Experimental Analysis of Diesel and Bio Diesel Blending and Suggest the Optimum Solution

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Abstract — Environmental concern and availability of petroleum fuels have caused interest in the search for alternative fuels for internal combustion engine. Many alternate fuels are tried by various researches. Based on literature review it is found that for diesel engine Bio Diesel is most promising fuel. In this project works prospects and opportunities of utilizing 100% biodiesel and increasing biodiesel-diesel blend ratio as fuel in diesel engine is going to be studied by varying compression ratio. Also based on experimentation an optimum blend and engine parameters are to be suggested for obtaining better performance and emission control. Biodiesel present a very promising scenario of functioning as alternative fuels to fossil diesel fuel. The properties of these can be compared favorably with the characteristics required for internal combustion engine fuels specially diesel engine. Experiments were performed for three compression ratio i.e. 14, 16 and 18 using biodiesel diesel blends i.e. B10, B20, B30, B40, B60, B80 and pure biodiesel with load variation from no load to full load and compared with base cases i.e. engine using diesel as a fuel. The parameters which studied are in performance brake power, brake specific fuel consumption and brake thermal efficiency, in emission carbon monoxide, carbon dioxide, nitrogen oxide and unburned hydrocarbon of diesel engine. It was observed that out of three compression ratios i.e. 14, 16 and 18, compression ratio 18 results of brake thermal efficiency, brake specific fuel consumption and brake power as better results and emission for it was also lower except nitrogen oxide. In diesel-biodiesel blend , B20 having a better performance out of all combination of test fuel and emission of carbon monoxide (CO), carbon dioxide (CO2), unburned hydro carbon (HC) and oxides of nitrogen (NOx) decrease. Also same trend was observed for engine running with 100% biodiesel. As per the literature survey B20 (20%biodiesel and 80% diesel) is best in performance compare to other blends. Similar results were observed but emission is reduced. Diesel engine is running smoothly with 100% biodiesel by compromising on performance parameters i.e. brake power, brake thermal efficiency and brake specific fuel consumption.

Keywords— Biodiesel, Biodiesel-Diesel Blend, Varying Compression Ratio

I INTRODUCTION

1.1 RATIONALE

In this scenario the interest in this world to invent substitute fuels for the diesel engines. So there are vegetables oil is favorable option as it has many advantages. It is reusable, ecofriendly, and cheaper to make and easily produce in villages, where there is no acute need for modern form of energy. Some institution and research organizations they produced bio diesel with properties that very close to use of diesel. Such types of fuels are already in use due to compatibility, largely because of cheaper as compare to diesel and continued availability to the future. In addition the international pressure to reduce the carbon dioxide emitting hydrocarbons has made it essential to examine the properties of different green energy fuels, having potential in of using these in diesel engines. While biodiesel has much gain over diesel fuel, but there are many problems that need to address, such as its higher flash point, high viscosity, and poor cold flow properties, lower calorific value, poor oxidative stability and sometimes its moderately higher secretion of nitrogen oxides. As a result many fuels are being scrutinized auxiliary for fossil fuels, especially diesel vegetable oils may give one such substitute and their potential has been test in the past few years by several researchers.

1.2 SOME BENEFITS OF BIODIESEL LISTED BELOW

(1) It decreases the dependency on imported petroleum.
(2) It is regenerative and underwrites less to global warming than petroleum fuel due to its closed carbon cycle. In the initial feedstock can grow time to time and most of the carbon in the fuel was uniquely removed from the air by the plant.
(3) It imparted good engine performances and can use without engine modification.
(4) It imparted a production of more vegetable oils and animal fats so the economy of rural areas increases.
(5) It is biodegraded and harmless.
(6) It demonstrate lower combustion profile, specially SOx

II ADVANTAGES OF BIO DIESEL

There are many technical advantages of bio diesel fuel:

- It extends engine life and reduces the need for preservation (bio-diesel have good lubricating qualities than fossil fuel)
- It is innocuous to handle, being minor harmful, major bio degradable, and having a higher Flash point,
- It reduces some exhaust emissions (although it may, in some circumstances, advance others).

- Bio diesel is an efficient, hygienic, 100% natural energy substitute to petroleum fuels. As well as the many advantages of bio diesel fuel include the following: safe for use in entirely conventional diesel engines, approach the same performance and engine robustness as petroleum diesel fuel, non-flammable and non-toxic, reduces tail pipe emissions, observable Smoke and noxious fumes and redolence.
- Bio diesel as good with respect to diesel fuel in terms of sulfur content, flash point, odors content and bio-degradability.

III CHALLENGES OF BIODIESEL AS AN ALTERNATIVE FUEL

At high temperatures, biodiesel can oxidize if air is present, causing the formation of acids and solids, which can corrode and plug fuel system components. Additives can help prevent this deterioration. Much as vegetable oils become cloudy in the refrigerator, biodiesel will form wax at cold temperatures. These wax crystals plug fuel filters, so flow-improving additives are necessary in cold weather. Biodiesel crops yield comparatively less energy per unit of crop area than that available for ethanol crops.

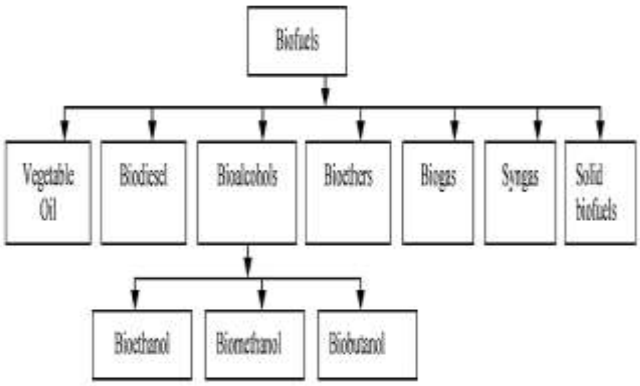


Figure 3.1 Block diagram of various outcomes of biofuels.(source of internet)

IV CHARACTERIZATION OF JATROPHA OIL

The jatropha seed oil is also known as Panogamia pinnata oil or jatropha oil. The Honge oil is obtained from the seeds of Honge plant also called the karanja tree. The Honge oil is red-brown, thick, bitter, non-drying and non- edible.

