Comparison study on effect of ethanol and HOME biodiesel blends on the Performance and emission characteristics of CI engine with and without Preheat

Sunil S Kattimani[1], B M Dodamani[2], Kushal Ambli[3], N M Ukkali[4] Anant Bhavimani
M.Tech Student[1,5], Hirasugar Institute of Tech, Nidasoshi
Assistant Professors[2, 3, 4,] Mechanical Engineering Department Hirasugar Institute of Tech, Nidasoshi
Corresponding author email**: sunilkumarsk@gmail.com**

Abstract- The internal combustion engines used in Propulsion, Transportation and marine applications, will leads to socio economical growth of any country. The emissions from the fossil fuels leads too many environmental problems like green houses effect, ozone depletion etc. This paper depicts the use of biodiesel as an alternative source of energy for an IC engine. The experimental investigation were carried out on single cylinder 4-stroke compression Ignition (CI) engine operating on Ethanol and Honge oil methyl ester (HOME) biodiesel and diesel blends, with and without preheat and studied the performance and emission characteristics. From the results obtained, it is observed that ethanol blend with biodiesel and up to 10%, will give superior results in concern with Brake thermal efficiency and emissions and for 5%, 15%, 20% ethanol with HOME shows inferior results in concern with Performance and emissions. NO_x emissions and smoke opacity were higher for pure biodiesels when compared to diesel operation. With reference to emissions, there will be an increased NO_x and Smoke emissions for pure biodiesel operation when compared with diesel operation and there will be a considerable reduction in NO_x and Smoke when blended with Ethanol up to 10% by volume. The experimental study were also be conducted with preheated ethanol up to 10% ethanol in a HOME blends and compare the results with pure diesel operation and found that up to 10% of ethanol will give us almost similar properties in terms of Performance and emission characteristics.

Keywords: ***Honge oil methyl ester (HOME), Biodiesel, Emission, Ethanol***

1. Introduction

Internal combustion engines the key devices for various applications directly or indirectly and also that attracts the concentration of researchers towards the innovation of alternative fuel for their operation for having the objective in mind that reduced emissions and improved efficiency. In that contrary many researchers worked on this area some of them are *A.M. Liaquat et.al* [1], studied to analyze engine performance and emissions characteristics for diesel engine using different blend fuels without any engine modification. They prepare four fuel sample, such as DF (100% diesel fuel), JB5 (5% Jatropha biodiesel and 95%DF0, JB 10(10% JB and 90% DF) and J5W5 (5% JB, 5% waste cooking oil and 90% DF), respectively were used in this study. They carried out engine performance test at 100% load keeping throttle 100% wide open with variable speed of 1500 to 2400 rpm at an interval of 100 rpm, and also carried out emission test at 2300 rpm at 100% and 80% throttle position. In this engine performance parameters have been measured are engine torque, brake power, and brake specific fuel consumption (BSFC).

Madan mohan Avulupati et.al[2], stated that in recent times, searches for alternatives fuels has been intensified due to depleting fossils fuels and environmental impact. With the increase concern of the environment and more stringent regulation on exhaust emission, the reduction in engine emission is a major research objective for engine development. Ethanol is an attractive alternative fuels because it can renewable bio-based resource it has hydroxyl group, There by providing the potential to reduce particulate emission in compression ignition engines. Complete replacement of diesel with ethanol for CI engines is not a feasible solution due to difference in physical and chemical properties, which affects injection and combustion processes. He made the fuel preparation has fuel emission of various mixture proportion were prepared using magnetic stirrer at a temperature of 25ºC.Diesel-ethanol blends formed macro emulsions, whereas all other mixture compositions seemed to formed micro emulsions. Experiments were performed using various fuels of different compositions. The distance between heating filaments and the droplet was maintained at about 2mm to ignite the droplets smoothly without contact. The time lapse between starting of heating element and ignition of droplet was observed to vary between 1 and 1.5 s based on the composition of fuels. Three types of droplet burning phenom`ena are observed, via smooth burning, puffing and explosion. After he conducted experiment he conclude that from above discussed data , it can be corroborated that diesel-biodiesel-ethanol blends used in his study have potential to undergo micro explosion at conditions encountered in diesel engines during injection and pre combustion phases. However, for precise understanding, studying micro explosion of diesel-biodiesel-ethanol blends at elevated pressure could be an interesting problem for future research

2. Properties of fuels

The properties of HOME and Diesel were determined and summarized in the table. The properties were measured in the Energy conversion laboratory of the college

