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Performance and Emissions Evaluation of Diesel Engine with Pre-Heated Bio Diesel

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***ABSTRACT*:** *In this present work the performance and emission evaluation of diesel engine, with various samples of bio diesel is considered. Bio-diesel is taken in pre-Heated condition and is injected into the combustion chamber. The pre-heated condition increases the temperature of biodiesel. We evaluate the performance and combustion parameters in terms of BP,IP, BMEP,BSEC, IMEP, MFC, heat balance, heat release ,CO,NO_X, cylinder pressure at various crank angles and volume. And the process is done at various loads.*

KEYWORDS: *Bio-Diesel, Pre-Heating, Crank angle and emissions etc.*

I. INTRODUCTION

The highly increasing trend of oil price especially in year 2013 has had a great impact on both the agricultural and industrial sectors because of the higher cost of production. The tremendous loss of foreign exchange through the import of petroleum products has caused the government and private sector to consider new sources of energy to substitute for the expensive petroleum products. Using biodiesel is an alternative to diesel fuel, which will improve the environment, reduce foreign imports and increase the use of renewable fuels. It can be produced from various vegetable and/or animal oils with methanol or ethanol, yielding methyl or ethyl ester – or biodiesel – with glycerol as the by-product. The production of biodiesel entails emissions to the environment such as fertilizers and herbicides during plantation and emissions from fuel use during oil extraction, transportation, etc. Hence, the environmental implications of biodiesel production need to be addressed. Life from raw material extraction through production, to use and disposal. Evaluation of Biodiesel Production from Palm Oil in a Life Cycle Perspective. Estimating assessing the environmental impacts attributable to the life cycle a product, such as climate change, stratospheric ozone depletion, photochemical ozone (smog) creation, eutrophication, acidification, toxicological stress on human health and ecosystems, the depletion of resources, water use and others. The emissions and consumption of resources, as well as other environmental exchanges at every relevant stage (phase) in a product's life cycle are compiled. After the compilation and preliminary analysis of all environmental exchanges (emissions, resource, consumptions, etc.), it is often necessary to calculate, as well as to interpret, indicators of the potential impacts associated with such exchanges with the natural environment.

II. ENGINE AND EXPERIMENTAL SETUP

2.1. Description of the Test Rig:

The setup consists of single cylinder, four strokes, water-cooled diesel engine coupled to eddy current dynamometer with the help of flexible rubber coupling is mounted on a centrally balanced base frame made of ms channels. The set up has stand alone fully powder coated panel box consisting of air box, fuel tank, manometer, fuel measuring unit digital indicators and transmitter for measuring various parameters. It is also provided with necessary sensors with transmitters for combustion pressure and crank angle measurements. All these signals are interfaced to computer through signal conditioner and signal converter for computerization. The engine is arranged with pre heated setup with thermo stator arrangement, as the process is fully arranged with computerized setup. As the thermo stator is arranged it automatically prefixes the inlet temperature of bio-diesel entering into engine.

Fig: 2.1: Experimental Setup of Preheating

2.2. Test rig specification:

- ENGINE: 4 stroke 1 cylinder water cooled diesel engine
- Make: kirloskar
- Rated power: 3.7KW (5HP)
- Bore diameter: 80mm
- Stroke length: 110mm
- Connecting rod length: 234mm
- Swept volume: 562cc
- Compression ratio:16.5:1
- Rated speed: 1500 rpm
- DYNAMOMETER: eddy current dynamometer
- Make: POWER MAG
- Rated torque:2.4kg-m
- Arm length: 150mm

2.3. Test rig constants:

- Orifice diameter: 20mm
- Density of air: 1.193kg/m^3
- Density of water: 1000kg/m^3
- Density of diesel: .82 gram/cc
- CV of diesel: 44500kJ/kg
- Value of C_d: 0.62
- Value of "C_P" for water: 4.18KJ/kg k

2.3. Preheating set up:

This Pre-heating set up is maintained at constant temperature of 55^{o}C water bath and the blends entering into the combustion chamber is at 45^{o}C. This is maintained at all the load conditions and for all the blends. This Pre-Heated set up is having Thermostat in order to regulate the temperature.

