OPEN ACCESS
ISSN: 2249-6645

International
Journal
Of Modern Engineering Research (IJMER)

Performance and Emission Characteristics of 4 S DI diesel Engine fueled with Calophyllum Inophyllum Biodiesel Blends

Kalyani Radha. K[1]*, Rama Siva Reddy. K[2]
[1,2](Department of Mechanical Engineering, JNTUA College of Engineering, Ananthapuramu, A.P
*Email: kalyaniradha@gmail.com

ABSTRACT : *Experiments were conducted on a single cylinder, 4 stroke water cooled, constant speed diesel engine using various blends of calophyllum inophyllum methyl ester and diesel to find out performance and emissions. Diesel was blended with Calophyllum inophyllum methyl ester by volume as B20, B40, B60 and B80 respectively. Tests were conducted from no load to full load condition and performance was analyzed for various parameters such as brake thermal efficiency, specific fuel consumption, mechanical efficiency and emissions like oxides of carbon, oxides of nitrogen and unburned hydro carbons. The results showed that B20 was 30.9% brake thermal efficiency followed by B40, B60 and B80 at 80% load, B20 was very close to the diesel. Emissions of hydrocarbon and oxides of nitrogen were reduced by 6.6% and 10.8% respectively. Carbon monoxide and carbon dioxide were increased by 8.3% and 5.7% respectively*

Keywords: *calophyllum inophyllum methyl ester; biodeiesl blends; performance; emission characteristics*

I. INTRODUCTION

Recent days, copious use of fossil fuels has led to their fast dwindling. Though, biofuels has emerged as a promising surrogate to diesel fuel, there are issues allied with them. Among those, the essential one is higher viscosity. Viscosity of fuel plays an important role in the combustion characteristics because the direct injection of fuel through the nozzle and fuel spray pattern in the open combustion chamber decides the ease of thermal efficiency and combustion characteristics of the engine. Very low viscosity can result in excessive internal pump leakage and on the other hand, system pressure reaches an undesirable level that will affect the injection process during the spray atomization. The effect of viscosity is critical at low-speed or light load conditions. Various methods such as blending, preheating, transesterification and other super critical methods are available to treat the molecular structure of vegetable oils. Among those, transesterification process has been widely used to prepare bio diesels from vegetable oils and animal fats. There is a reduction in viscosity and enhancement of fuel properties by the transesterification process. Calophyllum inophyllum is an ornamental evergreen tree belonging to Guttifereae family, native to eastern Africa, South Asia, Australia, and south pacific. The fruit is a round, green drupe reaching 20-40mm in diameter, which has a single large seed. The kernels have very high oil content of around 50 – 75%. From all above facts, an effort has been made to test the performance, and emission characteristics of methyl esters of calophyllum inophyllum oil with the aid of Kirloskar single cylinder (water-cooled) diesel engine.

II. MATERIALS AND METHODS

The tested fuels are conventional diesel fuel, B20, B40, B60 and B80. Calophyllum inophyllum oil was extracted from seeds by oil press and transesterification process was carried out. The properties of biodiesel fuel are shown in table1.

The experiments were carried out in a vertical, single cylinder, water cooled, four stroke compression ignition, naturally aspirated direct injection diesel engine, coupled with an ac generator, and loaded by resistive load system Output of generator is connected to the resistive load system. The specifications of the diesel engine are given in Table2.

Table 1 fuel properties of calophyllum inophyllum methyl ester

Parameters	**CIME**
Density in kg/m^3	875
Kinematic viscosity cSt (40°C)	5.4
Calorific value, MJ/kg	37.4
Flash point, °C	175
Fire point, °C	186

Table 2: specifications of a diesel engine

Parameters	**Specifications**
Make	KIRLOSKAR AV1
bore	80mm
stroke	110
Swept volume	553cc
Speed	1500 rpm
Rated power	3.72 kW
Compression ratio	17.5: 1

The engine was started at ideal condition and allowed to run for 10 minutes for warm-up and then tests were conducted. The fuel flow rate was measured by noting down the time taken for the consumption of a known quantity of fuel (5cc) from a burette. The engine was tested under seven distinct load conditions from ideal to full load condition. The viscosity esterifies oil was measured by red wood Viscometer, density by hydrometer, calorific value by bomb calorimeter, flash and fire point by open cup method. Gas analyzer was used to record the exhaust tail pipe emissions such as HC, CO, CO_2, and NO_x.