Objectives of the Work

(i). To check feasibility of biodiesel in C.I. engine fuelled with diesel-biodiesel blends with more fraction of biodiesel.
(ii). To analyse the effect on performance and emission engine by changing compression ratio by using different blends of diesel-biodiesel.
(iii). To suggest best blend based on experimental work as an optimum blend.

V LITERATURE REVIEW

Demirbas [1] reviewed the bio-diesel making, characteristics and the experimental outcomes carried out in the field of bio-diesel. It is detailed that the transesterification of triglycerides by methanol, ethanol, propanol and butanol has proved to be the most suitable process. There is molar ratio of alcohol to vegetable oil and reaction temperature, catalyst, pressure, reaction time of biodiesel and the contents of the free fatty acids and water in oils are the variables affecting the methyl ester yield during the transesterification response. It is also reported that in the supercritical methanol transesterification method, the yield of transformation increases 96% in 10 minute.

Karmee and Chala [2], production of biodiesel from Pongamia pinnata by transesterification of the crude oil with methanol and KOH as the catalyst and matched a 92% conversion at 60 1C with 1:10M proportion for KOH with the properties such as viscosity, flash point of the bio-diesel relatively along with accepted standards.

Burnwal and Sharma [3] observed the work done on bio-diesel preparation and make use of , storing available, methods developed/being developed, engine running, ecological considerations, economical aspects, merits and barriers to the use of bio-diesel. It is matched that triglycerides (vegetable oils/animal fats) hold promise as substitutes fuels in diesel engines and the methods for development in fuel properties are catalytic transesterification of triglycerides with alcohols form di-alkyl esters of extended chain fatty acids and the supercritical method of producing bio-diesel, which is quite same to hydrocarbon depend on diesel fuels.

Kumar et al. [4] He have tested a constant speed diesel engine with Jatropha oil methyl ester and reported a higher ignition delay as compared to that diesel.

Dorado et al. [5] have experimented a three cylinder, four stroke, 2500 cm3 DI diesel engine along with olive oil methyl ester and reported a persistent combustion efficiency for methyl ester of olive oil and diesel oil, a slight deduction in brake specific fuel consumption (BSFC), deduction of 58.89% in CO, 8.89% in CO2, 37.55% in NO and 32.0% in NOx for olive oil methyl ester as compared to diesel.

Senatore et al. [6] have discussed that with rapeseed oil methyl ester, heat release always takes place in progress as compared to diesel. Also injection starts earlier than usual and the average cylinder gas temperature are above in case of biodiesel as a fuel.

Puhan et al. [7] have observed with mahua oil ethyl ester (MOEE) in a four stroke naturally aspirated direct or effectively injection diesel engine and have gotten an increase in BSFC for MOEE related to diesel. Also, a little increase in brake thermal efficiency, deduction in CO emission, increase in CO2 emission, 63% deduction in HC emission, deduction in NOx and 70% deduction in smoke are observed.

Altin et al. [8] have organize performance and emission tests in a diesel engine fueled with methyl esters of sun flower oil, cotton seed oil, soya bean oil, purified corn oil, condensed opium poppy oil and extracted rape seed oil and accomplish that compared to diesel fuel, some power loss, higher particulate matter emission, minimum NOx emission were reported for vegetable oils. Also vegetable oil methyl esters with their performance and emissions nearby to diesel fuel are acceptable substitute of diesel.

Magın Lapuerta etal [9] worked on emission analysis using biodiesel in diesel engine. Experiments were carried out on diesel engine using biodiesel fuels as opposed to conventional diesel fuels. Since the basis for comparison is to maintain engine performance, the first section is dedicated to the effect of biodiesel fuel on engine power, fuel consumption and thermal efficiency. The highest consensus lies in an increase in fuel consumption in approximate proportion to the loss of heating value. In the subsequent sections, the engine emissions from biodiesel and diesel fuels are compared, paying special attention to the most concerning emissions: nitric oxides and particulate matter, the latter not only in mass and composition but also in size distributions. They analyzed sharp reduction in particulate emissions.

M. Gumus, S. Kasifoglu [10] used biodiesel made from apricot seed kernel oil methyl ester. Apricot (Prunus armeniaca) seed kernel oil was transesterified with methanol using potassium hydroxide as catalyst to obtain apricot seed kernel oil methyl ester. Neat apricot seed kernel oil methyl ester and its blends with diesel fuel were tested in a compression ignition diesel engine to evaluate performance and emissions. Apricot seed kernel oil methyl ester and its blends can be successfully used in diesel engines without any modification. Lower concentration of apricot seed kernel oil methyl ester in blends gives a better improvement in the engine performance and exhaust emissions. Therefore lower percent of apricot seed kernel oil methyl ester can be used as additive.

Pramanik,K,[11] worked on Properties and use of jatropha curcas oil and diesel fuel blends in compression ignition engine. They present as the world finds itself in the midst of universal energy shortage, compounded by a parallel need to reduce pollutant of all kinds. . These characteristics included specific gravity, density, viscosity, pour point, flash point, fire point, heating value, copper strip corrosion etc. The biodiesels were then tested in a diesel engine to observe their actual performance and emissions. The fuel spray of biodiesels was also compared with the conventional diesel oil.

LZ.G.A. Karim[12]&[13] used as hydrogen fuel as biofuel and show emission effect related to the NOx ,CO,CO_2 These conventional fuels have major disadvantages with regards to their exhaust emission of nitrogen oxides(NOx), unburned hydrocarbons(UBHC), carbon dioxides(CO_2) and particulate matter that are hazardous to human and environment like

VI METHODOLOGY OF WORK

6.1 Planning of experimental work

The main aim of the experimentation is to check feasibility of biodiesel in C.I. engine fuelled with diesel-biodiesel blends with more fractions and 100% biodiesel. The experimental work under this project consists of two parts, initial experimental work to analyze the effect of different compression ratio on engine performance and emission in second phase, optimizing work for finding the optimum diesel-biodiesel blend.

Initial experimental work includes preparation of experimental setup, various biodiesel-diesel blends and measurement of various engine parameters and emission parameters by running the engine on different compression ratio.

Work in line with the actual objective of the project is planned out as follows,

- Generation of base line performance data from the C.I engine fuelled by diesel, Compare different Diesel-biodiesel blends and 100% biodiesel data with base line data for various load.
- Optimize the best blend out of given different blends.

