Performance of Simarouba Oil Ester in CRDI Engine at Variable Injection Timing and Pressure

N R Raghavendra Swamy[1], M.R.Indudhar[2]
[1, 2] Department of Mechanical engineering
[1, 2] RYMEC, Bellary

Abstract- *The various biodiesel demand increasing in this world. In this experiment the ester of simarouba oil and common rail direct injection engine is used.By using transesterification process the biodiesel is obtained. It uses single cylinder diesel engine. It also uses modified conventional mechanical fuel injection system which is scrimpy by the single cylinder diesel engine. Engine modification done in a such a way that it must operate on common rail direct injection and biodiesel can be injected. CRDI engine is used for the conducting experiments. In order to optimize the injection timing the disel and biodiesel is used in CRDI engine. In this experiment 25degree before top dead centre to 5degree after top dead centre the varied IT is used. In this experiment the pressure of injection is 600bar and keeping compression ratio of 17.5 and maintaining constant engine speed of 1500rpm at 80% and 100% loading condition. Brake thermal efficiency improved at 10degree. Further experiments were conducted on to optimize the injector pressure by using CRDI engine. In CRDI engine fuelled with ESO and diesel. In this IPs were varied from 600 bar to 1000bar keeping optimized IT of 10degree bTDC. At 900 bar maximum BTE obtained. In this experiment the maximum BTE was obtained at IT of 10degree bTDC and IP of 900 bar. It produces lower hydrocarbon (HC),carbon monoxide(CO) and smoke emission. But in this case nitrogen oxide were higher with comparison to other ITs and IPs. At IT of 10degree bTDC and IP of 900 bar the maximum heat release rate and peak pressure is obtained.*

Keywords- Discrete event simulation, queuing system, size delay function

I. INTRODUCTION

It is interest to search the suitable alternative fuel in the diesel engine and it must meet the emission norms of Bharat stage. India has large agriculture base. Biodiesel is one suitable alternative for the replacing the diesel. The use of biodiesel have higher viscosity compared to diesel.The petroleum demand and pollutants increased in this environment due to increased number of vehicles on the road. The health of human beings is effected due to vehicular pollutants increased in the environment and it also effects the ecological system. Hence reducing emission is importatant. Alternative biodiesel is used to replace the petroleum oil and to reduce the emission and further significantly contain the life succession production of importantly carbon dioxide.

II. CHARACTERIZATION OF SIMAROUBA OIL

Ester of simarouba oil is also called as tree of paradise. This tree posses a tap root system. This tree grows upto 15m height.This tree can be seen in so many states such as Orissa ,Karnataka,Bihar,Tamilnadu etc.For this requires upto 40 degree Celsius temperature. The rainfall around may be 800mm.The available pH range for this plant to be grown is 8 and it suitable for the plantation of the tree

Figure 1. Simarouba oil seeds

Table 1. properties of simarouba oil

Properties	Diesel	ESO
Density	827	865
Kinematic viscosity	3.57	4.68
Flash point	54	165
Calorific value	42	37.9-39.8
Cloud point	-12	19
Pour point	-16	14.2
Carbon residue	0.15	0.10
Acid value	-	5.34
Iodine number	-	83.4
Ash content	0.01	0.005

III. EXPERIMENTAL SETUP

The main key of the study to make an attempt of solving the material handling station with the implementation of the discrete even simulation i.e. modeling the entire procedural steps exactly by using queues and the probability and statistic functions the simple model of 3 station material handling system is considered and the steps which as the intermediate process elements such as the machining centers inspection stations, packing, conveyor belts etc. are part of this study.

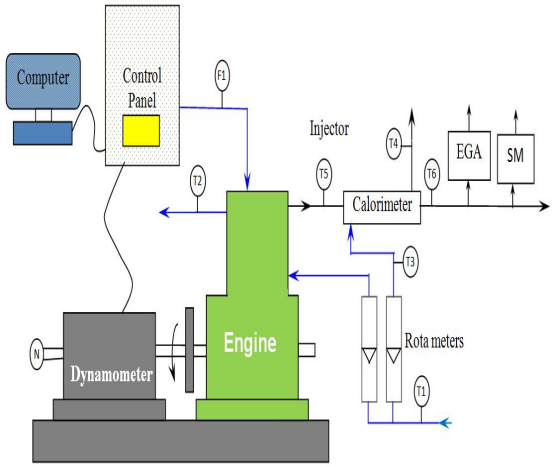


Figure 2. Experimental setup

Table 2. Specification of the engine.