2.1 Honge oil methyl ester (HOME)

Vegetable oils are produced from numerous oil seed crops. While all vegetable oils have high-energy content, most require some processing to assure safe use in internal combustion engines. Honge tree and seeds can be seen as shown fig.1. The extraction of oil from karanja seed was done by using different methods, i.e. mechanical expression, solvent extraction and cold percolation using n-hexane as solvent. As a diesel fuel substitute, Honge falls under the category of bio-diesel. Biodiesel are naturally available fuels that can be replaced by fossil fuels to some extent. In this study Honge oil methyl ester is used as a fuel and the properties such as Density, Viscosity, Flashpoint, Fire point and Calorific value of the fuels were determined and the values are tabulated in table 1

Table 1 Properties of fuels used

Properties	Values	Instruments Used
Flash point	178 ^{0}C	Cleveland Apparatus
Fire point	185 ^{0}C	Cleveland Apparatus
Density	1078 kg/m^{2}	Redwood viscometer
Kinematic Viscosity	5.0 mm^{2}/s @ 50^{0} C	Redwood viscometer
Calorific value	37600 KJ/Kg	Bomb calorimeter

3. Experimental set up

Experiments were conducted on a Kirloskar TV1 type, four stroke, single cylinder, water-cooled diesel engine test rig fuelled with HOME. Figure4.1 shows the test rig used. In the study different blends of ethanol and HOME is used for different operating conditions like CR 17, CR 18 and blends like E5B95, E10B90, E15B85 and E20B80.

Fig 2 Biodiesel blends with Ethanol

Performance and emissions characteristics were studied on each blend. The optimized blend combination was preheated to 35, 45, and 55º C and again noted the performance and emission characteristics so that the optimized combination of blends with and without preheated were suggested. The variation of Brake thermal efficiency with reference to performance characteristics and CO, HC and NOx were studied with reference to emission characteristics

Fig 3. Experimental set up

The specification of the test rig used in the study is mentioned in the table 2

Table 2 Specifications of the Engine

Sl. No	Parameters	Specification
1	Type of engine	Kirloskar make Single cylinder four stroke direct injection diesel engine
2	Nozzle opening pressure	200 to 205 bar
3	Rated power	5.2 kW (7 HP) @1500 RPM
4	Cylinder diameter (Bore)	87.5 mm
5	Stroke length	110 mm
6	Compression ratio	17.5 : 1
7	Displacement volume	660cc
8	Arrangement of valves	Over head
9	Combustion chamber	Open chamber (Direct injection)
10	Cooling type	Water cooled
11	Loading	Eddy current dynamometer

4. Results and Discussions

4.1 Variation of Carbon Monoxide with Load

From graph 4 it is observed that as load increases brake thermal efficiency increases gradually. And all preheated ethanol-biodiesel blends compared with E10B90 blend in above graph. From graph it shows that B90E10 T45^{0}C blend leads to improved brake thermal efficiency compared to all blends because after 10% of ethanol used in Biodiesel separation takes place due to this separation there is a improper mixing of ethanol and biodiesel blends taking place so that leads to inferior combustion so that the brake thermal efficiency of the engine is going to be reduces.

