The Effect of Bio Diesel Blends on the Performance of Four Stroke CI Engine

[1]S.Rahamathullah, [2]P.V.Ramana, [3]Neeraj Kumar Jha

[1]Assoc.professor, [2]Assoc. professor, [3]Assoc. professor
[1]Mech.Dept-GATES Institute of Technology-Gooty-Anantapur (A.P)-India
[2]Mechanical Engineering Depart-CVR College of Engineering-Hyderabad (T.S)-India
[3]Mechanical Engineering. Depart-CVR College of Engineering-Hyderabad (T.S)-India

Abstract: **fuel reserves are depleting day by day as the consumption is increasing very rapidly due to increased urbanisation, increased transportations and increased number of vehicles and also due to increased use of fossil fuels the environmental pollution is increasing year to year so world today is facing a serious environmental problems like global warming. It is our responsibility to seek the alternatives to prolong the availability of fissile fuels for long run and at the same time protecting the environment from the damage so it is necessary to study the I.C engine fuels with suitable mixing with other fuels which are produced from renewable resources to prolong the availability of diesel reserves for future needs and to meet the requirement of diesel engine performance.**

In the present work, experiment is carried out on a single cylinder 4-stroke, naturally aspirated, direct injection and water cooled CI engine with Diesel and biodiesel blends are mixed in different proportions with diesel fuel, and performance like Brake thermal Efficiency (BTE), Brake specific fuel consumption (BSFC) and Exhaust Emissions are studied. From the experimental results obtained performance results for diesel and biodiesel and engine emissions are compared by graphs and conclusions are given for suitability of better usage of fuel for the future needs without deteriorating engine performance and without damaging the environment.

IndexTerms **- BTE, BSFC, I.C Engine, Biodiesel, Environment**

I. INTRODUCTION

Diesel fuels: are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms. It contains high percentages of carbon and hydrogen. Diesel fuel in general is a liquid fuel used in diesel engines. Diesel engines have found broad use as a result of higher thermodynamic efficiency and thus fuel efficiency. This is particularly noted where diesel engines are run at part-load; as their air supply is not throttled as in a petrol engine, their efficiency still remains very high.

Biodiesels: are oils and fats including animal's fats, vegetable oils, nut oils, hemp and algae[23]-[26]. Biodiesel is mostly developed from vegetable oils and may be utilized in any diesel automobile devoid of modification. The viscosity of vegetable oil can be reduced in number of ways and the most common way is Transesterification process, which converts the raw plant oil into bio-diesel with reduced viscosity[4]. Bio-diesel is an efficient clean, 100% natural energy alternative to petroleum fuels. The use of bio-diesel has grown dramatically during the last few years. Vegetable oil, bio-diesel and ethanol are the three most common renewable energy sources which act as alternate fuel.

The experiments are conducted in a single cylinder, water cooled, naturally aspirated, Diesel engine commonly used for transport vehicles. A rope brake dynamometer is coupled to the engine with suitable propeller shaft for balancing. The volumetric fuel metering system for fuel flow rate (burette) and air box method for measuring air flow rate and exhaust gas analyser are arranged. The exhaust gas analyser is used to measure the exhaust emission like HC, CO, CO_2 and O_2 emissions.

2. EXPERIMENTAL TEST SETUP

The experimental setup has been designed and fabricated in accordance with the scheme of experimentation planned to achieve the objectives formed under the research problems. The experimental techniques and testing instruments are carefully selected to minimize the errors.

A test rig was framed to analyze the performance and emission parameters of an engine. In this work it is aimed to conduct number of test runs on the developed test rig to judge the performance and emission parameters of a bio-Diesel at different operating conditions and to compare the results with normal engine operating on Diesel.

Fig1. Experimental setup

Table.1 Specifications of an engine used for the experiment

Engine	4 stroke Diesel engine
No. of cylinders	Single cylinder
Cooling media	Water cooled
Rated capacity	3.5 kW @ 1500 RPM
Cylinder diameter	87.5 mm
Stroke length	110 mm
Connecting rod length	234 mm
Compression ratio	12:1-18:1
Orifice diameter	20 mm
Dynamometer	Rope brake dynamometer
Dynamometer arm length	145 mm

3.0 ENGINE INSTRUMENTATION

The details of the engine instrumentation associated with the present test set are given below.