III. RESULTS AND DISCUSSION

Brake specific fuel consumption

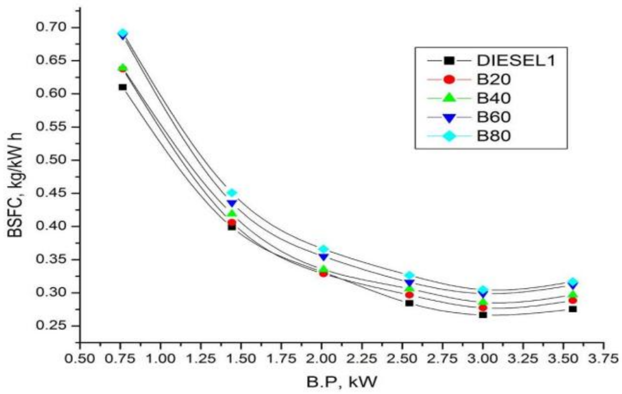

Figure 1. Variation of BSFC with brake power

The fig 1 shows the variation of Brake specific fuel consumption with brake power for diesel and CIME-diesel blends. It is observed that with increase in brake power the brake specific fuel consumption is decreases for both diesel and blends. The minimum BSFC was obtained for B20 is 0.2773 kg/kWh in comparison with blends B40, B60, B80 at 80% load which is very similar to the diesel but slightly greater than diesel (0.26678%). With an increase in biodiesel content in blends the value of BSFC also increased. B80 has maximum value of BSFC compared to the other blends. The primary reason is the additional consumption of biodiesel fuel by the test engine in order to maintain constant power output. On the other hand, the fuel pump of the engine delivers fuel in volumetric basis. Since the density of blended fuels is higher than that of diesel, the plunger in the injection pump discharges more blended fuel compared to that of diesel to maintain constant output power. This trend could be as a result of lower calorific value and higher density of the blended fuels. The practical diesel engine combustion chamber systems are only suitable when the calorific value of the fuel is high. It is always desirable for the vegetable oils have a calorific value closer to that of diesel. Since the calorific value of B20 blend was closer to that of diesel, lesser fuel consumption was noted with these blend than the other blends.

Brake thermal efficiency

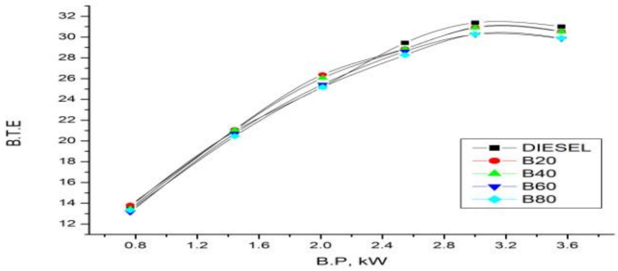

Figure 2. Variation of brake thermal efficiency with brake power

The fig 2 shows the variation of brake thermal efficiency with respect to brake power. It is found that with increase in brake power brake thermal efficiency also increases up to 80% load, and a slight decrease at full load. The brake thermal efficiency indicates the ability of the combustion system to accept the experimental fuel and provides comparable means of assessing how efficient the energy in the fuel can be converted into mechanical output. From the figure it is observed that B20 showed 30.9% brake thermal efficiency at 80% load which is very similar to diesel (31.38%). This may be due to better spray characteristics of diesel in the combustion chamber, which lead to effective utilization of air resulting in complete combustion. It is also evident from the plots that the brake thermal efficiency gradually decreased with increasing percentage of biodiesel content in blends. The lowest value of brake thermal efficiency was noted with B80 bio diesel operation. This may be due to the large amount of bio diesel supplied to the engine when compared to diesel in order to maintain the equal energy input to the engine. The high viscosity of the blended fuels inhibits the proper atomization of fuel vaporization, and combustion. This trend is also due to the combined effect of lower calorific value, higher density, and viscosity of the blended fuel.