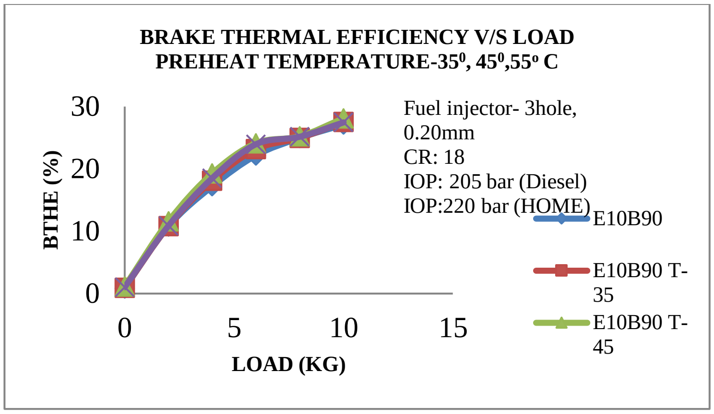

Fig 4: Variation of Carbon Monoxide with Load

4.2 Variation of Carbon Monoxide with Load

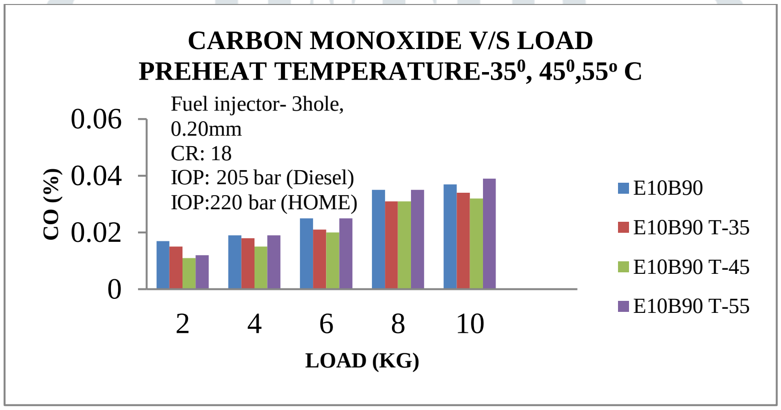

Fig 5: Variation of Carbon Monoxide with Load

From the graph 4.2 it is observed that emission of CO and CO_2 for B90E10 T-45^{0}C less compared to other preheated blends because of more oxygen content in biodiesel which leads efficient combustion of biodiesel. So that E10B90 blend is more emission compared to all preheated blends.

4.3 Variation of Hydrocarbon with Load

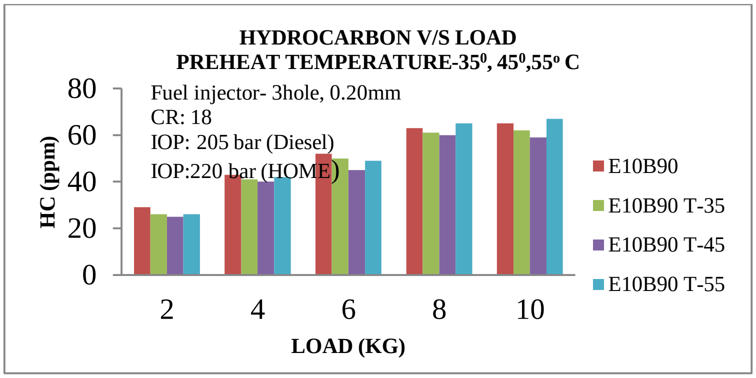

Fig 6: Variation of hydrocarbon with Load.

From the graph it shows that emission of HC of preheated blends is lesser than without preheated blend because viscosity of biodiesel decreases by heating it. And E10B90 T450C is less emission of HC compared to other blends.

4.4 Variation of Nitrous Oxide with Load

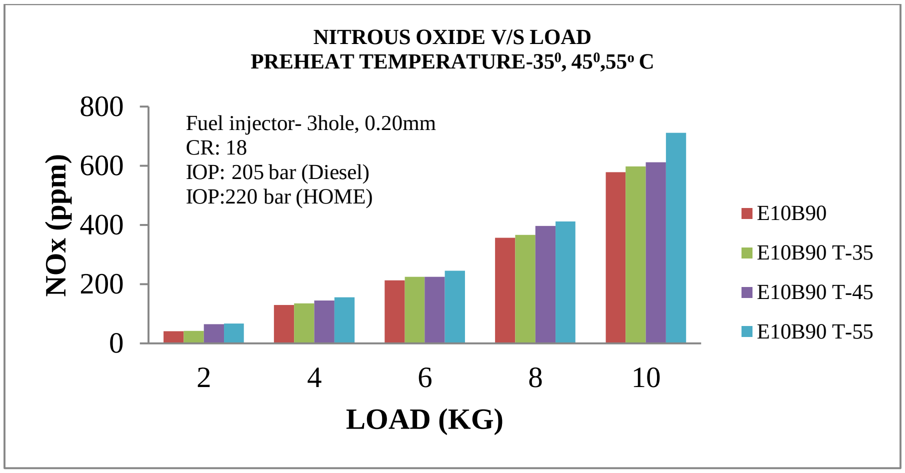

Fig 7: Variation of emissions of Nitrogen oxide with Load.

From the graph 4.4 it shows that emission of NOx of E10B90 T-45^{0}C is less compared toall preheated blends. E10B90 blend is less emission of NOx compared to preheated blends because of due to heating higher temperature in combustion chamber. And E10b90 t-55^{0}c is more emission of NOx compared to other blends.

