



# Experimental Evaluation of Palmyra Oil Blends in VCR Diesel Engine by using EGR Systems.

Pilli Uday Kumar, P.Vijay Kumar, A.Naresh Kumar

**Abstract:** In present days industries are growing at a rapid rate and so as the usage of the diesel. The fossil fuels are limited in nature, the increased usage of diesel is resulting in the depletion of its reserves this gives rise to the need of alternative fuels. Due to low specific fuel consumption and supreme power efficiency it has vast applications compared to other fuels but NO<sub>x</sub> and smoke has seriously causing problem to environment. For this the Palmyra oil has same properties of diesel with varying compression ratios effects the performance and emission characteristics are evaluated. In this process step wise increase of CRs from 16 initially .Then increases EGRs of 0%,5% and 10% and studied performance and emission characteristics. There is improvement in engine efficiency during EGR increment and at low load .There is simltanously decrease in NO<sub>x</sub> emissions . The single cylinder four stroke variable compression performance and emissions can be varied.. when fuel is pure diesel,b15and b35 of Palmyra oil is examined and bear with standard automobile usable diesel was conducted at compression ratio of 16:1 at the degrees of 19 and 23 degrees. The influence of Palmyra oil like compression ratio on fuel consumption ,brake thermal efficiency and exhaust gas emissions like NO<sub>x</sub> and hc has been investigated .the overall optimum is found to be b15 biodiesel –diesel blended for compression ratio of 16 at different exhaust gas recirculation such as 0, 5 and 10. The same experimentation is done for other blends B<sub>15</sub> and B<sub>35</sub> with palmyra oil. All the values are compared with each other. The configuration which achieved highest Break thermal efficiency is compared to the common diesel engine configuration used and the advantages and the disadvantages are listed out.

**KEY WORDS:** Palmyra oil diesel blend, Exhaust gas regeneration, Variable compression ratio, Exhaust emissions

## I. INTRODUCTION

The conventional fossil fuel resources are depleting at a rapid rate, due to ever increasing population, growing demands of mankind for energy, industrialization and increase in usage of automobiles in transportation and other applications. Diesel is considered as one of the major fuels that is used in both automobiles and industries. The rapid consumption of diesel is resulting in an increase in the scarcity of fuel in near future. Diesel has its own advantages and disadvantages; one such disadvantage is pollution caused by the exhaust gases which contain NO<sub>x</sub> emissions and carbon emissions mainly CO which results in degradation of Ozone (O<sub>3</sub>) and CO<sub>2</sub> which is a green house gas resulting in global warming.

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The above reasons have really led the researcher to realize the need of alternate fuels which can be substituted for diesel engine without the need of creating a new engine and also which can result in less emissions and eco-friendly. Bio diesels can be such alternatives used as substitute for the diesel. However, using cent percent bio diesel is not suitable for diesel engines due to density variations and other thermal properties like fire point and flash point.

Considering the limitations blends which are prepared using both diesel and Bio fuels are considered as viable alternate fuels.

So, in the present work the authors have considered palmyra oil as the biofuel and subsequently to prepare palmyra oil diesel blends in order to conduct the experiments and tests. The main advantages of a bio fuel is that it is a renewable fuel unlike petroleum-based diesel. Bio fuels are not considered as eco-friendly as they produce less pollutants but also economic for producing the oil. The lubricating property may lengthen the lifetime of engines. Palmyra oil is one of the bio fuels which has very similar properties with respect to diesel. The drawback of direct use of palmyra oil is that it causes fuel filter plugging and choking of injector nozzle, but can be overcome by making palmyra oil diesel blends.

## II. LITERATURE SURVEY

[1]K. Sivaramakrishnan :The standared diesel is compared with karanja of 20%'25% and 30% of fuel of performance with emissions are investigated.This experimented is conducted with different compression ratios of 15:1,16:1, 7:1 & 18:1.the presentation was fuel consumption impact on compression ratio,brake thermal efficiency & emissions of exhaust gas .The analysis was optimized by a method by response surface .The 18:1 is the compression ratio at 25% of biodiesel at overall experiment 2014. [2]Swarup Kumar Nayak :To find the engine application the admixing of biodiesel with suitable additive Dimethyl carbonate with mahua oil for production of biodiesel for number of tests at different volume of proportions for preparation of number of tests.The engine performance and engine emissions are discovered at various loads in water cooled single cylinder engine.for a prepared test fuels the brake power & brake therma efficiency was increases.there is increase in additives in test fuels there is increase in brake thermal efficiency and there is a decrease in brake specific fuel consumption.The additive % increases there is decrease in exhaust gas temperature at all tests. There is also HC and CO decrease in emissions with adding more additives and same for NO<sub>x</sub> & SMOKE . At last all results was some better as compared with older results .To give best results the engine parameters with adding additives for further investigation this paper is best 2015.