Sl No	Parameters	Specification
1	Type of engine/engine make	Kirloskar make single cylinder 4-stroke DI diesel engines
2	Nozzle opening pressure	200 -205 bar
3	Rated power	5.2KW (7HP) @1500rpm
4	Bore	87.5mm
5	Stroke length	110mm
6	Compression ratio	17.5:1
7	Displacement volume	660cc
8	Arrangement of volume	Over head
9	Combustion chamber	Open chamber(direct injection)
10	Cooling type	Water cooled

IV. RESULTS AND DISCUSSIONS

[1] INJECTION TIMING OPTIMIZATION

Brake thermal efficiency

Figure depicts the graph between BTE and injection timing at 80% load and 100% load. Keeping the inlet pressure constant 600 bar for both the fuels. The maximum BTE for the higher loads is obtained between 10 degree to 5degree bTDC.From this graph at 10degree IT the engine performance is better comparison to other IT tested. Biodiesel has higher viscosity and lower calorific value hence with respect to diesel the biodiesel performance is poor

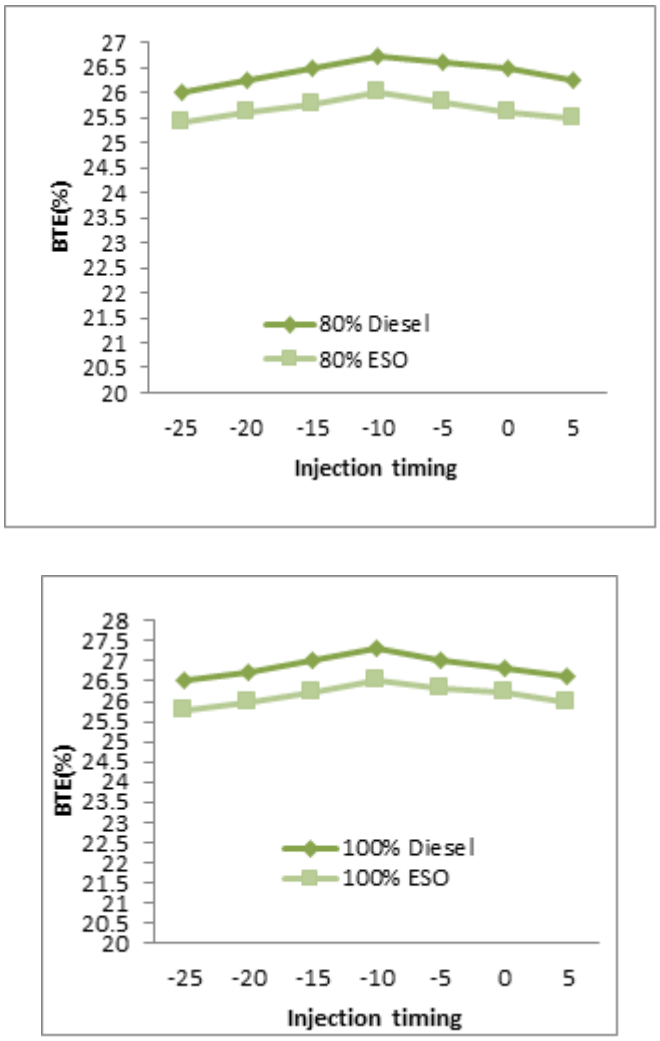
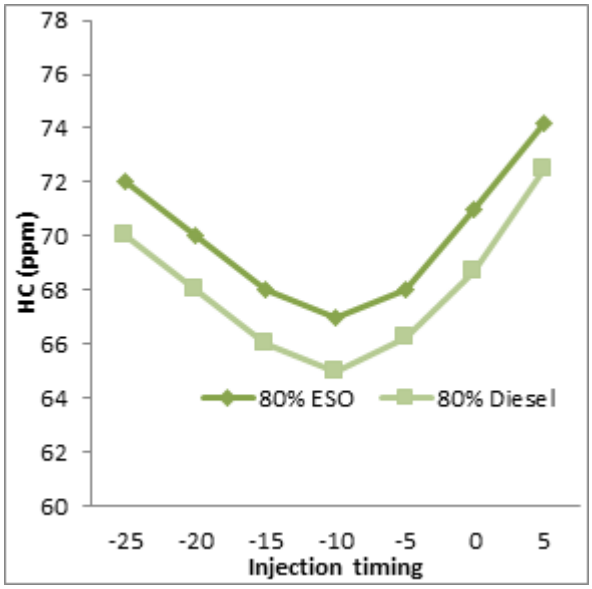