- For Fuel Consumption- burette
- For air consumption- air box with orifice and connected to manometer
- To apply load on the engine- rope brake dynamometer,
- For temperature measurement- thermo couples and
- To measure exhaust gas- multi gas analyser

4.0 EXPERIMENTAL INVESTIGATION

Experimental Investigations are carried one is to find performance characteristics and to know emissions characteristics [2] and also to know its effect on environment

Performance characteristics: To know performance characteristics experiments were conducted with varying loads at rated speed to measure Brake power and fuel consumption at different load conditions, with the different bio-Diesel blends B10, B20 and B30i.eIn this investigation[2] Diesel and bio-diesel blends thermal efficiencies (B10, B20 and B30) are tested at varying loads at rated speed.

4.1 Brake Thermal Efficiency

The Brake Thermal Efficiency of the engine increases with load for all the waste vegetable oil fuel blends up to three fourth loads. After three fourth load the thermal efficiency starts decreasing due to increase in load. It is be observed from the figure2 that the thermal efficiency of the engine[30] operated with 20% bio-diesel blend is lower than that of Diesel fuel and which is higher than the remaining blendsB10 andB30

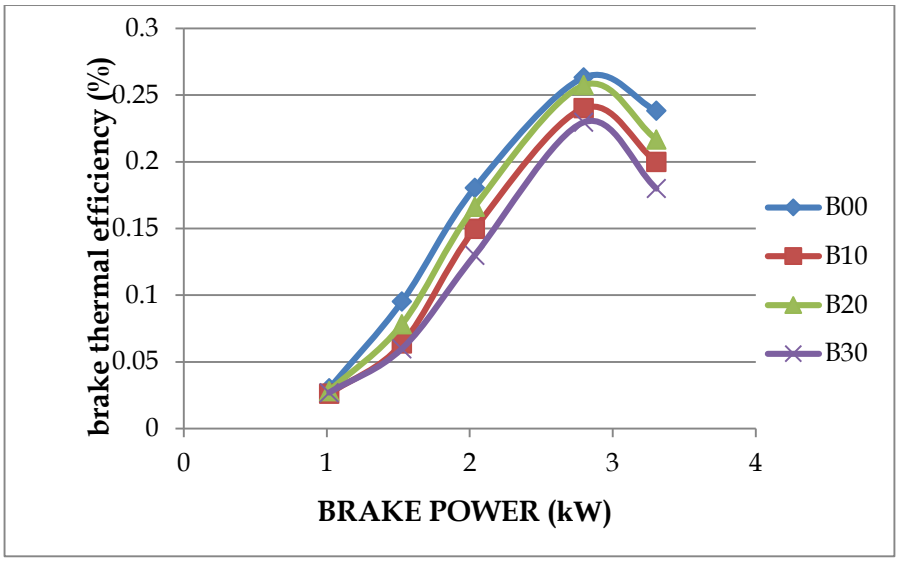

Fig: 2 Variation of Brake Thermal Efficiency with brake power

The brake thermal efficiency of the engine depends on fuel blends, cetane number, heating value and specific gravity. When the percentage of bio-diesel in the blend increases the thermal efficiency decreases. The higher viscosity leads to decreased atomization fuel vaporization and combustion. Hence the thermal efficiency of higher quantity of bio-diesel is lower than that of Diesel.

4.2 Brake Specific Fuel Consumption

The brake specific fuel consumption with load is shown in Figure3. It is observed from the figure that the brake specific fuel consumption of the engine increases with the increase in the percentage of bio-diesel which is higher for B30 and decreasing with increase in load to a particular point and then again it is increasing in this case that is 2.79Kw. This is mainly due to the combined effects of the fuel density, viscosity and lower heating value of blends. As the percentage of bio-diesel in the blend increases, its viscosity also increases causes improper atomization and mixing of fuel with air leads to decreased combustion efficiency thereby increasing fuel consumption.