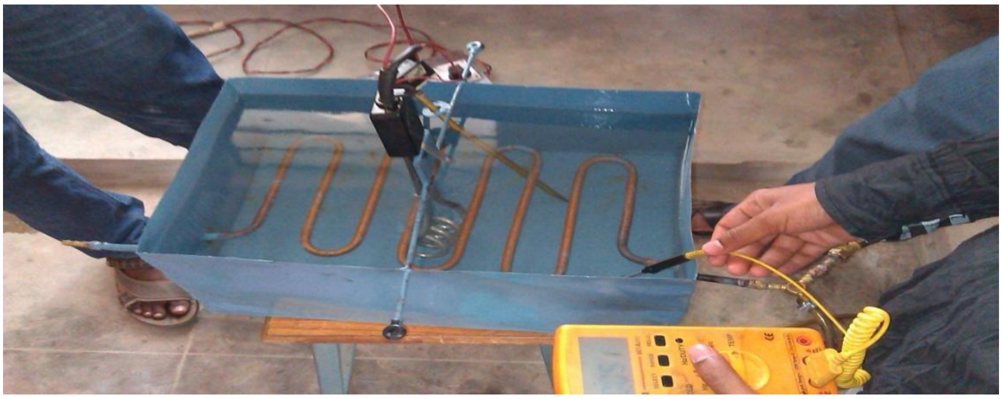


Fig: 2.3.Preparation of preheating setup

2.4. Dissolved Oxygen & Properties:

Dissolved oxygen is measured for 200ml of biodiesel; at room temperature of 27^{o}c.And it is taken at a pressure of 760mm of Hg.There are some standard inputs like value of distilled water is 6.4 ppm.In this process Dissolved oxygen measurer probe is taken. The Probe is filled with 0.1% concentrated KOH solution inside the apparatus. And the apparatus should in wet condition before calibrating the values.

Fig: 2.4.Dissolve oxygen Probe

2.5. Working Procedure:

Palm sterin Bio diesel is taken in a glass jar of 200ml and is freely left into the atmosphere, at room temperature.

KOH filled probe is dipped into the glass jar.

1. The Probe is left for few minutes. All the particles are allowed to settle down
2. The Readings are calibrated.

Palm sterin biodiesel the dissolved oxygen levels will vary as shown in the Table.

S.no	Time (Min)	PPM (At stable condition)
1	1	5.1
2	2	4.1
3	3	3.5
4	4	3.2
5	5	3
6	6	2.9
7	7	2.8
8	8	2.8

2.5 Dissolved oxygen levels of pure bio diesel

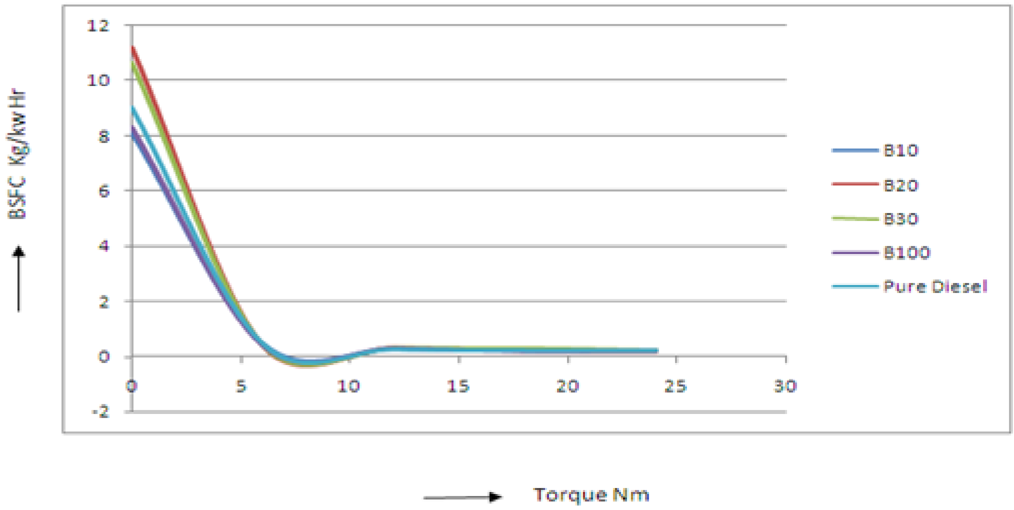
Properties of palm sterin			
		Units	**Test Result**
1	Flash Point	Deg C	168
2	Fire Point	Deg C	174
3	Density at room temperature	gm/ml	0.873
4	Kinematic viscosity at 40 C	cst	4.8
5	Smoke Point length	mm	18-Oct
6	% of carbon content	% m/m	0.035
7	Acid value	mg KOH/gm	0.42
8	cetane number		min 51
9	Glycerin content	%m/m	0.13
10	Ester content	% m/m	98.9
11	Iodine Value	% level	18