## Experimental Evaluation of Palmyra Oil Blends in VCR Diesel Engine by using EGR Systems.

[3]S. Nagaraja :the standard diesel the investigation was performed that engine performance and emissions the characteristics with direct injection,variable compression ratios and pre heated palm oil at 5%,10%,15% and 20% are blended.The 90<sup>o</sup> temperature range is used for pre-heating the raw palm.The experiments was conducted at compression ratios of 16:1,17:1,18:1 and 20:1 at speed of 1500 rpm at full load.the investigation is performed at brake power, mechanical efficiency ,indicated mean effective pressure and engine emissions.The compression ratio is higher for O20 is 14.6% higher at maximum mechanical efficiency then diesel.The O20 has higher compression ratio of indicated pressure and lower then diesel.The CO2 emissions and CO,HC increase with maximum load at increase in compression with blending ratio.The O20 at 20:1 is optimum during full load 2016.

[4]K. Nantha Gopal :in this paper also performance and emissions characteristics of pongamia oil at engine like brake thermal efficiency ,carbon monoxide,smoke,unburned hydrocarbons ,brake specific fuel consumption and NOX are verified.the blends like PME 20,PME 40PME60 and PME 80 is prepared at (PME100) and tested on diesel engine. In this states that reduces CO,HC and smoke and slight reduce in performance 2015.

[5]Mohit Vasudeva:in this paper crude rice oil says that the influence factor for geographical region is the feedstock for petroleum importing countries because it is friendly relationship with environment and high potential as renewable resource.the crude rice bran oil has blends 10,20 and 40% by volume is tested in variable compression engine at compression ratios of 15,16,17 and 18 because it is higher free fatty acid for two step esterification process.the increased parameters like brake thermal efficiency , carbon dioxide by 17.43% ,NOX by 22.76% and compression ratios from 15 to 18 and the decreased parameters like 18.6 brake specific fuel consumption, carbonmonoxide by 22.27,hydrocarbon by 38.4. the crude rice bran oil show some better performance 2014.

[6]P. Bridjesh, :In this paper the analysis is done between diesel and calophyllum inophyllum of engine performance and emission characteristics at various compression ratios.In this calophyllum inophyllum oil and diesel blends are prepared and different statistical analysis was done at variable compression ratios.The brake specific fuel consumption ,brake thermal efficiency and emissions are nitric oxides, carbon monoxide ,hydrocarbons are checked and analysed.In this experiment analysis the out put results are there is a increase in brake specific fuel consumption ,carbon monoxide ,hydrocarbons and decrease in nitric oxide,brake thermal efficiency 2013.

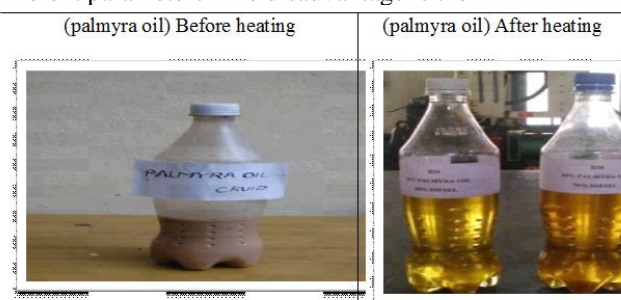
[7]M. Vjaya Kumar :In this paper he analysed that the combustion, emission parameters and performance of engine is improved by modifying the nozzle (NHD) from base 0.28mm to 0.20mm by reducing hole diameter.There is a substantial increase in NOX emissions are short coming majorly.In this he used Mahua oil is blended with diesel and prepared B20 at different loads like 2.46,4.92,7.38 and 12.3 kgs and varied EGR rates by 10,20 and 30% in partially-cooled exhaust gas recirculation in modified single cylinder diesel engine.In this the modified diesel engine the 3-hole nozzle with an orifice diameter of 0.20mm the performance ,combustion and emission characteristics are improved for both B20 and diesel except NOX emissions .For the 20% Mahua oil and diesel there is EGR 10% is best

for combustion recommended successfully implemented for partially cooled EGR for increase in NOX emissions.The CO2 H2O and O2 increases as the loads increases and effects the engine performance and emission characteristics in modified engine recirculation 2012.