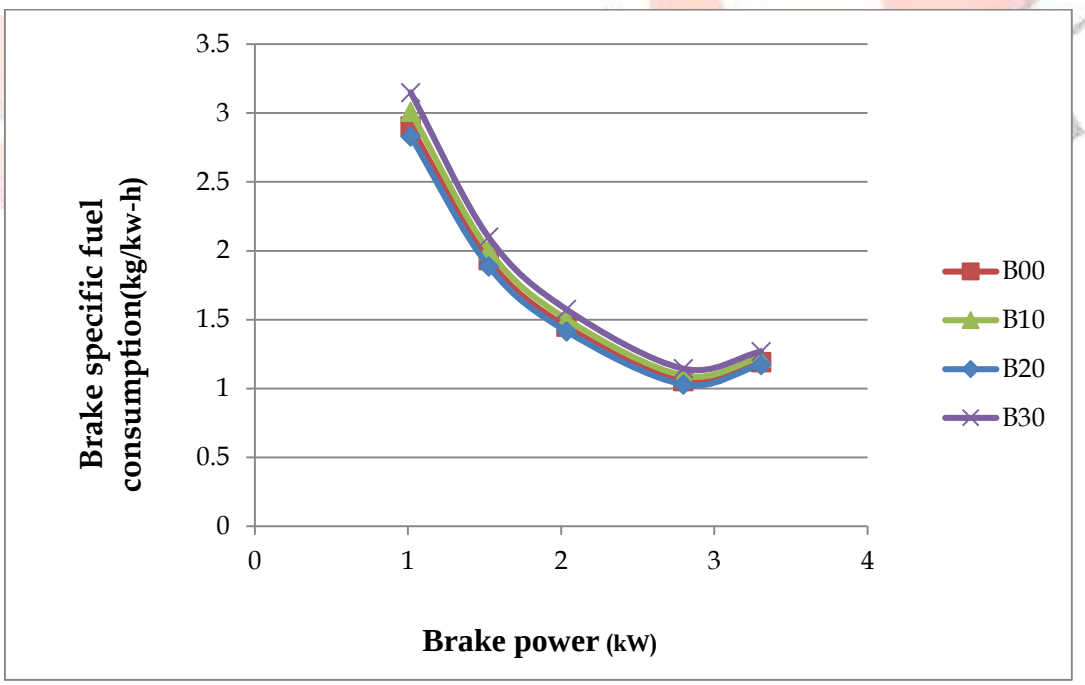

Fig: 3 Variation of Brake Specific Fuel Consumption with brake power

5.0 EMISSION CHARACTERISTICS

To know the emission characteristics a multi gas analyser is usedfor evaluation of the pollutants in the exhaust gas is attached to the engine. This analyzer is used to measure three important pollutants

- Carbon dioxide (CO_2)
- Carbon Monoxide (CO) and
- Un burnt Hydrocarbons (HC).

Fig 4: Photographic view of multi gas analyzer

The following emission characteristics of the fuel were studied by the experiment

5.1 Carbon Dioxide

The carbon dioxide emission increases linearly with the load of the engine (Figure5.Thismightbeduetocompletecombustionat higher loads which is higher for diesel and showing combustion is more efficient for diesel. The reduction in CO_2emissionfor all the blended fuels are observed. It is also noted from the figure that when the percentage of bio-diesel in the blend B30 increases theCO_2 emission is decreased shows incomplete conversion of CO in to CO_2. However it is quite obvious that the CO_2 emitted from the bio-diesel is entirely different with the CO_2 emitted fromB20 and B10 in the fuel operation.