Mechanical efficiency

The fig 3 is shows the variation of mechanical efficiency with respect to Brake power, from the figure it is observed that B40 has higher mechanical efficiency followed by B20, B60, B80 and diesel at all the loads. Better lubricating properties of biodiesel contribute to get higher mechanical efficiencies of CIME blends.

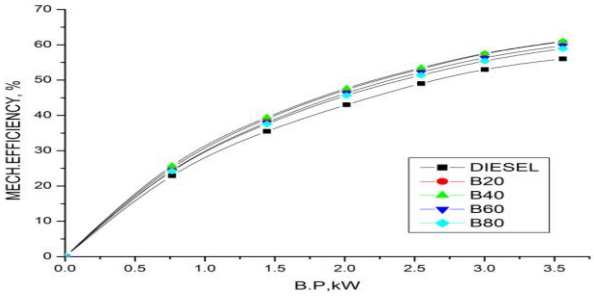

Figure 3. Variation of mechanical efficiency of with brake power

Hydrocarbons

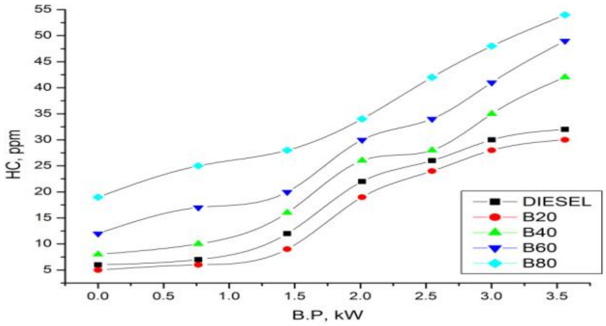

Figure 4.Variation of hydro carbons with brake power

Fig 4. shows the variation of HC with respect to Brake power. Hydrocarbon (HC) emission result from the presence of unburned fuel in the engine exhaust. HC emissions increases with engine load because of rich air fuel mixture. From the graph it is observed that B20 has low HC emissions than blend and diesel at all the loads. B60 and B80 showed more HC emissions compared with diesel and other blends because of heterogeneous mixture of denser fuel.

Carbon monoxide

Fig 5. shows the variation of carbon monoxide with respect to brake power. It is observed that load increases the CO emissions also increases. A low flame temperature and too rich air fuel ratio are the major causes of CO emissions from engines. Higher carbon monoxide emission results in loss of power in engines. It is observed from the figure B80 shows more carbon monoxide emission compared with diesel and remaining blends at all the loads, because of low flame temperature and too rich air fuel ratios. The low temperatures attained because of viscous biodiesel inhibit better spray characteristics.

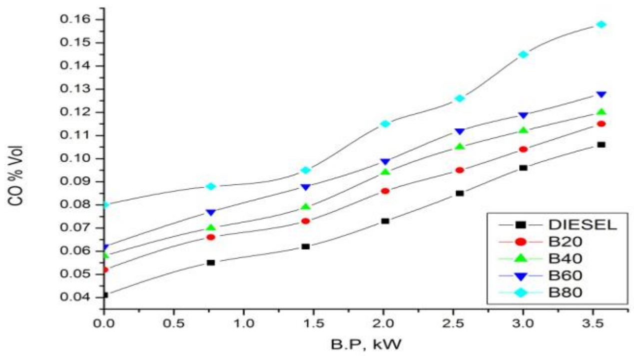

Figure 5. variation of carbon monoxide with brake power

Carbon dioxide

The fig 6 shows the variation of carbon dioxide with respect to brake power diesel showed lower volume of CO_2 than calophyllum inophyllum methyl ester blends at all the loads. The CIME blends has higher emissions than diesel.