Table 6.1: Variable Parameters for Experiment

Fuel	Pure Diesel, B10, B20, B30, B40, B60, B80, Pure Biodiesel
Compression Ratio	14, 16, 18
Load (%)	0, 25, 50, 75, 100

Figure 6.1: Engine Test Setup

6.2 Engine Setup Specifications

Table 6.2: Specifications of research engine

Engine	1 cylinder, 4 stroke, water cooled, stroke 110 mm, bore 87.5 mm. **Diesel mode**: Power 3.5 KW CR range 12:1-18:1 Speed 1500 rpm Injection variation 0-25 Deg BTDC
Dynamometer	Type eddy current, water cooled, with loading unit
Calorimeter	Type Pipe in pipe
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Piezo sensor	Combustion: Range 5000 PSI, with low noise cable Diesel line: Range 5000 PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Fuel tank	Capacity 15 lit, Type: Duel compartment, with fuel metering pipe of glass
Software	"Enginesoft" Engine performance analysis software

6.3 Test Procedure

Engine tests were carried out at different loads on the engine at different combination of the fuel and compression ratio and the following performance and emission parameters were analyzed.

Performance Parameters

- Brake specific fuel consumption. Kg/kwh
- Brake thermal efficiency, %
- Brake power, kW
- Exhaust Gas Temperature

Emission Parameters

- Carbon Monoxide (CO), % vol.

- Carbon Dioxide (CO2), % vol.
- Unburned Hydrocarbons (UBHC), ppm
- Nitrogen Oxide (NOx), ppm

VII RESULT AND DISCUSSION

Experiments were conducted for various combinations as data given in Table3.1. Performance and emission data were recorded used for various analysis. First results of pure diesel with pure biodiesel are compared. The effect of compression ratio has been analyzed and finally in third category the analysis of effect of different diesel-biodiesel blends on various parameters has been carried out.

7.1 Performance Analysis for Experimental investigation

7.1.1 Brake Thermal Efficiency

- Comparison of BTHE for Pure Diesel and Pure Biodiesel

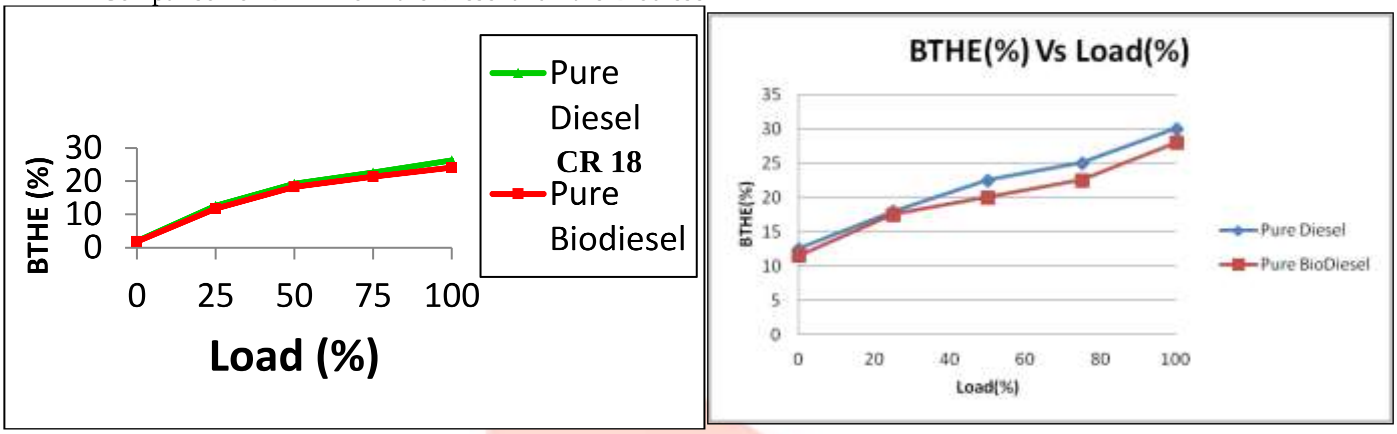


Figure 7.1: Comparison between BTHE Vs Load for Pure Diesel and Pure Biodiesel Experimental investigation

The brake thermal efficiency distribution is shown in figures for diesel and biodiesel at compression ratio 18. At every load we got higher efficiency with diesel compare to biodiesel. The brake thermal efficiency of an engine increases significantly with load. At full load the brake thermal efficiency of biodiesel 8.29 % lower than diesel and at 50% part load it was 5.28% lesser than diesel. At full load the brake thermal efficiency of biodiesel 8.3 % lower than diesel and at 50% part load it was 4.76% lesser than diesel. This happened because of the lower calorific value of the biodiesel.

Effect of Compression Ratio on BTHE for all Diesel-Biodiesel Blends

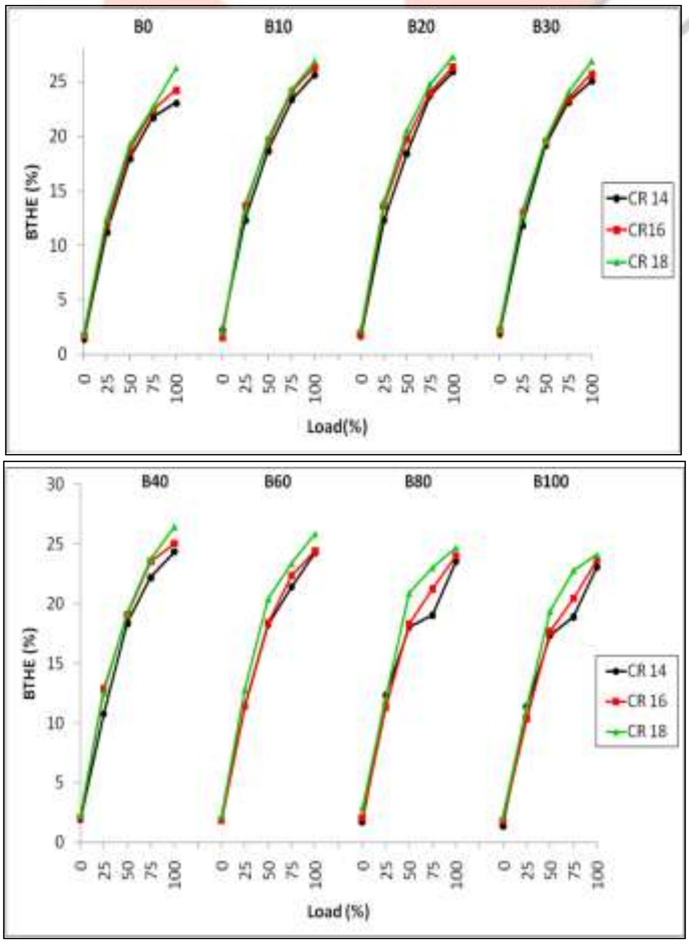


Figure: 7.2: Effect of Compression Ratio on BTHE Vs Load for all Diesel-Biodiesel Blends

In this fig the effect of compression ratio on brake thermal efficiency is shown for all the different diesel biodiesel blends. It can be observed that as compression ratio increase brake thermal efficiency was considerably increased for all the blends. This is because as higher compression ratio the combustion was much better compare to lower compression ratio.