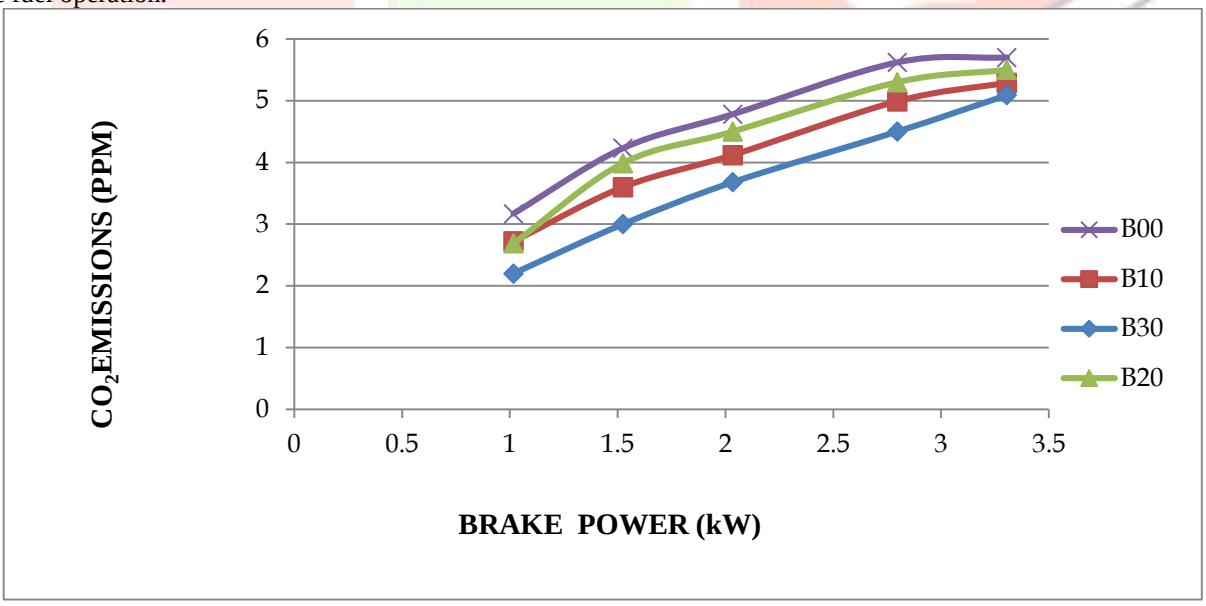

Fig: 5 Variation of Carbon Dioxide Emission with brake power

5.2 Carbon Monoxide Emission (CO)

The Carbon Monoxide Emission in the exhaust with load is shown in Figure6 .It is observed from the figure that the Carbon Monoxide Emission is higher for diesel than bio diesel blends and is decreased with the waste vegetable oil bio-diesel in the blend. The maximum reduction is observed with B30 blend followed by B20 blends .This is due to the higher percentage of bio-diesel in the blend which increases the oxygen percentage and most of the CO converted into CO_2.