2.6 properties of palm sterin

III. RESULTS AND DISCUSSION

In this study four stroke single cylinder water cooled naturally aspirated stationary Diesel engine characteristics are investigated using palm sterin oil and its blends under pre heated condition. The obtained results were compared with standard base line petroleum diesel. The tests were conducted on engine at 1/4.,1/2,3/4,full load and this section highlights the performance characteristics such as BSFC,BTHE,IMEP,EGT,Mechanical effiency and combustion characteristics such as burnt, peak pressure, heat release, cumulative heat release. The load variations and other blends are taken at Pre heated condition at constant temperature which is taken in a water bath of heated condition.

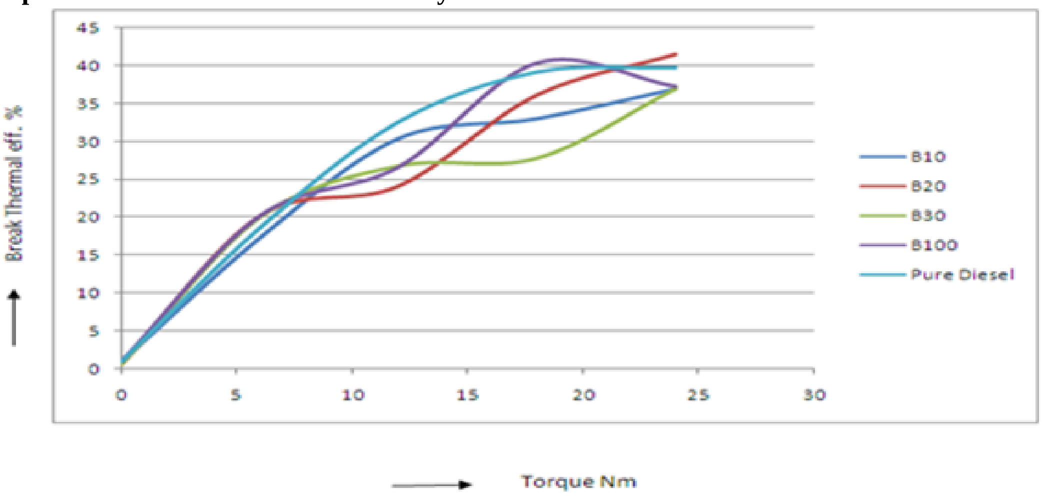
3.1. Comparisons of BSFC and Load:



Graph: 3.1.Comparisons of BSFC and Load

Generally BSFC gradually decreases with increasing load due to increase in break power. It is even applicable to various blends .As the percentage of bio diesel in blend increases the calorific value of fuel decreases and kinematic viscosity of fuel increases so break specific fuel consumption decreases. While coming to the case of B10, B20, B30and B100 the viscosity of pure diesel is less so BSFC is more.