Figure 3. BTE vs IT

Characteristics of emission

Hydrocarbon emission

Figure depicts the graph between HC and IT at 80% load and 100% load. In this case with respect to diesel the emission is higher for the biodiesel. The emission of biodiesel is slightly more than the diesel. The main cause for this is BTE.BTE is less for biodiesel. Biodiesel poses the higher viscosity and lower atomization at same injection pressure. In biodiesel the wall setting phenomenon is observed. At IT between 10degree to 5degree bTDC the HC emission decreases and where BTE was higher



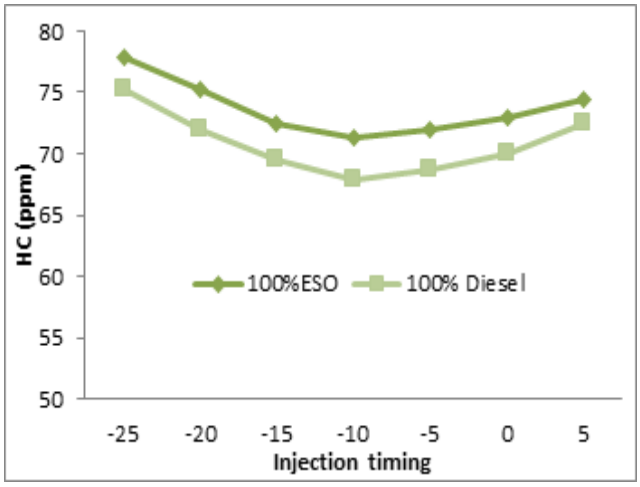
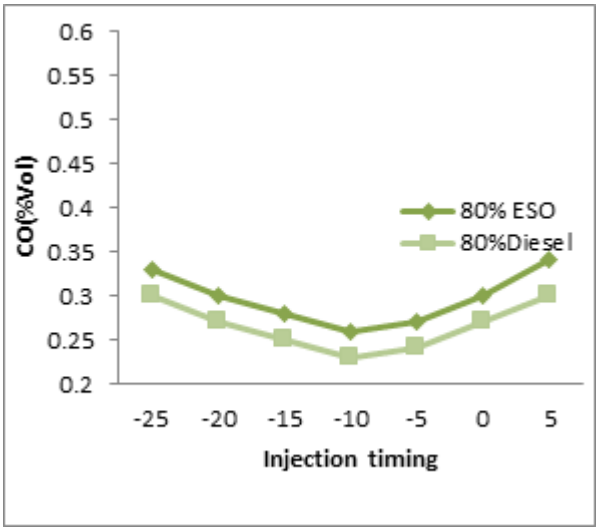


Figure 4. HC vs IT

Carbon monoxide emission

Figure depicts the graph between ITs and CO for both the fuels at 80% and 100% load respectively.The emission of carbon monoxide is similar to hydrocarbon emission at higher loads.CO emission similar upto 5degree bTDC and when IT was retarted the emission increases.This phenomenon observed because the temperature variation occurs in the inside of the combustion chamber.The BTE decreases when IT is retarded and the amount of fuel delivered increases with same power output.This is major cause for increasing carbon monoxide level. The air of the initial temperature and the pressure is high at retarded IT.The oxygen molecules and carbon molecules the oxidation process occurs and it increases the oxidation process.The volatility of biodiesel is less with respect to diesel due to this the emission is higher and lower BTE is obtained.



