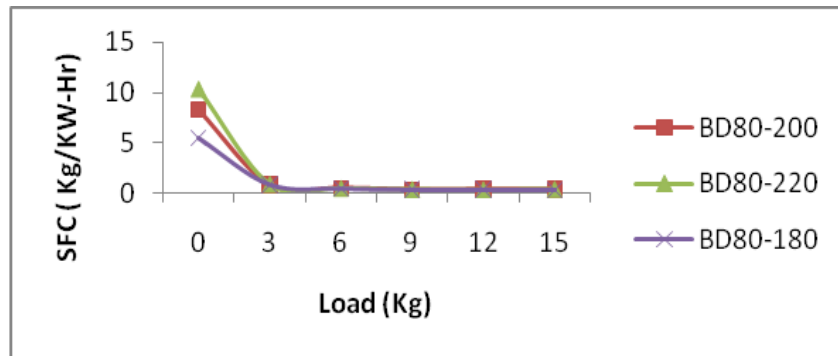


Figure 5.9.2: SFC v/s Load

Variation in brake specific fuel consumption for BD-80 at different injector opening pressure is shown in figure 5.9.2 highest brake specific fuel consumption is observed at IOP of 180 bar at which brake thermal efficiency is minimum.

5.9.3 Exhaust Gas Temperature:

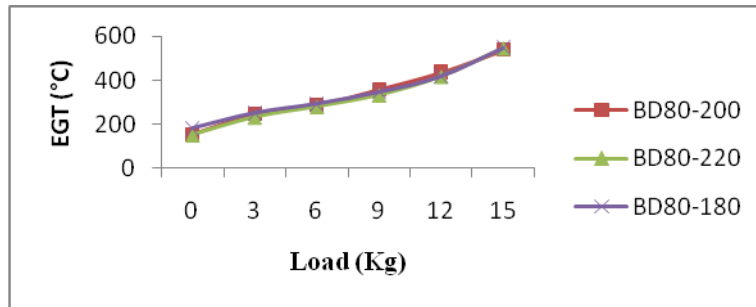


Figure 5.9.3: EGT v/s Load

Highest EGT is observed at IOP of 180 bar. Reduction in exhaust gas temperature is observed with increase in injector opening pressure from 180 to 200 bar. This is due to improvement in combustion during premixed phase and improvement in BTE. Further increase in IOP shows increase in EGT due to improper combustion.

5.9.4 Carbon Monoxide Emission:

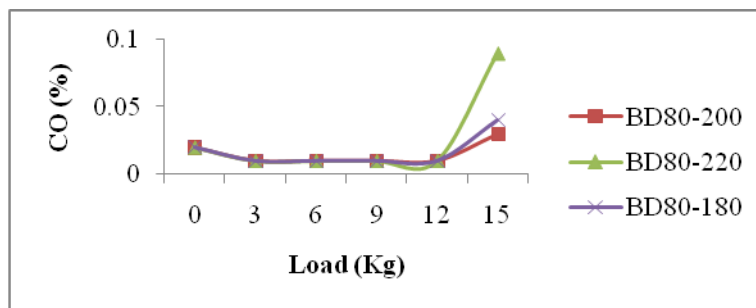


Figure 5.9.4: CO v/s Load

The highest carbon monoxide emission is observed at 180 bar. The CO emission reached to minimum at 220 bar. However, increase in IOP from 200 to 220 bar resulted in increase in CO emission as compared to 200 bar over entire load range.

5.9.5 Carbon Dioxide Emission:

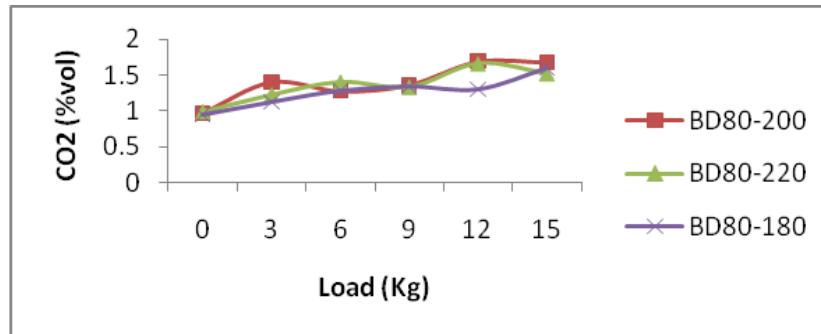


Figure 5.9.5: CO₂ v/s Load

At the injector opening pressure of 200 bar the carbon dioxide emission are found to be highest and lowest at 180 bar. The decrease in CO₂ emission is in the order of 180 bar- 200bar- 200 bar.