[8] T. Venkata Srinivasa Rao :In this paper Palmyra oil is blended with diesel are 10%,20% and 30% and added additive as ethanol and hexanol to ignition improver to investigate to increase engine performance and decrease in emissions at different varying load conditions.The diesel has major transport because superior efficiency compared to s.i engines.In spite there is serious impact on environment of NOX and smoke emissions 2017.

### III. FUEL PREPARATION

Palmyra palm is a tree that gives fruit called Palmyra. It is grown in clusters and has diameter is 4 to 7 inches.it has three jelly seed sockets inside the fruit so the top portion must be cut off.it has yellowish-brown skin on jelly.when the additives are added and preheating ,blending made changes.The different transfiguration process is made and Palmyra oil is prepared .B15- For every 1000 ml of Diesel blend 150 ml is Palmyra oil and the remaining is diesel. Quantities are measured and mixed manually.B35- For every 1000 ml of Diesel blend 150 ml is Palmyra oil and the remaining is diesel. Quantities are measured and mixed manually. so 0%,5% and 10% is taken for studying the different parameters The disadvantage is the



### Experimental Setup

Before starting the engine is warmed up for correct readings.The values are recorded at ENGINE SOFTWARE with the help of hard disk in enabled computer. the kinematic viscosity is more than the diesel.the injection nozzle, sticking for piston rings and crankcase oil dilution is the major problems of Palmyra oil for direct use.the experiment was conducted at different engine varying from low to maximum at fixed rated speeds.The engine is maintain stable during low speed and gradually increases.The values are noted when the the rig is get stable condition. The present investigations were Brake thermal efficiency,Brake thermal efficiency ,mechanical eff,hydrocabond and nitrogen oxides are investigated for pure diesel,B15 and B35. The engine components and combustion chamber may cause rapture if the limit is exceeds 30% of exhaust gas is used. life time of the engine decreases but in contrary the emissions ejected to the environment decreases.





**Engine specifications:**

Power (Kw)	13.5
Max Speed (rpm)	1500.
Cylinder Bore (mm)	887.5.
Stroke length (mm)	110.
Connecting Rod Length (mm)	234.
Compression Ratio	18.
Swept Volume(ccc)	661.5.
Stoke type	4.
Number of cylinders	1
Speed Type	. constant
Cooling Type	Water.
Fuel type	Diesel.
Compression Type	VCR.

**properties of Palmyra oil:**

Property	Diesel	Palmyra oil	B15	B35
Specific gravity(gm/cc)	0.83	0.876	0.838	0.856
Kinematic Viscosity(mm <sup>2</sup> /s)	4.3	31.2	5.5	8.1
Flash Point(°C)	54	172	81	101
Fire point(°C)	65	198	104	141
Calorific value(kj/kg)	42500	37710	41490	40562

IV. RESULTS AND DISCUSSION

Brake Specific Fuel Consumption Vs Load:

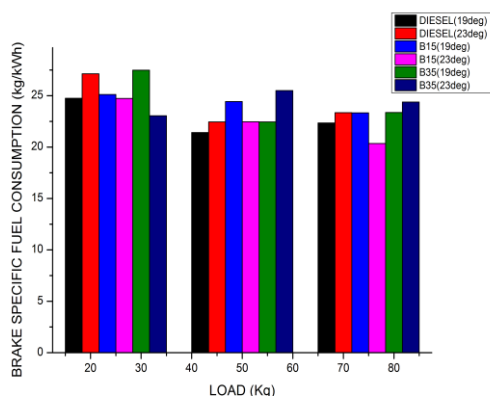


Fig 1 :BSFC VS LOAD CR16 ,0 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has near specific fuel consumption values at half load and full load conditions, but at starting load condition diesel having the highest value preceding to the B15 and B35.

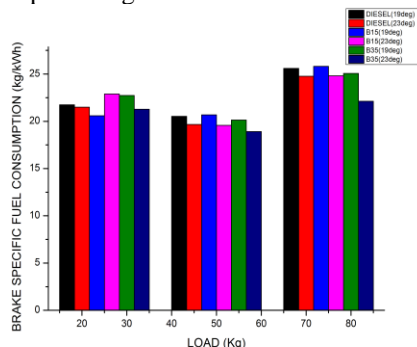


Fig 2: BSFC VS LOAD CR16 ,5 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has near specific fuel consumption values at half load and full load conditions, but at starting load condition B35 having the highest value preceding to the diesel and B15.