Optimized Blend comparison with Diesel

4.5 Variation of Brake Thermal Efficiency with Load

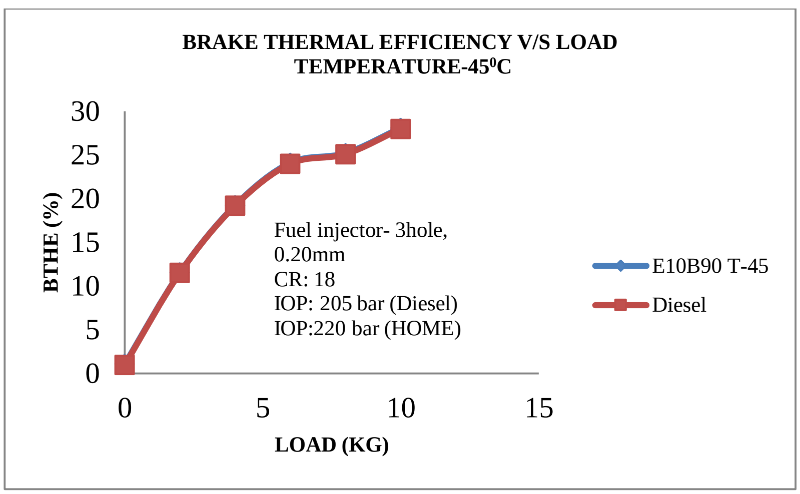

Fig 8: Variation of Brake Thermal Efficiency with Load.

From graph 4.5 it shows that brake thermal efficiency of optimised blend and diesel increases with increases of load gradually. And E10B90 T-45^{0}C is comparatively more brake thermal efficiency than diesel because of proper combustion in E10B90 T-45^{0}C blend compared diesel

4.6 Variation of Carbon Monoxide with Load

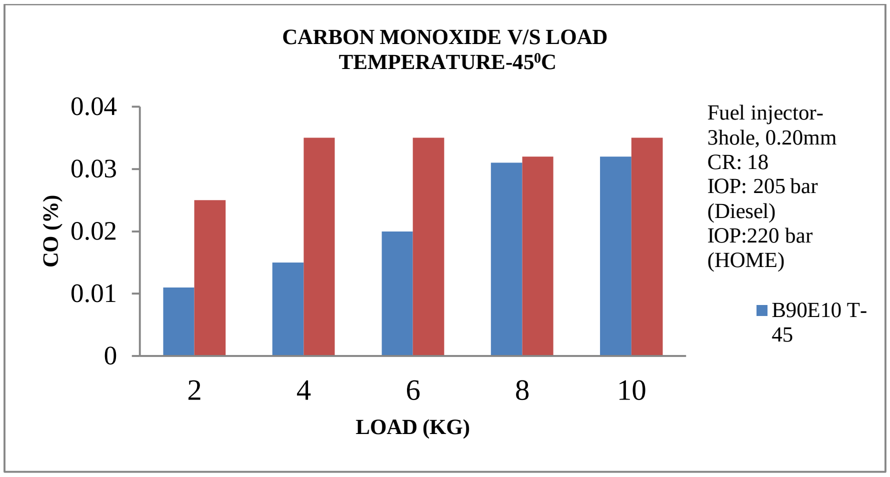

Fig 9: Variation of Carbon Monoxide with Load.

From graph 4.6 it shows that B90E10 T-45^{0}C is lesser emission of CO than diesel because of more oxygen in biodiesel compared to diesel due than more emission in CO and CO_2 in diesel.

4.9 Variation of Hydrocarbon with Load

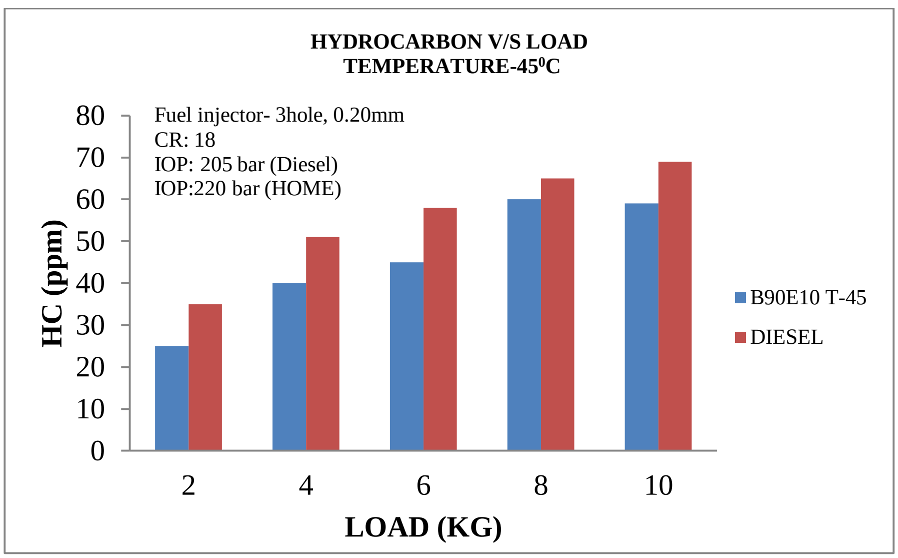

Fig 10: Variation of Hydrocarbon with Load.