Effect of Compression Ratio on BSFC Vs Load for all Diesel-Biodiesel Blends

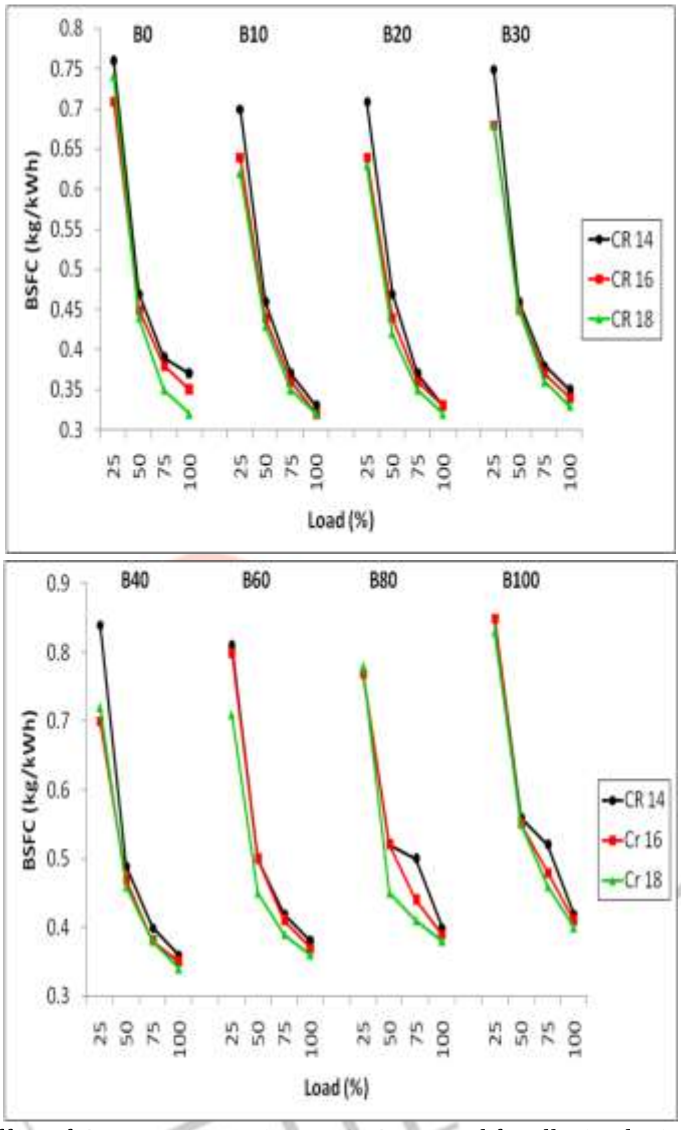
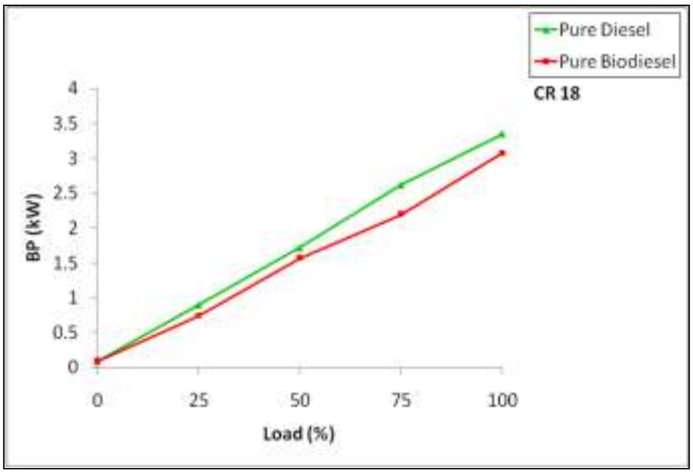


Figure 7.3: Effect of Compression Ratio on BSFC Vs Load for all Diesel-Biodiesel Blends

The effect of compression ratio on brake specific fuel consumption is shown in the fig. The value of brake specific fuel consumption for diesel at full load for compression ratio 14, 16 and 18 was 0.37kg/kWh, 0.35kg/kWh and 0.32kg/kWh respectively. The value of brake specific fuel consumption decreases with the increment of compression ratio. Same approach continues for all the blends. For pure biodiesel due to its low volatility and higher viscosity it might be performing relatively better well at higher compression ratio