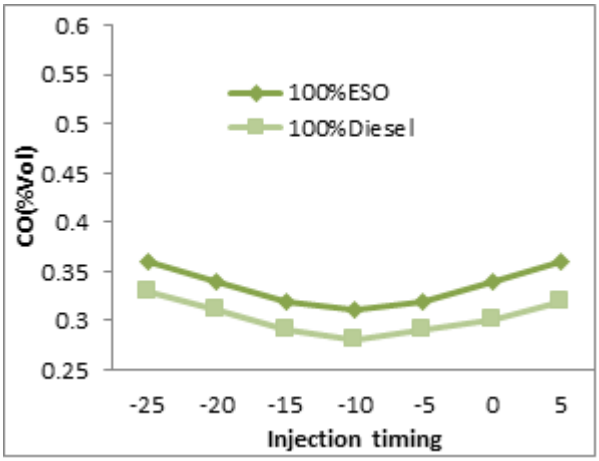


Figure 5. CO vs IT

NOx emission

The below figure depicts the graph between ITs and nitrogen oxide for both the fuels at 80% and 100 % load respectively.The peak temperature of the gas in the cylinder is lower hence the emission of nitrogen oxide of the biodiesel is low with respect to the diesel.When ITs is advanced the emission of the both the fuel is increased.The premixed combustion and cetane number will effect the nitrogen oxide emission is lower.The temperature and pressure of the biodiesel is less compared to the diesel fuel.