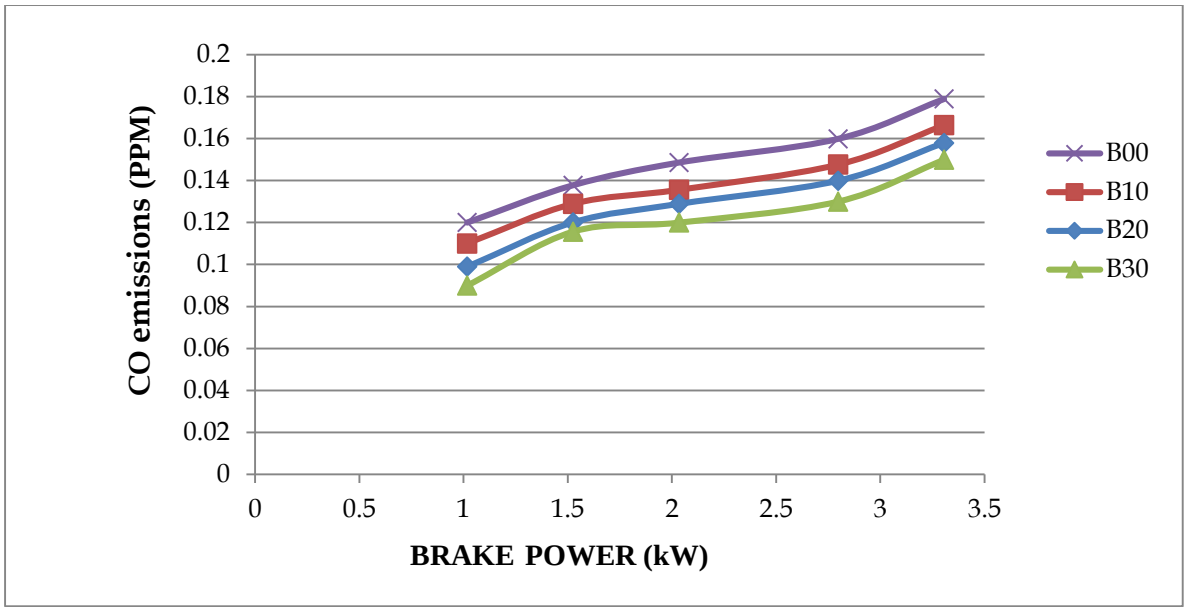

Fig: 6 Variation of Carbon Monoxide Emission with brake power

5.3 Unburned Hydrocarbon

The unburned hydrocarbon (HC) in the exhaust with load is shown in Figure7.It is observed from the figure that the HC emission is decreased with the waste vegetable oil bio-diesel then the diesel. The maximum reduction is observed with B30 blend followed by B20 and B10 blends .This is dueto the higher percentage of oxygen associated with bio-diesel in the blend.

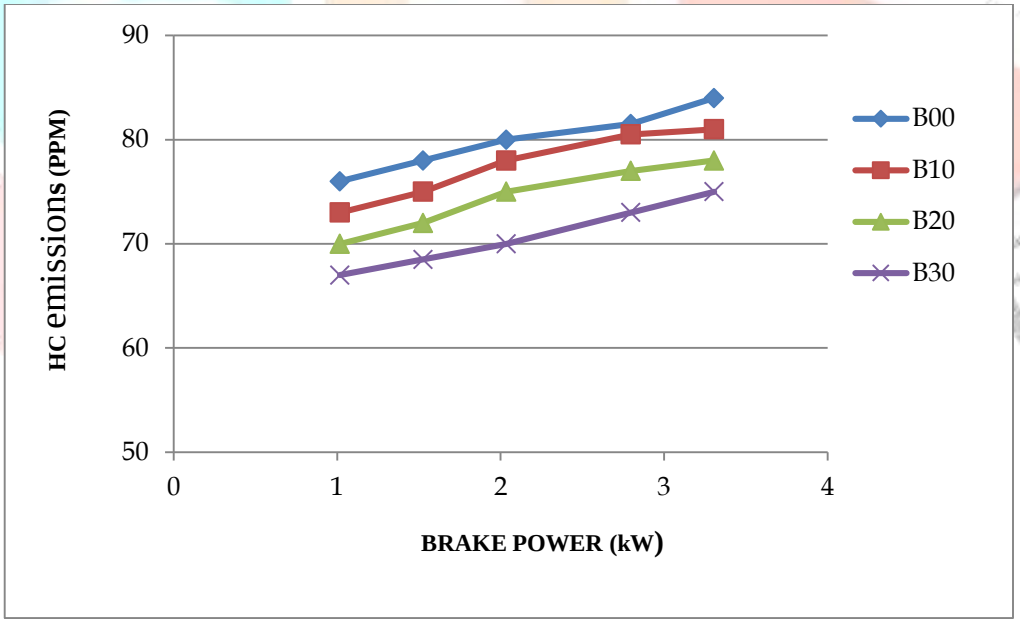

Fig: 7 Variation of Unburned Hydro Carbon Emission with brake power

5.4 Exhaust Gas Temperature:

Exhaust gas temperature (EGT) is varying with brake power and the results for different bio-fuel blends are presented in Figure8. EGT of all the tested fuels increased with brake power. EGT of B20 is higher than that of diesel fuel at all load due to the blends' higher viscosities, which resulted in poorer atomization, poorer evaporation, and extended combustion during the exhaust stroke. When percentage of bio-fuel is increases its viscosity also increases which results in increased EGT of the blends.