7.1.2 Brake Power

- Comparison of BP for Pure Diesel and Pure Biodiesel



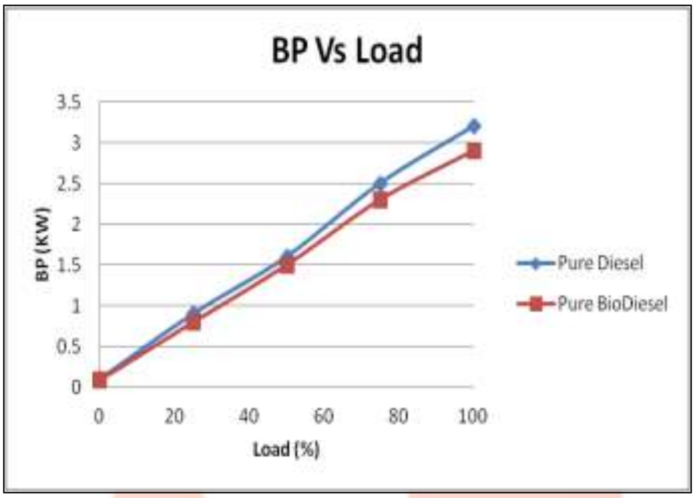
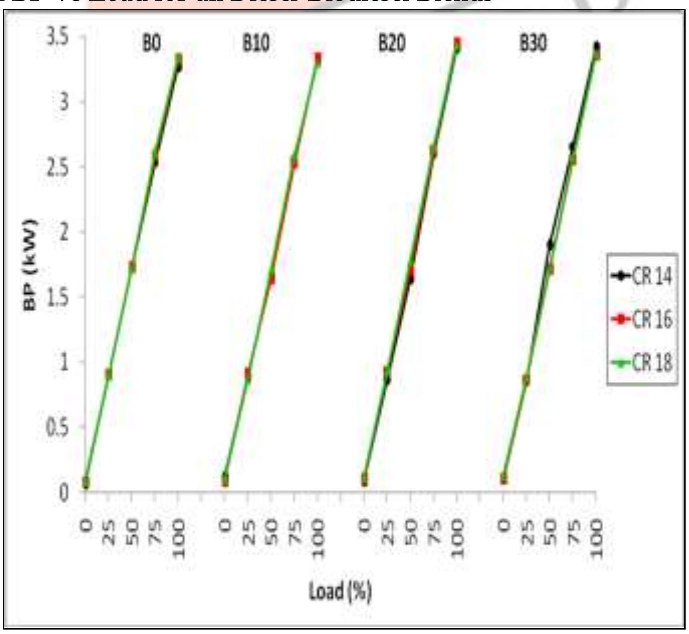


Figure : 7.4 Comparison of BP Vs Load for Pure Diesel and Pure Biodiesel by Experimental investigation.

The brake power distribution is shown in Figures 5.3(a) for diesel and biodiesel at compression ratio 18. The brake power of an engine increases significantly with load. At full load the brake power of biodiesel was comparatively 8.05 % and at part load (50% load) it was 8.27% lesser than diesel because of the higher viscosity and density of the biodiesel.

Effect of Compression Ratio on BP Vs Load for all Diesel-Biodiesel Blends



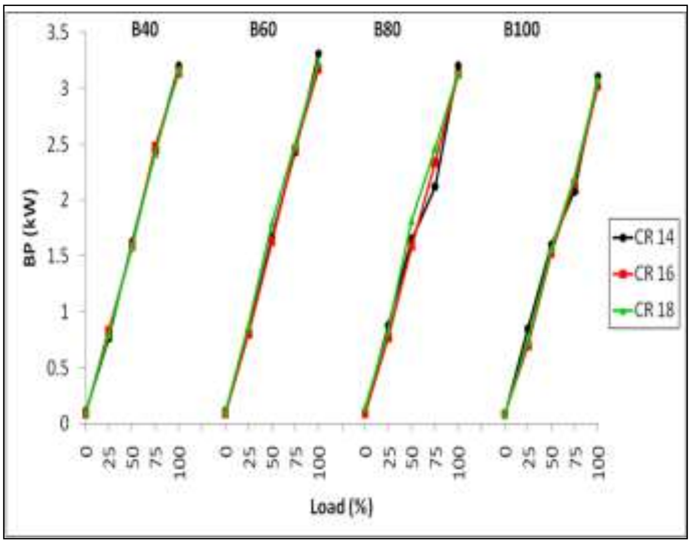


Figure 7.5 Effect of Compression Ratio on BP Vs Load for all Diesel-Biodiesel Blends

In fig. the values of brake power for the entire blends for three compression ratio is plotted. By the It is observed from the figure that there is no considerable effect on brake power. The nature of brake power increase with the increase in load.

Effect of Compression Ratio on Exhaust Gas Temperature Vs Load for all Diesel-Biodiesel Blends

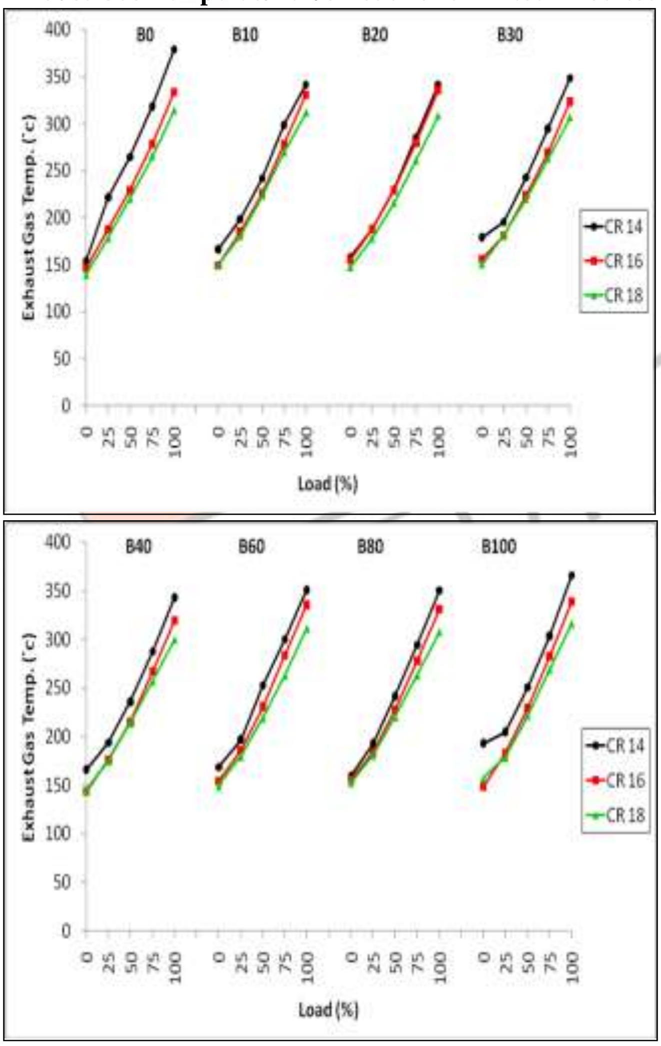


Figure 7.6: Effect of Compr.6ession Ratio on Exhaust Gas Temperature Vs Load for all Diesel-Biodiesel Blends

In fig. the effect of compression ratio on exhaust gas temperature for all the blends at the entire load is shown. For pure diesel the value of exhaust gas temperature at compression ratio 14, 16 and 18 was 378.95 °C, 333.56 °C and 314.36 °C respectively. From figure we can observed that the value of exhaust gas temperature decreases with increment of compression ratio.