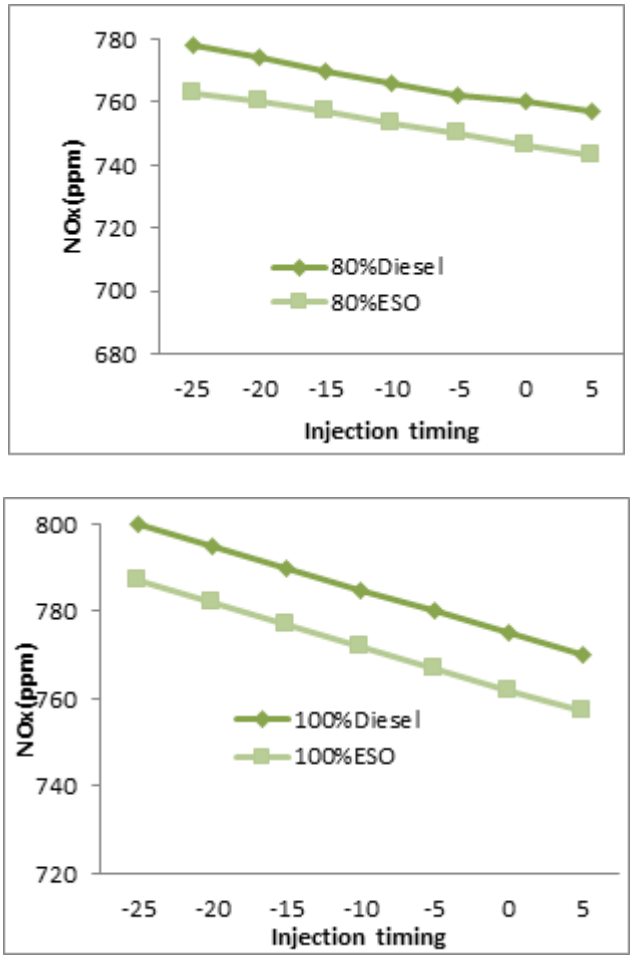


Figure 6. NOx vs IT

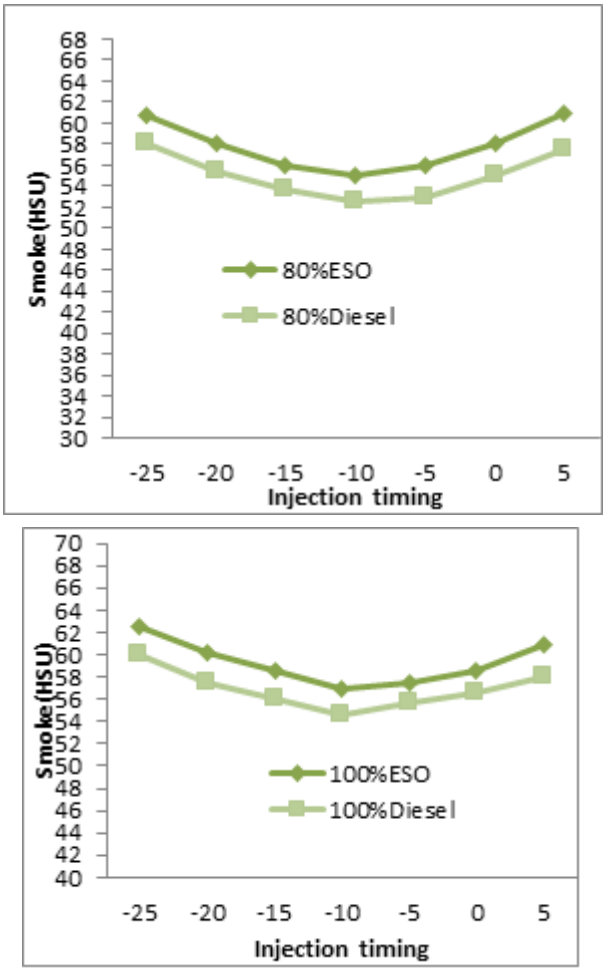


Figure 7. SMOKE vs IT

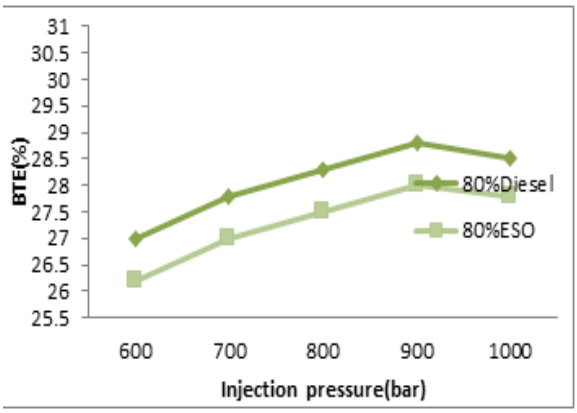
Smoke emission

The below figure shows the graph between IT and the smoke emission.The experiment conducted in the CRDI engine for the both the fuels at 80% and 100% load respectively. In this case the ester of simarouba oil was found to higher smoke for the same operating condition with respect to diesel. In the biodiesel the free fatty acids present and the fuel air mixture is low.The emission is reduced with retarded IT upto 10degree bTDC and the occurance of minimum between 10degree to 5degree bTDC.This process occurs due to the better combustion process and time available for the combustion process is more. The fuel air mixture is reduced then the smoke emission of all fuels is increased. Sluggishness causes the lower fuel air mixture. Smoke results from the soot particles.

[2] OPTIMIZATION OF INJECTION PRESSURE

Brake thermal efficiency

Ignition is less for the biodiesel with respect to diesel.Hence fuel air mixture is increased at the higher loads.And at higher IP it also helps for better combustion of fuel air mixture.The combustible mixture is good for the higher pressure. If at 900 bar the combustible mixture is more compared to the at 800 bar of the combustible mixture.If in case there is no significant improvement in BTE when pressure increased beyond 900 bar.Also wall wetting occurs at higher pressure.



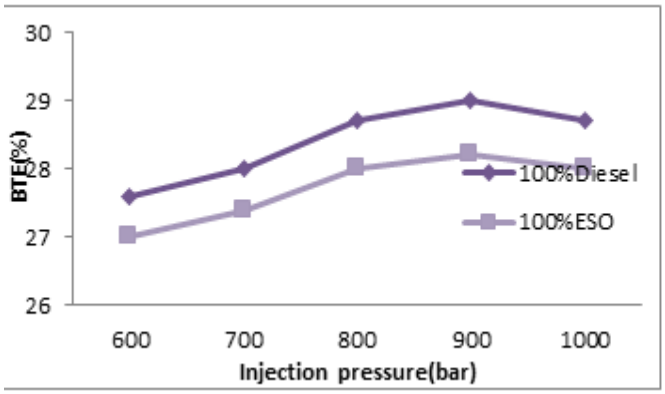
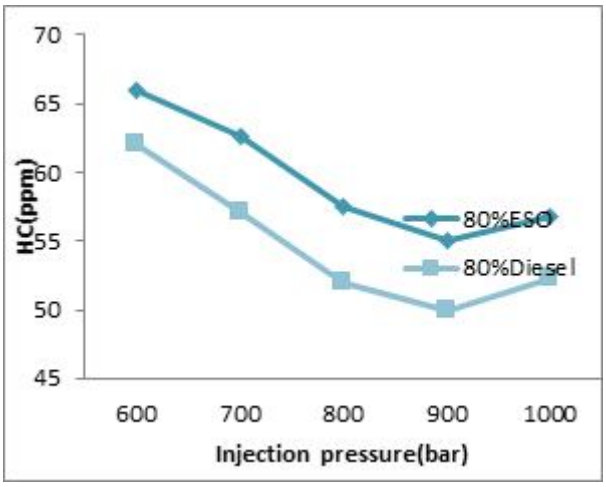