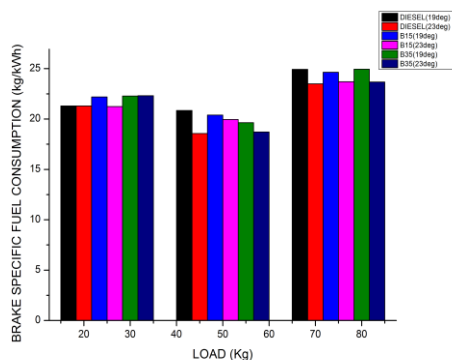


Fig 3: BSFC VS LOAD CR16 ,10 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has near specific fuel consumption values at half load and full load conditions, but at starting load condition diesel and B15 having the same value but B35 differs.

It is observed from the above figures fig1,fig2 and fig 3 that for B15 and B35 has near specific fuel consumption values at half load and full load conditions, but at starting load

condition diesel and B15 having the same value but B35 differs. Brake specific fuel consumption at different injecting timings like 19 and 23 degrees at compression ratio 16 is varied at all loads. Only B35 has higher value because of increase in input of Palmyra oil bio-diesel there is a decrease in calorific value and increase in viscosity of fuel. For at certain load conditions the brake power and fuel intake ratio for B.S.F.C is higher due to rise in viscosity and calorific value. There is a high viscosity due to low atomization purposely improper mixing.

V. BRAKE THERMAL EFFICIENCY VS LOAD

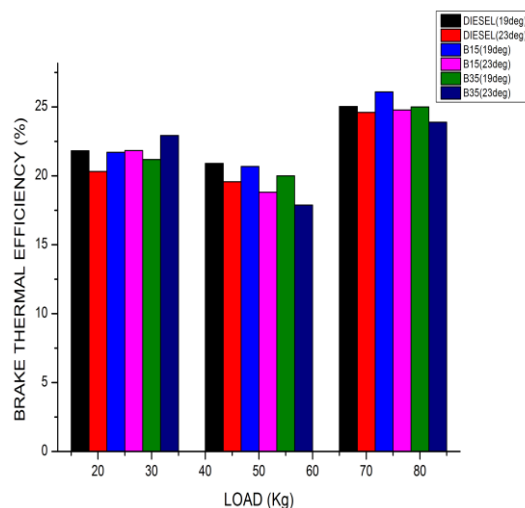


Fig 1: BTHE VS LOAD CR16 ,0 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has almost near brake thermal efficiency when compared to pure diesel.

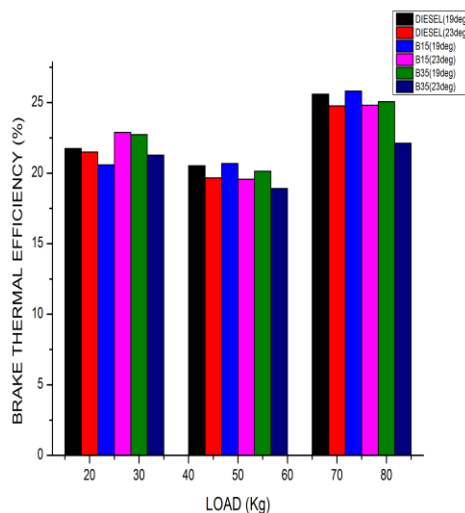


Fig 2: BTHE VS LOAD CR16 ,5 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has almost near brake thermal efficiency at zero and half load but varies at full load conditions when compared to pure diesel

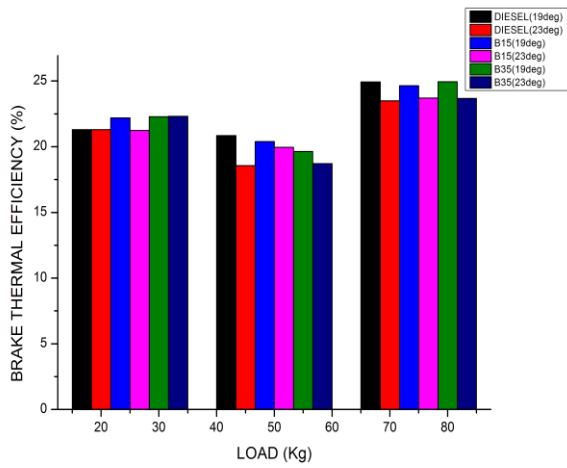


Fig 3: BTHE VS LOAD CR16, 10 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has almost near brake thermal efficiency when compared to pure diesel. It is observed from the above figures fig1, fig2 and fig 3 that B35 has some rise of brake thermal efficiency with diesel. But when compared with diesel and B15 has some decrease of brake thermal efficiency. That for B15 and B35 has near brake thermal efficiency values at half load and full load conditions, but at starting load condition diesel and B15 having the same value but B35 differs. Brake thermal efficiency at different injecting timings like 19 and 23 degrees at compression ratio 16 is varied at all loads. Only B35 has higher value because increase in input of Palmyra oil bio-diesel there is a decrease in calorific value and increase in viscosity of fuel. For at certain load conditions the brake power and fuel intake ratio for B.S.F.C is higher due to rise in viscosity and calorific value. There is a high viscosity due to low atomization purposely improper mixing.