Effect of Compression Ratio on Emission of CO Vs Load for all Diesel-Biodiesel Blends

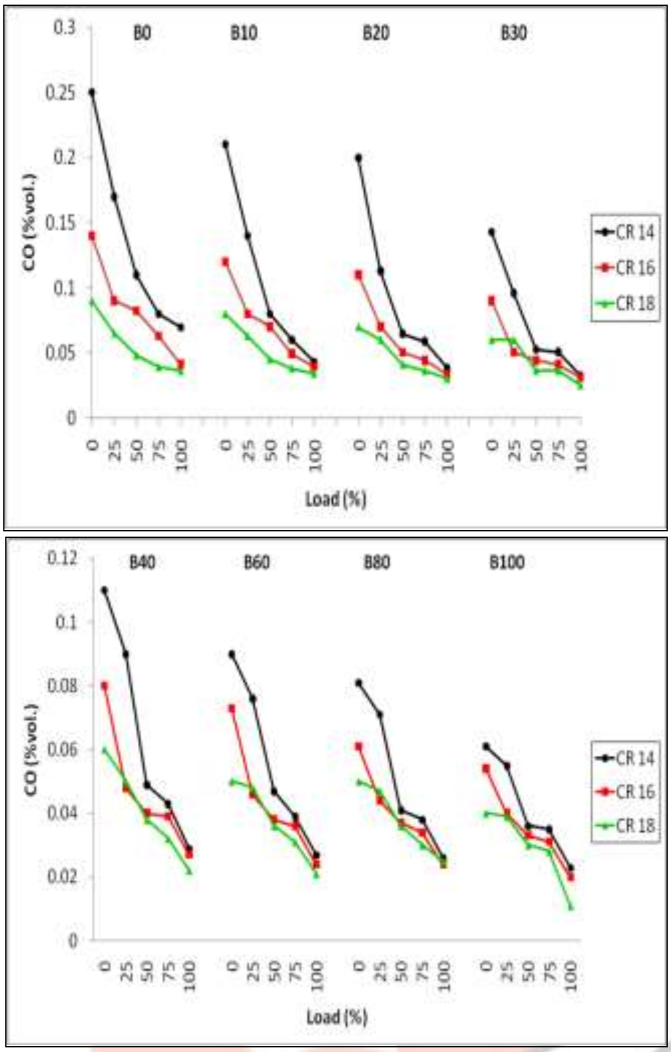
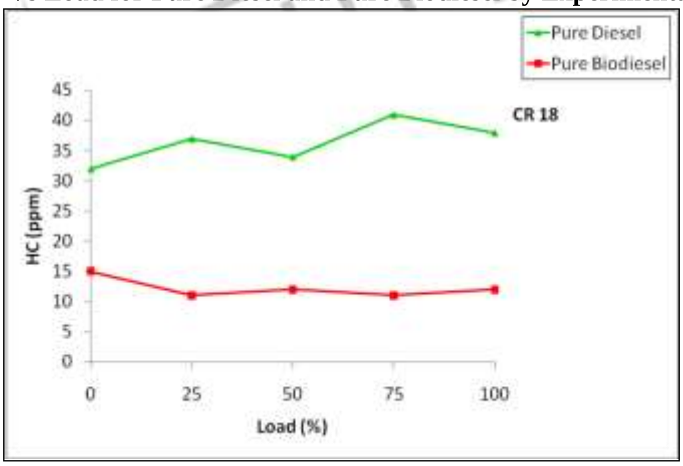


Figure 7.7 : Effect of Compression Ratio on Emission of CO Vs Load for all Diesel-Biodiesel Blends

In fig. the effect of compression ratio on emission of carbon monoxide for all the blends at the entire load is shown. It was clear from the figure that as compression ratio increases emission of carbon monoxide decreases. At higher compression ratio the combustion characteristics are good due to that the emission of carbon monoxide is less. Emission of carbon monoxide of pure diesel was 0.036%vol. and emission of carbon monoxide of B10, B20, B30, B40, B60, B80 and B100 was 0.034%vol., 0.030%vol., 0.025%vol., 0.022%vol., 0.021%vol., 0.025%vol and 0.011%vol. respectively

Comparison of Emission of HC Vs Load for Pure Diesel and Pure Biodiesel by Experimental investigation.



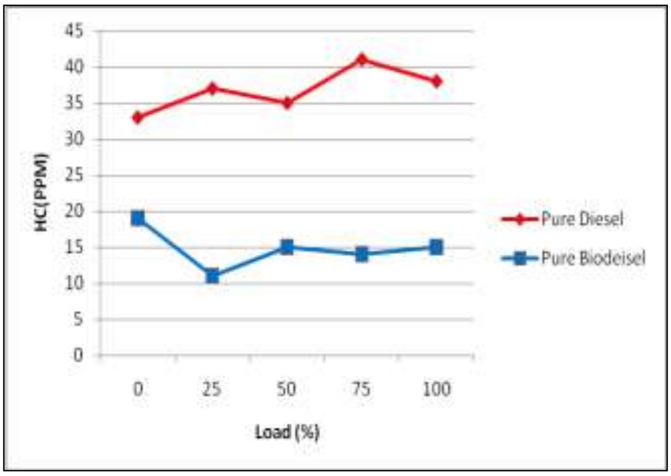


Figure 7.8: Comparison of Emission of HC Vs Load for Pure Diesel and Pure Biodiesel by Experimental investigation.

In fig comparison of emission of unburned hydrocarbon of diesel and biodiesel is shown. The emission of biodiesel was considerably less compare to diesel. At compression ratio 18 the emission of hydrocarbon of diesel and biodiesel were 34ppm and 15ppm respectively, but compression ratio 18 the emission of hydrocarbon of diesel and biodiesel were 34ppm and 15ppm respectively. The higher cetane number of biodiesel and oxygen availability of fuel is responsible for this decrease.[6]

Effect of Compression Ratio on Emission of HC Vs Load for all Diesel-Biodiesel Blends