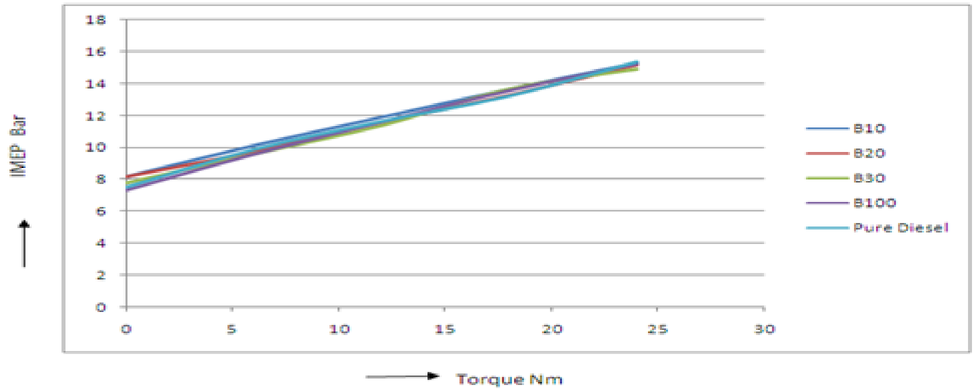
3.2. Comparisons of Break Thermal Efficiency and Load:



Graph: 3.2. Comparisons Of Break Thermal Efficiency And Load

Brake thermal efficiency increase with increasing load for all fuels even for bio diesel blends, however Brake thermal efficiency of bio diesel blends is less compared to diesel at all loads. This is due the reason that BP and MFC of fuel is less when compared to diesel because they are oxygenated fuels so they result in effective combustion. Viscosity of fuel is an important factor, even though all blends are same in composition viscosity of fuel is less for pure diesel than that of B100i.e pre heating of fuel leads to effective flow resulting in increasing of brake thermal efficiency.

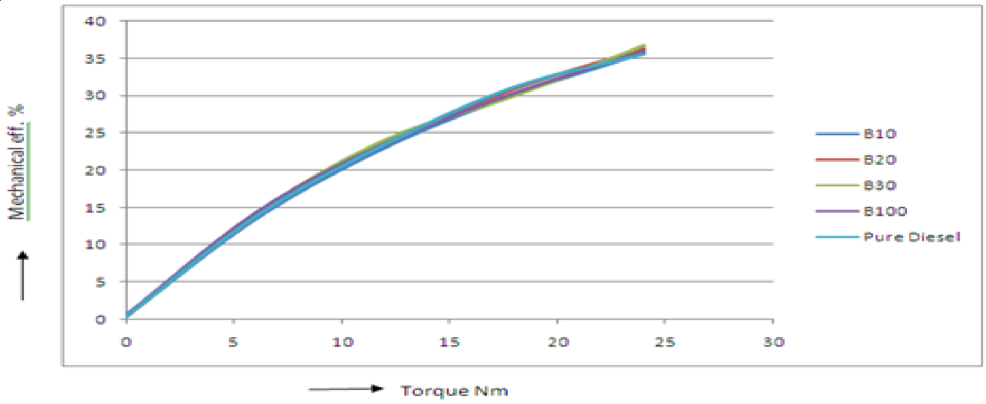
3.3. Comparisons of IMEP and load:



Graph:3.3. Comparisons of IMEP and load:

IMEP was found to be increasing with increasing loads for all fuels .IMEP was found to be more for bio diesels because of effective combustion of fuel when compared to diesel. Imep is always high at all the pre heating conditions.