**MECHANICAL EFFICIENCY VS LOAD**

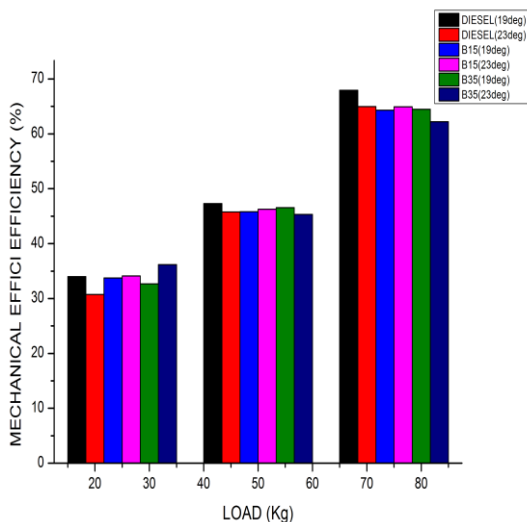


Fig 1: MECH VS LOAD CR16, 0 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has almost near mechanical efficiency when compared to pure diesel

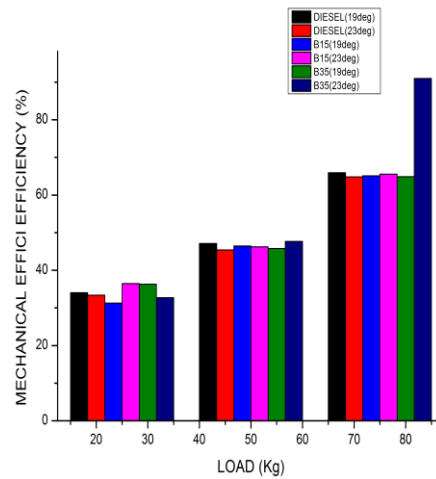


Fig 2: MECH VS LOAD CR16, 5 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has almost near mechanical efficiency when compared to pure diesel. Since the application of EGR is used it may show lesser value when compared to 0 EGR process in some cases.

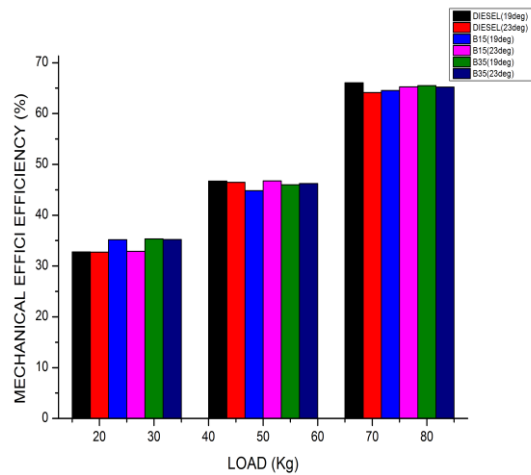


Fig 3: MECH VS LOAD CR16, 10 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has almost near mechanical efficiency when compared to pure diesel. It is observed from the above figures fig1, fig2 and fig 3 that B35 has some rise of Mechanical efficiency with diesel. But when compared with diesel and B15 has some decrease of Mechanical efficiency. That for B15 and B35 has near brake thermal efficiency values at half load and full load conditions, but at starting load condition diesel and B15 having the same value but B35 differs Mechanical efficiency at different injecting timings like 19 and 23 degrees at compression ratio 16 is varied at all loads. Only B35 has higher value because increase in input of Palmyra oil bio-diesel there is a decrease in calorific value and increase in viscosity of fuel. For at certain load conditions the brake power and fuel intake ratio for B.S.F.C is higher due to rise in viscosity and calorific value. There is a high viscosity due to low atomization purposely improper mixing.