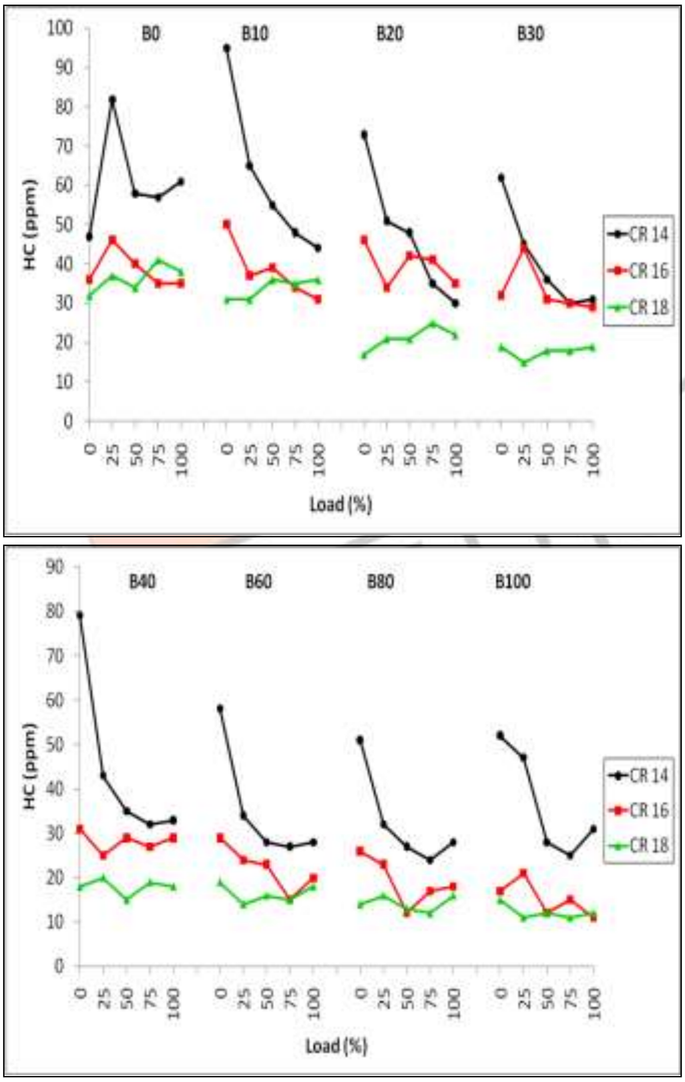


Figure 7.9: Effect of Compression Ratio on Emission of HC Vs Load for all Diesel-Biodiesel Blends

The effect of compression ratio is shown in figure on emission of hydrocarbon. It was found that as the compression ratio increase the results are improved. The emission is considerably lower when compression ratio is 18 compare to compression ratio was set to 14. For every combination of blend the approach was found to be same the emission of unburned hydrocarbon is small for all the fuels. The hydrocarbon emission of B20, B30, B40, B60 B80 and B100 were lower than that of diesel fuel. The higher cetane number is responsible for this decrease

Effect of Compression Ratio on Emission of NOx Vs Load for all Diesel-Biodiesel Blends

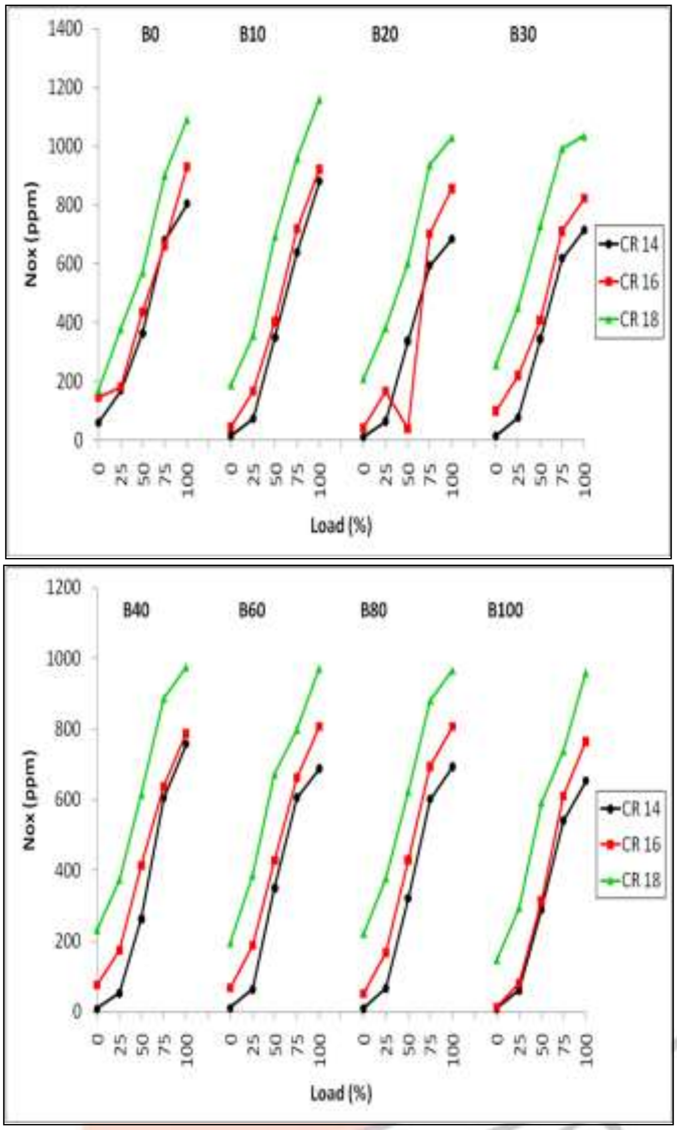
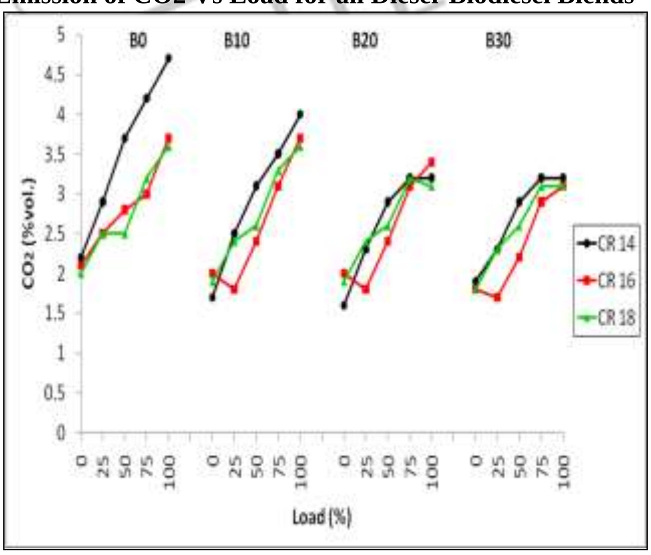


Figure 7.10: Effect of Compression Ratio on Emission of NOx Vs Load for all Diesel-Biodiesel Blends

The effect of compression ratio on emission of nitrogen oxide is shown in the fig. The value of nitrogen oxide emission for diesel at full load for compression ratio 14, 16 and 18 was 804ppm, 929ppm, and 1093ppm respectively. The value of nitrogen oxide emission increases with the increment of compression ratio. All the other blends the approach remains same as diesel.