Figure 8. BTE vs IP



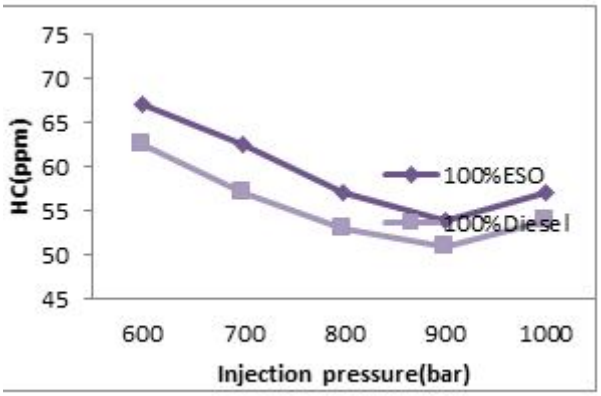
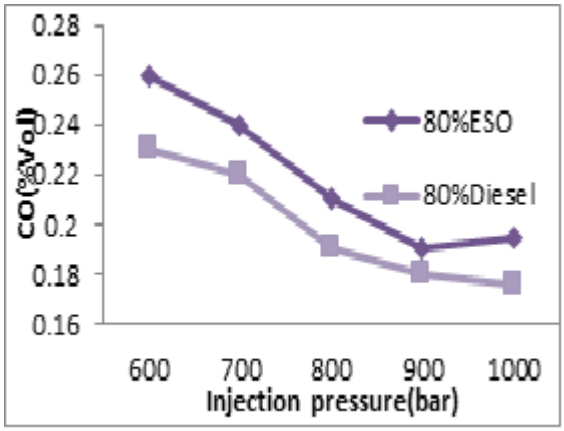


Figure 9. HC vs IP

Emissions of exhaust

HC and CO emissions

The emission decreases when complete air fuel mixture occurs inside the cylinder. At higher pressure the emission was found to be lower due to better mixing of combustible chamber. If pressure increases the emission decreases. In high pressure the atomization of fuel occurs more and emission reduces and also homogeneous fuel air mixture occurs. In this case the emission of CO and HC is smaller. But which is more than the diesel oil and the BTE is low for the biodiesel. At 1000bar HC emission increases due to reduction in BTE.



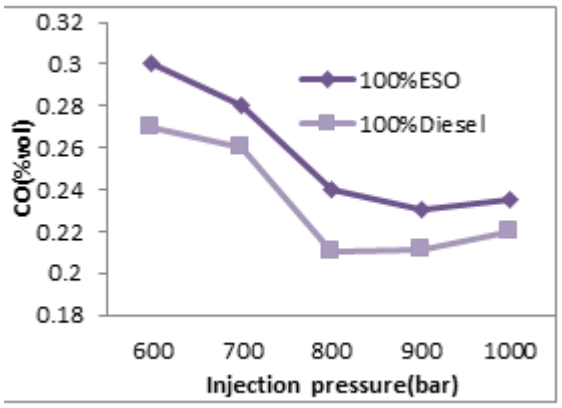
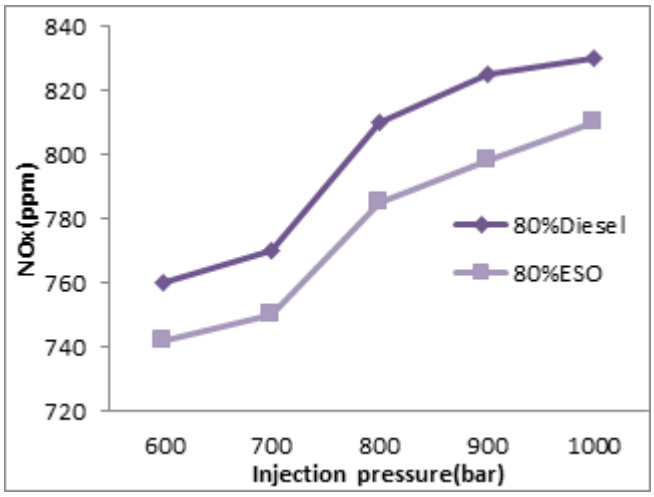