**Emission characteristics**

In internal combustion engines all emissions are emitted due to such parameters like air –fuel ratio, fuel type ,combustion chamber design and atomization design. The human health and ozone layer is permanent effects of emissions like CO<sub>2</sub>, NO<sub>x</sub> CO and unburned HC emitted from the internal combustion engines. because they are less chemical energy gradients. The different compression ratios at different injection timings and different EGR the emissions like HC, NO<sub>x</sub> and CO are evaluated by Palmyra oil.

**HYDRO CARBONS (HC) VS LOAD**

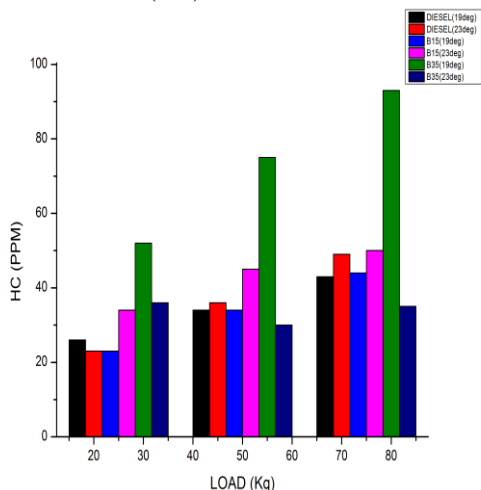


Fig 1: HC VS LOAD CR16 ,0 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for diesel and B35 has near HC(ppm) values but B15 emission values lesser with comparison

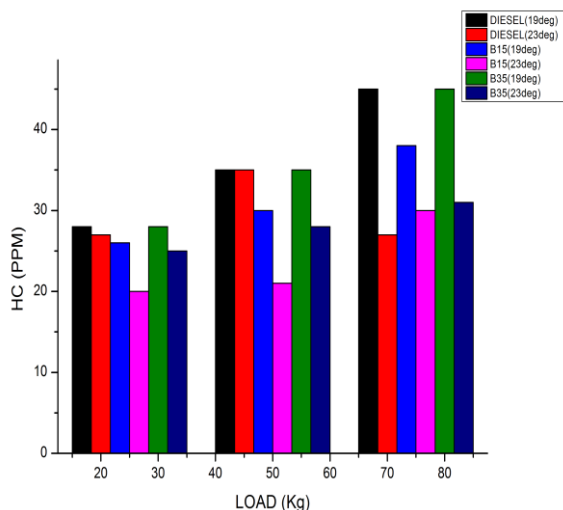


Fig 2: HC VS LOAD CR16 ,5 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has near HC(ppm) emission values when compared to the emission values for diesel and with the usage of EGR process decrease of emission value we can observe.

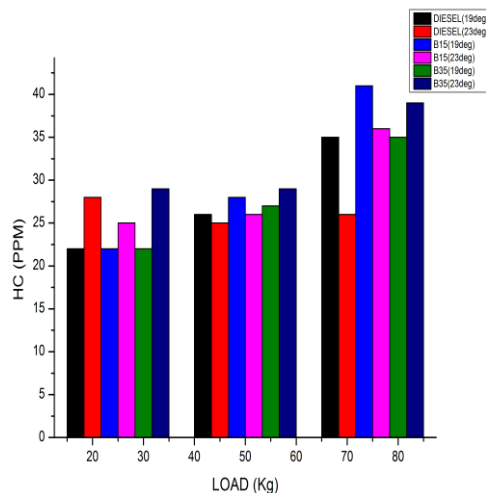


Fig 3: HC VS LOAD CR16 ,10 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 has near HC(ppm) emission values when compared to the emission values for diesel at part load conditions but at full load conditions it shows little deviation with diesel and with the usage of EGR process decrease of emission value we can observe

It is observed from the above figures fig1, fig2 and fig 3 that for B15 and B35 has near HC(ppm) emission values when compared to the emission values for diesel at half load conditions but at 100% load conditions it shows little deviation with diesel and with the usage of EGR process decrease of emission value we can observe .it is seen above figure that hydrocarbon (hc) emissions for bio-diesel like B15 and B35 are slightly less when compared to diesel by 14 % .hc emissions are low with rise in compression ratio. the injection timing is decreased from 19 to 23 degrees there is increase in temperature. the oxygen is added with increase in temperature then decrease in emissions .