5.9.6 Unburnt Hydrocarbon Emission:

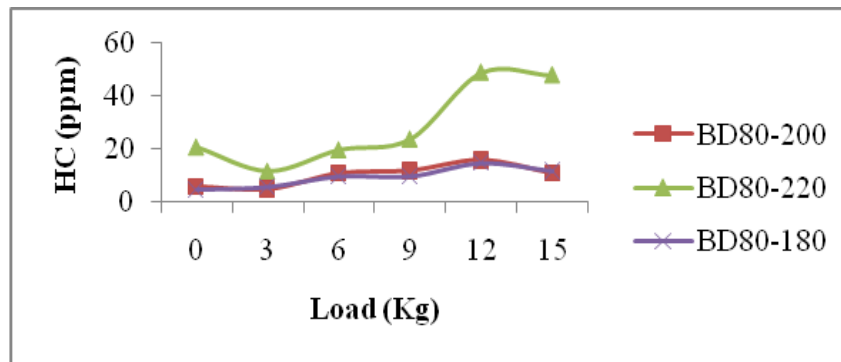


Figure 5.9.6: HC v/s Load

The unburnt hydrocarbon emission is highest at IOP of 180 bar. The UBHC emission is reduced with increase in IOP and reached to minimum at 200 bar. Increase in IOP from 200 bar to 220 bar resulted in increase in HC emission due to improper combustion because of poor distribution fuel in combustion chamber (**refer figure 5.9.6**).

5.9.7 Oxides of Nitrogen Emission:

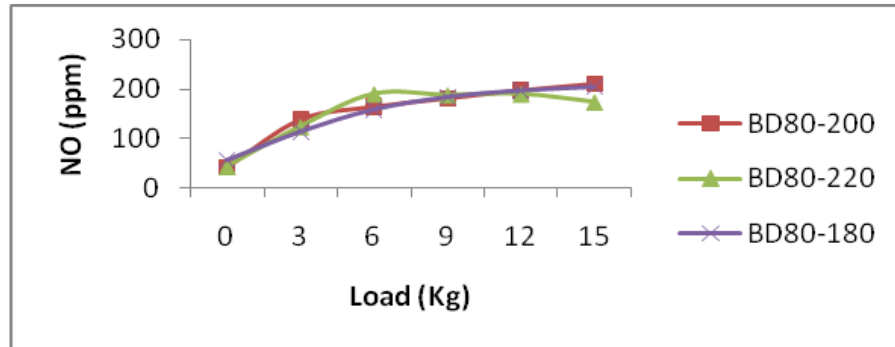


Figure 5.9.7: Oxides of Nitrogen Emission v/s Load

It is clear that, NO_x emission at 180 bar is lowest due to poor combustion. Increase in NO_x emission is observed with increase in IOP due to better atomization.

5.9.8 Smoke Opacity:

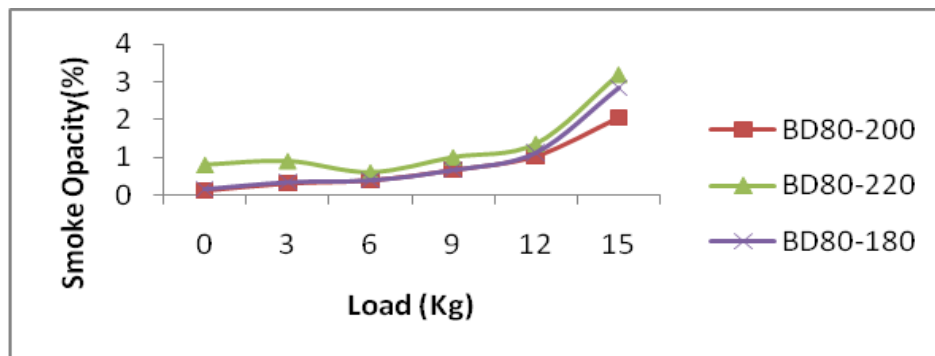


Figure 5.9.8: Smoke Opacity v/s Load

Decrease in smoke opacity is observed with increase in IOP and it is lowest at 200 bar. This is due to improvement in mixture formation because of well-atomized spray.

CONCLUSION

In this work, experimental investigations into use of bio diesel obtained from Pongamia Pinnata for compression ignition engine is carried out. Initially, engine characteristics with neat bio diesel and its blends with diesel are carried out. With best performing blend, effect of injector opening pressure on engine characteristics is done.

From above investigation following conclusions are drawn.

- 1) Fuel properties of Bio diesel are slightly inferior as compared to diesel
- 2) Viscosity, flash and fire point of Bio diesel are higher than diesel and calorific value is lower than diesel.
- 3) Brake thermal efficiency with bio diesel is slightly inferior to diesel due to its higher viscosity.
- 4) An emission like smoke opacity is higher with bio diesel.
- 5) Highest brake thermal efficiency with blend B80 can be obtained at injector opening pressure of 200 bar as

compared to 180 bar which is designed for diesel fuel

- 6) Finally, we recommend use of bio diesel for diesel engine with IOP of 200 bar so that engine can run with highest brake thermal efficiency and lowest smoke opacity.

SCOPE FOR FUTURE

- Biodiesel can also be produced by using different non-edible seeds present in the nature
- Biodiesel can be used as an alternative for diesel by varying the blends of biodiesel.
- By varying the IOP value of biodiesel we can observe the variation in performance and emission characteristics of engine.

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