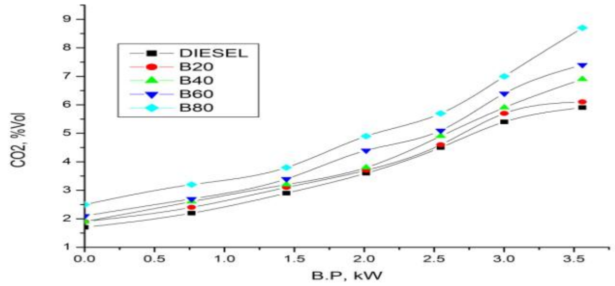

Figure 6. Variation of carbon dioxide with brake power

Oxides of nitrogen

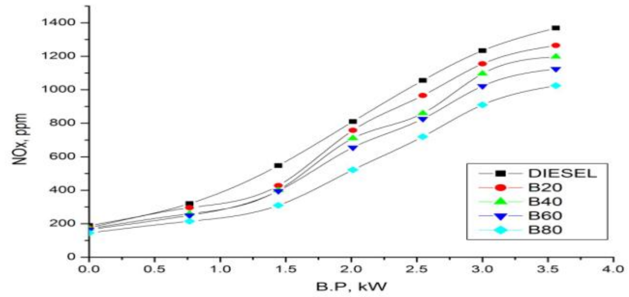

Figure 7: brake power vs. oxides of nitrogen

The variation of oxides of nitrogen emissions with respect to brake power is depicted in Fig 7 for diesel and CIME-diesel blends. The oxides of nitrogen in the exhaust emission are the combination of nitric oxide (NO) and nitrogen dioxide (NO_2). The formation of NO_x is highly dependent on in-cylinder temperature, oxygen Concentration in the cylinder, and dependent on engine technology. Oxides of nitrogen are mostly created from the nitrogen in the air and in fuel blends. In addition to nitrogen atoms, the fuel may contain Ammonia (NH_3) and Hydrogen Cyanide (HCN), which would contribute to a minor degree in the NOx formation. In general, the NOx concentration varies linearly with the load of the engine. As the load increases, the overall fuel–air ratio increases resulting in an increase in the average gas temperature in the combustion chamber and thus higher NOx. The NOx emission of diesel at maximum load was noted to be 1360 ppm, whereas for B80 was noted to be 1025 ppm which is 29% lesser than diesel. This reduced NOx emission for B80 bio diesel when compared to diesel may be due to the reduced premixed combustion rate leading to lower NOx emissions for B80 biodiesel operation. Moreover, B80 fuel had exhibited high viscosity during tests in comparison to other fuel blends, which primarily resulted in a lower amount of air entrainment and to poorer combustion leading to lower combustion temperatures.

V. CONCLUSION

Experiments were conducted on four stroke single cylinder direct injection diesel engine with diesel and blends of CIME 20%, 40%, 60%, and 80% with diesel and observed that 20 % blend is having higher brake thermal efficiency of 30.9% is very close to the diesel at 80% load.
HC emissions are 6.6% less than diesel.
NO_x emissions are 10.8% less than diesel.
Carbon monoxide emissions are 8.33% more than diesel.
Carbon dioxide emissions are 5.5% more than diesel.
Therefore B20 CIME blend may be a suitable alternative fuel to diesel than other blends without any engine modification.

REFERENCES

[1] Monyem A., Gerpen J.H.V., Biomass and Bioenergy, 20 (2001) 317–325
[2] Nurun Md., Rahman Md., Akhter Md., Applied Thermal Engineering ,29, (2009) 2265-2270
[3] Lapuerta M., Armas O., Fernandez F., Progress in Energy and Combustion sience,2008(198)
[4] Lapuerta M., Armas O., Fernandez F., Progress in Energy and Combustion Science,2008(198)
[5] Lina C.Y., Leec F.C., Fangd, F., Atmospheric Environment, 42 (2008) 1133–1143
[6] Lapuerta M., Armas O., Fernandez F., Progress in Energy and Combustion Science,2008(198)
[7] Roskilly P A., Nanda S.K., Wang D.W., Chirkowski J., Applied Thermal Engineering, 28
[8] Gaurav Dwivedi, Siddharth Jain, M.P. Sharma, J. Mater. Environmental Science. 4
[9] Heywood, J.B., (Internal Combustion Engine Fundamentals, McGraw Hill, 1988)
[10] Ganesan,V, (Internal Combustion Engine, Second Edition, Tata-Mc Graw Hill, 2004)