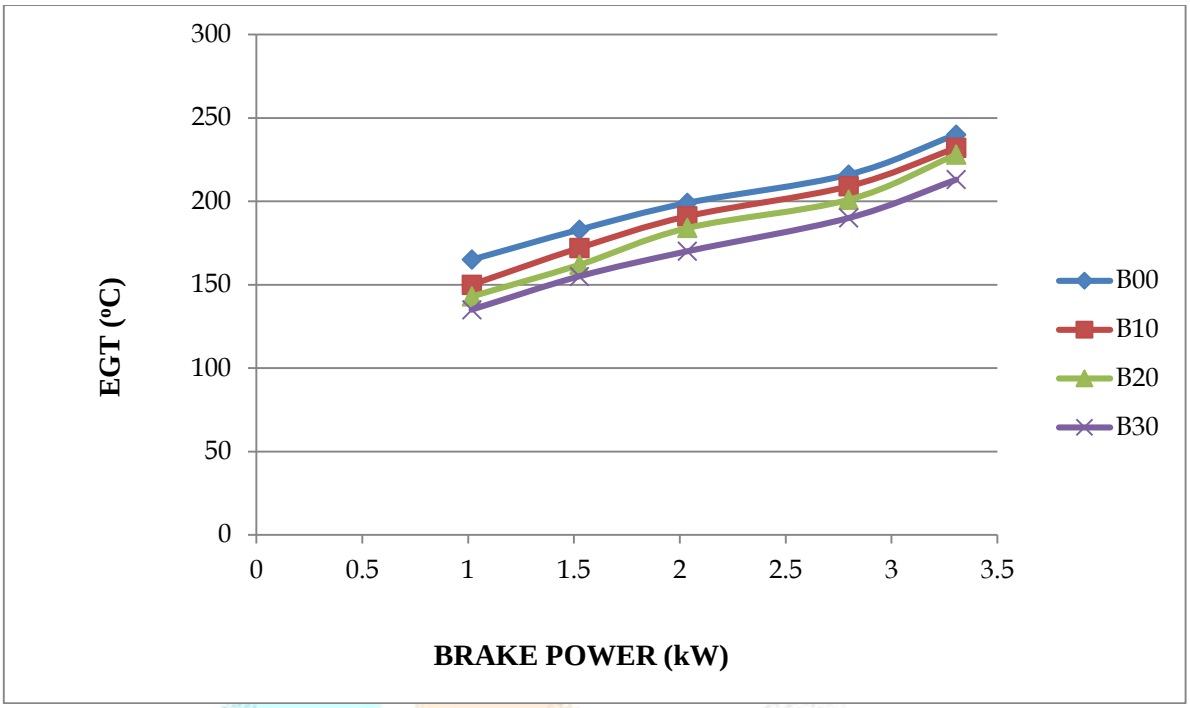

Fig: 8 Variation of Exhaust Gas Temperature with Brake Power

6.0 CONCLUSIONS

The investigation was carried out for the evaluation of modified engine with Waste vegetable oil bio-diesel B20 as fuel based on the performance parameters and exhaust emissions. The important conclusions drawn are as follows:

- Thethermal efficiency oftheengine isnearer to the Diesel engine for the blend B20.
- Brake specific fuel consumption of the engine with bio-diesel blend B20 as fuel is higher when compared with conventional engine with diesel as fuel.
- The CO_2 emission is also higher for bio-diesel blend.
- The Hydrocarbon emissions of bio-diesel blend B20 is less than Diesel fuel.
- The Carbon Monoxide emissions of bio-diesel blends B20 is less than Diesel fuel.
- Blend B20 is the optimum blend for Diesel engines for better performance and emissions.

The blend B20 is showing better performance than other blends that are tested.

- The percentage increase in BTE is 2.4%.
- The percentage decrease in BSFC is 2.08%.
- The percentage decrease in HC Emission 6.5%.
- The percentage decrease in CO Emission 9%.
- The percentage decrease in CO_2 is 2.5%.

7.0 SCOPE FOR FUTURE WORK

The above research work provides ample scope for future work, which are listed below:

- The research may be carried out on multi cylinder engine to enhance the performance of the engine.
- The same work can also be carried out on LHR (low heat rejection) engine.
- The above work can also be carried out for other bio-diesels.

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