From graph 4.9 shows that emission of HC of B90E10 T-45^{0}C is lesser than diesel because of more oxygen content in biodiesel compared to diesel .And due to increase in temperature of biodiesel viscosity decreases therefore emission of HC more compare to diesel.

4.10 Variation of Nitrous Oxides with Load

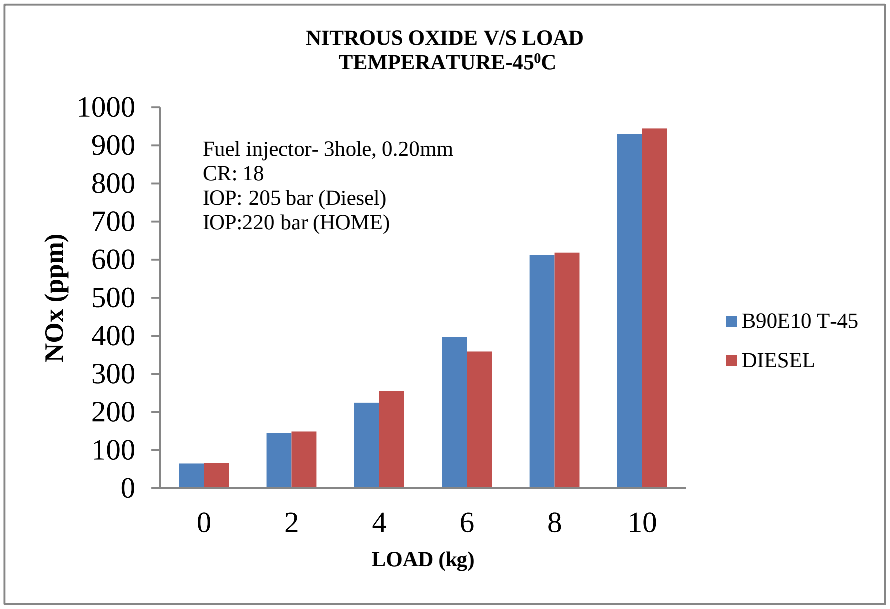

Fig 11: Variation of Nitrogen Oxides with Load.

From graph 4.10 it shows that emission of nitrous oxide inB90E10 T-45^{0}C is lesser than diesel because proper ethanol blend with biodiesel and preheating ethanol acts as boosting for combustion process therefore emission of nitrous oxide less compare to diesel.

Conclusion

The variable compression ratio diesel engine designed to run on bio-fuel has been tested with pure diesel and blend of ethanol-Honge biodiesel.

- The viscosity and density of the biodiesel is comparatively higher than the diesel and also the calorific value of the biodiesel is less that is 37600 KJ/Kg
- The study has been carried out on different compression to suggest the optimized compression ratio for the E5B95, E10B90, E15B85 and E20B80 blends.
- From the exhaustive study it is observed that the blend E10B90 gives good results than the other this is because of separation of ethanol with biodiesel.
- Increasing the proportion of ethanol in a biodiesel more than 10% by volume leads to separation of ethanol and biodiesel in turn it will affect the overall performance of the engine.
- The optimized blend E10B90 is preheated with different level of temperatures like 35^o, 45^o and 55^o C in order to analyse the results in terms of its performance and emissions
- Preheating up to 45^o C of charge gives considerable results in terms of brake thermal efficiency but it is observed that there will be a gradual increase in NO_x due to higher temperature within the combustion chamber.
- For a blend E10B90 shows lesser CO, HC and NO_x compared to other blends like E5B95, E15B85 and E20B80

References

[1] A.M. Liaquat ,H.H. Masjuki , M.A. Kalam , M. Varman , M.A. Hazrat, M. Shahabuddin, M. Mofijur. "Application of blend fuels in a disel engine ". Energy Procedia 14 (2012) 1124- 1133

[2] Madan mohan Avulupati, Lionel Christoper Ganippa , Jun Xias, Athanasios Megaritis. " Puffing and micro-explosion of desiel- biodiesel-ethanol blends".fueln 166(2016) 59-66.