**Nitrogen Oxides (No<sub>x</sub>) Vs Load:**

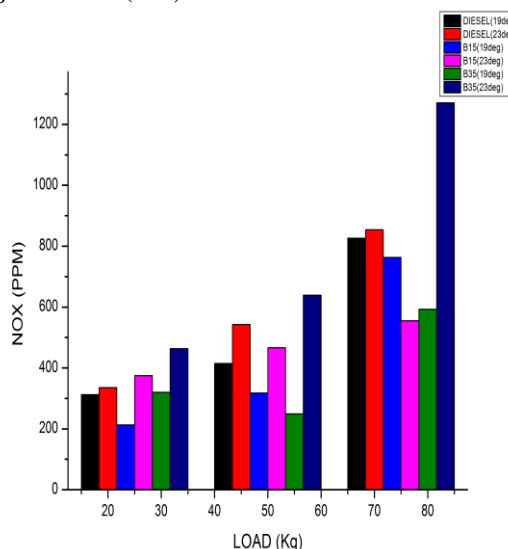
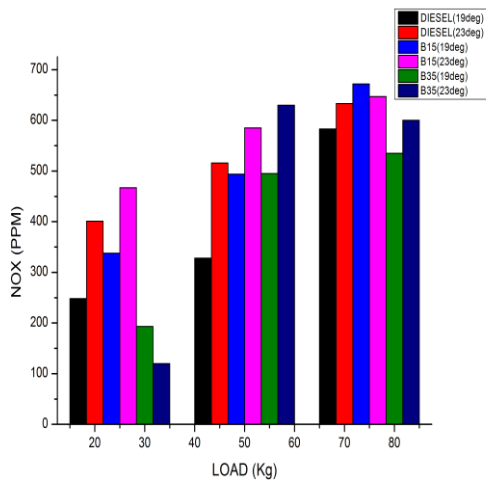


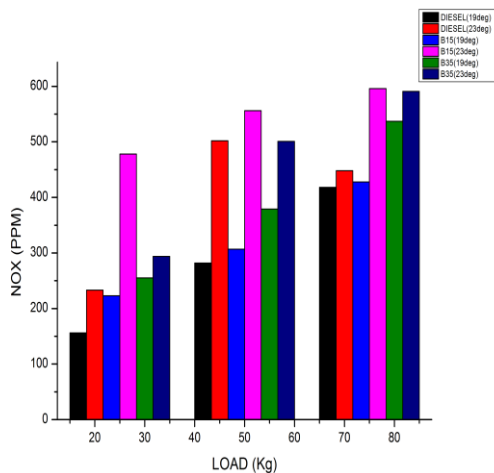
Fig 1: NOX VS LOAD CR16 ,0 EGR AT 19&23 DEGREES

**Discussion:** it is observed that for B15 and B35 have lesser values of NO<sub>x</sub> (ppm) when compared to the diesel emission values



**Fig 2: NOX VS LOAD CR16,5 EGR AT 19&23 DEGREES**

**Discussion:** it is observed that for B15 and B35 has near NO<sub>x</sub>(ppm) emission values when compared to the emission values for diesel at full load conditions but at part load conditions it shows little deviation with diesel and with the usage of EGR process decrease of emission value we can observe.



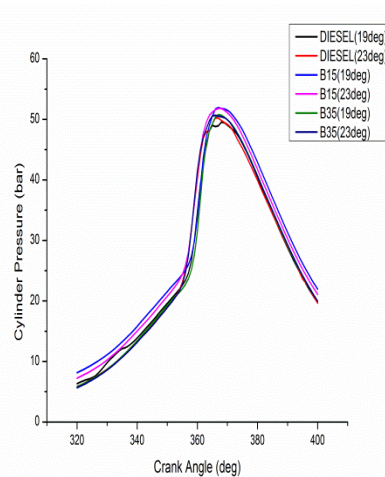
**Fig 3: NOX VS LOAD CR16,10 EGR AT 19&23 DEGREES**

**Discussion:** it is observed that for B15 and B35 has near NO<sub>x</sub>(ppm) emission values when compared to the emission values for diesel at full load conditions but at part load conditions it shows little deviation with diesel and with the usage of EGR process decrease of emission value we can observe

It is observed from the above figures fig1,fig2 and fig 3 that for B15 and B35 has near NO<sub>x</sub>(ppm) emission values when compared to the emission values for diesel at full load conditions but at part load conditions it shows little deviation with diesel and with the usage of EGR process decrease of emission value we can observe Treating observed that for B15 and B35 has near NO<sub>x</sub>(ppm) emission values when compared to the emission values for diesel at half load conditions but at 100% load conditions it shows