Effect of Compression Ratio on Emission of CO2 Vs Load for all Diesel-Biodiesel Blends



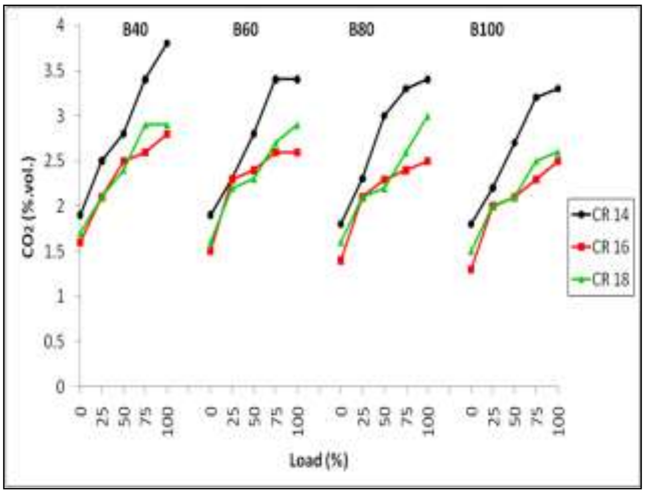


Figure 7.11: Effect of Compression Ratio on Emission of CO2 Vs Load for all Diesel-Biodiesel Blends

In Fig the effect of compression ratio on carbon dioxide emission is shown for all the different diesel biodiesel blends. From the fig. we can clearly visualized that as compression ratio increase carbon dioxide emission was considerably increased foe all the blends. At higher compression ratio the combustion was much better compare to lower compression ratio. It is observed that all the carbon dioxide emission of diesel fuels is higher than that of the blended fuels. This may be because the biodiesel contains oxygen elements the common context is relatively lower in the same volume of fuel consumed at the same engine load, consequently, the carbon dioxide emissions from the biodiesel and its blends are lower.

VIII CONCLUSION

This work is concentrated around the use of biodiesel and diesel-biodiesel blend in diesel engine as much as possible by analyzing the performance and emission of diesel engine.

1 Calorific value of Biodiesel is less (36844 kJ/kg) as compare to diesel (42235kJ/kg). Decrease in calorific value results in higher consumption of fuel for biodiesel-diesel blend and pure biodiesel as compare to diesel.

2 Biodiesel is more viscous (2.80cSt) as compare to diesel (2.10cSt).For higher blends of biodiesel, the modification in injection system of engine may be required due to increase in viscosity of fuel.

3 From performance and emission test analysis, it is found that when compression ratio increases brake thermal efficiency (BTHE) increases and brake specific fuel consumption (BSFC) decreases. The results of brake power remains unaffected by changing compression ratio. In emission parameters with the increment in compression ratio emission of carbon monoxide (CO), unburned hydrocarbons (HC) and carbon dioxide (CO2) was found to be decrease. Emission of nitrogen oxide (NOx) was increases considerably with the compression ratio increases. This was due to better combustion characteristics with increase in compression ratio.

4 Engine was running smoothly on pure biodiesel also. If we can agree for slight compromise with the engine performance parameters, we can replace the diesel fuel. In pure biodiesel all the emission parameters found to be lower compared to diesel.

5 Up to B20 the performance of the engine improve considerably but for more percentage of biodiesel (B30, B40, B60 and B80) it decreases compared to diesel. Based on performance and emission analysis of engine using different diesel-biodiesel blends, optimum blend was found is B20 (20% biodiesel, 80% diesel). B20 having comparatively 3.77% higher brake thermal efficiency than base line data. Brake specific fuel consumption of B20 slightly decrees compare to diesel. Brake power of B20 is also increases comparatively by 5.8%.

6 In exhaust gas analysis for diesel and B20 emission of carbon monoxide was 0.036%vol. and 0.030%vol., emission of carbon dioxide was 3.6%vol. and 3.1%vol., emission of unburned hydrocarbon was 38ppm and 36ppm, emission of nitrogen oxide was 1093ppm and 1031ppm.

7 The experimental investigation is being carried out to compare diesel-biodiesel duel fuel combustion and emission analysis. From performance and emission test analysis, it is found that when compression ratio increases brake thermal efficiency (BTHE) increases and brake specific fuel consumption (BSFC) decreases. The results of brake power remains unaffected by changing compression ratio. In emission parameters with the increment in compression ratio emission of carbon monoxide (CO), unburned hydrocarbons (HC) and carbon dioxide (CO2) was found to be decrease. Emission of nitrogen oxide (NOx) was increases considerably with the compression ratio increases. This was due to better combustion characteristics with increase in compression ratio. It has the following conclusion.

- From Experimental analysis between BTHE VS Load we can conclude that all values are nearly proximity.
- From Experimental analysis between BSFC VS Load we can conclude that B20 and B100 values are for CR 14,16,18 closely proximity, but B0 result views at compression ratio 14,16,18 decrease respectively by 18%,17%,12%.
- From Experimental analysis between BP VS Load we can conclude that the nature of brake power increase with the increase in load.
- From Experimental analysis between Exhaust gas temperatures VS Load we can conclude that values are same for the all results.

- From Experimental analysis between CO (vol %) VS Load we can conclude that same results at no load condition at varying CR -18.
- From Experimental analysis between HC (ppm) VS Load we can conclude that B0 and B100 are gives same values, but B20 condition gives results at CR 16 at 25% load 25% increases.
- From Experimental analysis between NO_x VS Load we can conclude that B0 results gives same values at CR-14 and B100 results gives 0 emission at no load and 25% load at CR 14,16.
- For CO_2 VS Load Experimental analysis for B0 , B20, B100 gives same values for at CR14,16,18.

Future Scope

- Engine is running smoothly on pure biodiesel also.
- If we can agree for slight compromise with the engine performance parameters, we can replace the diesel fuel. In pure biodiesel all the emission parameters found to be lower compared to diesel.

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