Figure 10. CO vs IP

NOx emissions

The nitrogen present in the air. In atmosphere nitrogen present around 78%. In the combustion chamber the fuel air mixture is present. Due to oxidation process the nitrogen converts to nitrogen oxidation. The flame temperature causes the formation of nitrogen oxide. Nitrogen oxide formation is mainly depend up on the fuel air ratio and temperature of the surrounding. If increasing the pressure the combustion ratio also increases and it forms more emission of nitric oxide. If pressure increases the vaporization also increases.



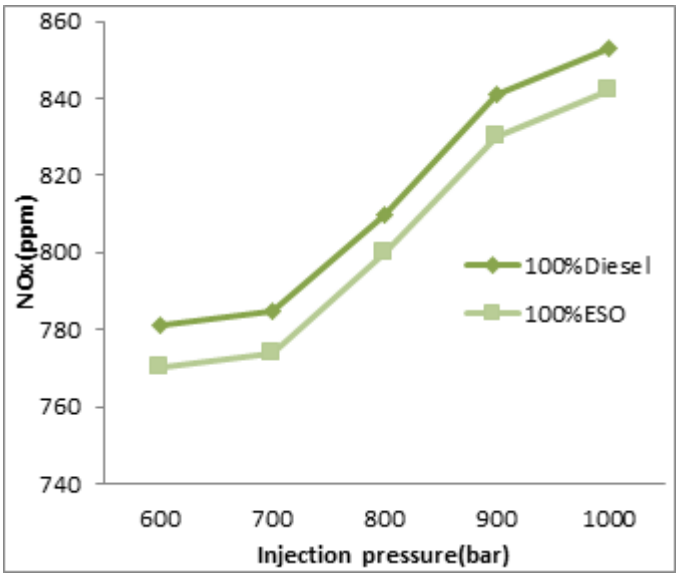


Figure 11. NOx vs IP

V. CONCLUSION

The single cylinder diesel engine was successfully modified to operate as CRDI engine. The facility allows us to vary IT & IP. The performance of diesel was better than biodiesel.

1. 1.BTE showed increasing trend for IT upto 10 degree bTDC and reduced afterwards.
2. 2. Due to retarding of IT HC emissions reduced and other emissions decreased considerable upto 10 degree bTDC
3. Advancing IT increasing NOx
4. As IP increased BTE also increases upto 900bar and reduces afterwards.BTE was maximum at 900 bar IP.
5. At both loads CO and HC emissions were similar with lowest values at 900 bar.
6. With increasing in IP the NOx emission was continuously increasing.

Hence the new CRDI engine was successfully operated with ESO oil the work showed the capacity of ESO to replace diesel in future. Because of CRDI engine the performance of ESO was tending towards that of diesel.

REFERENCES

[1] I.C Engines by M.L. Malthur & Sharma.

[2] I.C. Engines by V.Ganesan.

[3] Heywood J.B., Internal Combustion Engine Fundamentals, McGraw-Hill Book co,, New York,1988,15.

[4] N.R. Banapurmath,P.G. Tewari“Comparative performance studies of a 4-stroke CI engine operated on dual fuel mode with producer gas and Honge oil and its methyl ester (HOME) with and without carburetor”,RenewableEnergyVolume 34, Issue 4, April 2009, Pages 1009–1015;

[5] Keith ,openshaw“A review of Jatropha curcas: an oil plant of unfulfilled promise.”,Biomass and BioenergyVolume 19, Issue 1, 1 July 2000, Pages 1–15,

[6] M. LeenusJesu Martin, V. Edwin Geo and D. Prithviraj, “Effect of diesel addition on the performance of cottonseed oil fuelled DI diesel engine”.

[7] Labeckas L., Ganippa L.C. (2012) Effects of injection parameters and EGR on combustion and emission characteristics of rapeseed oil and its blends in diesel engines. Fuel, ”. journal of power and energy ,1256/vol. 114, 812417-23.