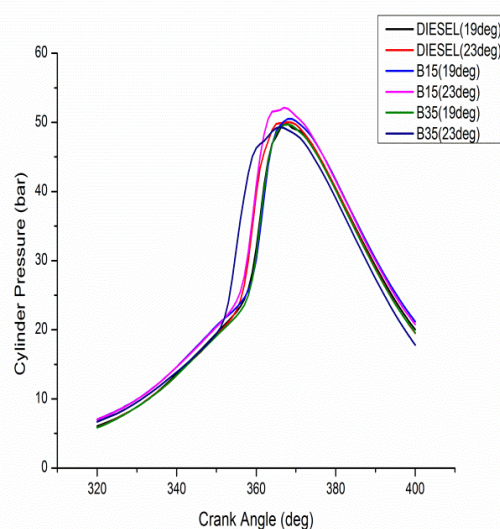
little deviation with diesel and with the usage of EGR process decrease of emission value we can observe .it is seen above figure that NO<sub>x</sub>(ppm emissions for bio-diesel like B15 and B35 are slightly less when compared to diesel by 14 %.hc emissions are low with rise in compression ratio.the injection timing is decreased from 19 to 23 degrees there is increase in temperature.the oxygen is added with increase in temperature then decrease in emissions .Nox emissions are less then 80 %..

**Cylinder Pressure vs Crank angle**



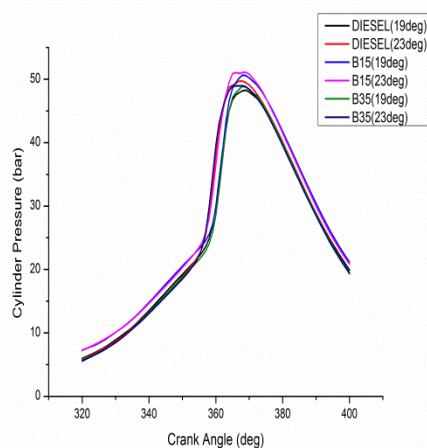
**Fig 1: P-0 VS LOAD CR16,0 EGR AT 19&23 DEGREES**

**Discussion:** the maximum pressure occurs at the end of one revolution the crank shaft and at that angle of flywheel the cylinder pressure is 50-55 bar for all three fuels



**Fig 2: P-0 VS LOAD CR16,5 EGR AT 19&23 DEGREES**

**Discussion:** the maximum pressure occurs at the end of one revolution the crank shaft and at that angle of flywheel the cylinder pressure is 50-55 bar for all three fuels



**Fig 3: P-0 VS LOAD CR16,10 EGR AT 19&23 DEGREES**

**Discussion:** the maximum pressure occurs at the end of one revolution the crank shaft and at that angle of flywheel the cylinder pressure is 50-55 bar for all three fuels

It is observed from the above figures fig1, fig2 and fig 3 that maximum pressure occurs at the end of one revolution the crank shaft and at that angle of flywheel the cylinder pressure is 50-55 bar for all three fuels. It is observed that B15 and B35 has great cylinder peak pressure with respect to ignition delay. In the expansion stroke at T.D.C near peak pressure is better mixing of air fuel at initial stage. At 19 degrees the peak pressure is 55.95%. Due to more oxygen the combustion reaction is greater. For this purpose there is a ignition delay is reduced for B15 and B35. During the initial stage of combustion there is a low atomization and mixing with rise of fuel viscosity, low calorific value at above blends. The peak pressure is less the result is obtained.

## VI. CONCLUSION:

The paper is about palm oil diesel blends are performed on four stroke diesel engine to get emission characteristics, variable compression ratio and exhaust gas recirculation.

On the experimental observations it is noticed that B15 blend can be used as a substitute for CR 16 engines and palmyra B35 can be used which exhibited similar results from test conditions.

In addition the NO<sub>x</sub> emissions are lower in the case of CR 16 and satisfactory results of NO<sub>x</sub> emissions are observed for B35 in comparison with diesel.

If there are engines with EGR capability for CR 16, B15 can be used with 5 EGR for better efficiency, whereas for CR 18 the maximum value is observed with 0 EGR. B35 had an increase of 1% it is to be noted that the consumption of the diesel can be decreased by 35% with increased efficiency and reduced NO<sub>x</sub> emissions for CR 18.

The findings are in compliance with previous study conducted on palmyra oil stating.

The 30% Palmyra oil in combustion ignition engine gives best results in performance and emissions but when compared to 30% diesel some less efficiency.

All the data provided in this study can be utilised as reference for future study in blends of palmyra oil with various EGR for reduced NO<sub>x</sub> emissions.

The efficiency increases as biofuel percentage increases automatically NO<sub>x</sub> emissions are less without any EGR.

Further increase in the blend percentage may lead to increase of efficiency with further low emissions.

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