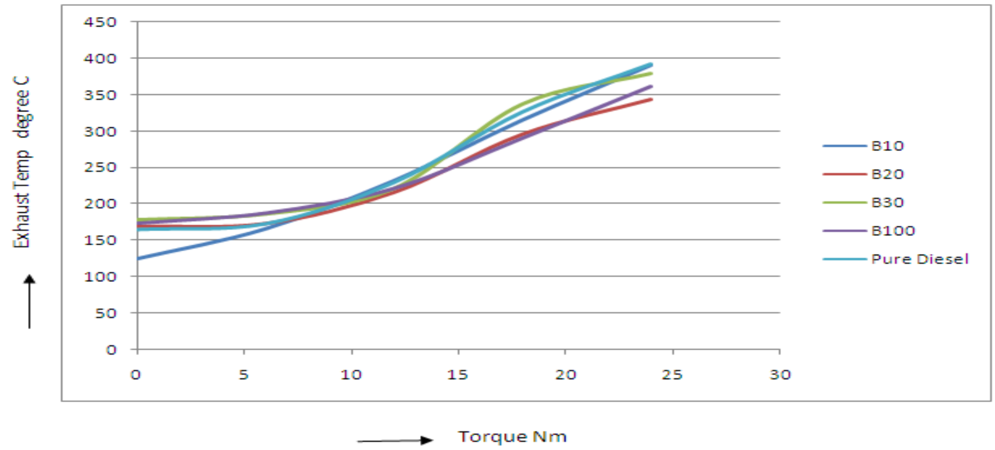
3.4. Comparisons of mechanical efficiency and load:



Graph: 3.4.Comparisons of mechanical efficiency and load

Mechanical effiency was found to be increasing with increasing loads for all fuels .Mechanical effiency was found to be similar for bio diesels because of effective combustion of fuel when compared to diesel. Mechanical effiency is always same at all the pre heating conditions because the load on the engine and the heat release during combustion is same at combustion reaction.

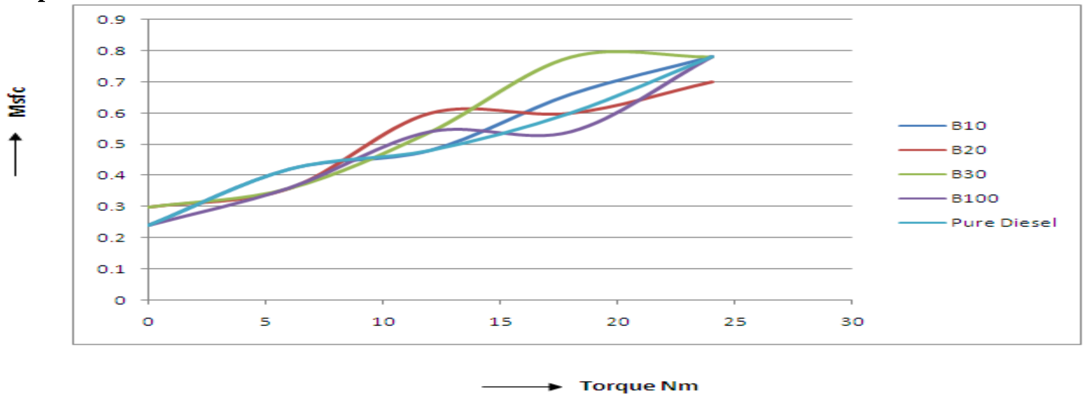
3.5. Comparisons of EGT and load:



Graph: 3.5.Comparisons of EGT and load

Generally fuel consumption also increases with increasing load i.e increasing fuel consumption leads to emission of more un combustible products leading to increase in exhaust temperature In case of bio diesel blends EGT increased with increased load.

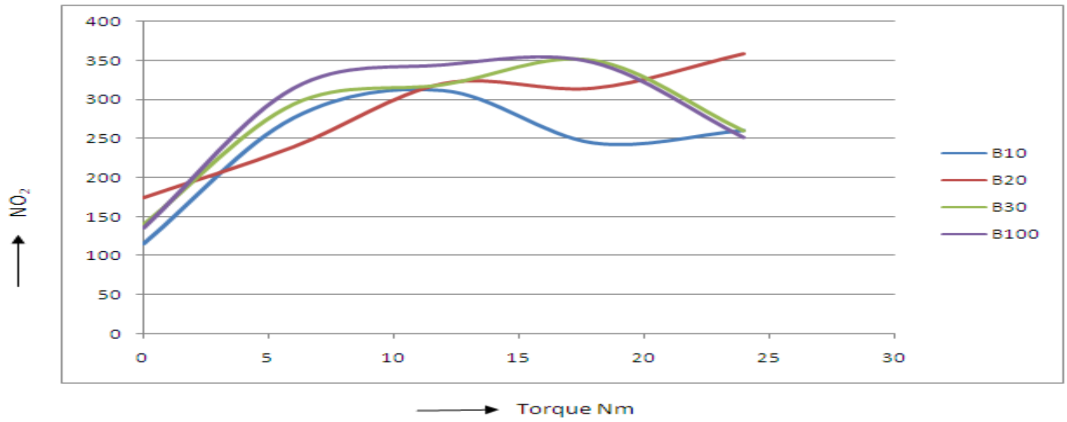
3.6.Comparisons of MSFC and load:



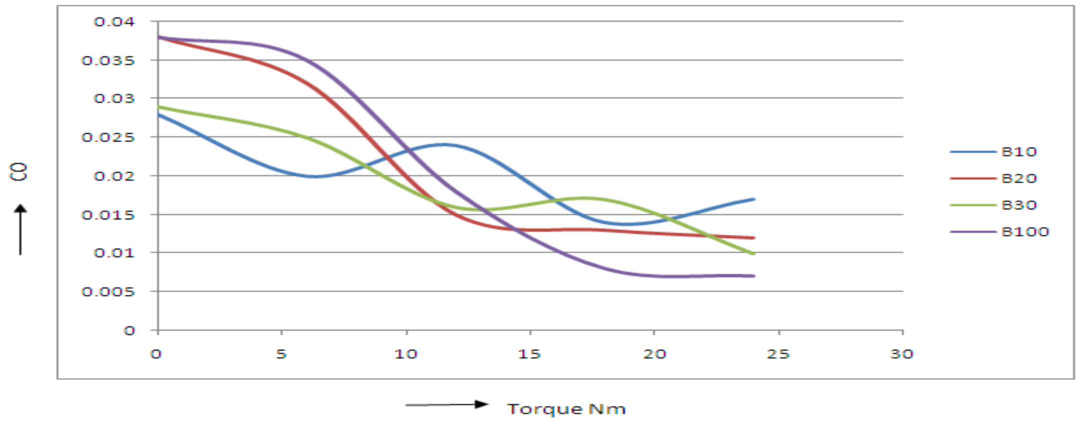
Graph: 3.6.Comparisons of MSFC and load:

Fuel consumption of fuel increase with increasing load for all the fuels. As MSFC is directly proportional to viscosity of fuel the fuel consumption showed the trend of increasing fuel consumption with increasing composition of Palm sterin biodiesel blends.

3.7. Exhaust emissions of CO and NO_X:



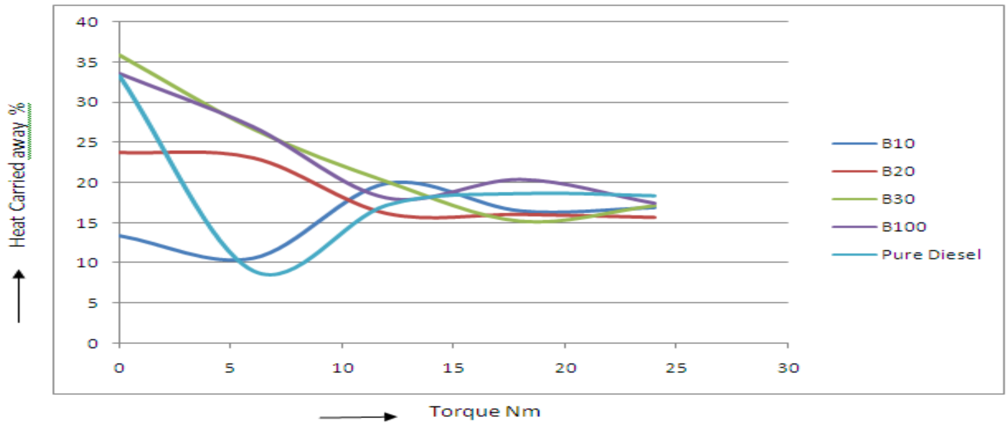
Graph: 3.7.Exhaust emissions of CO



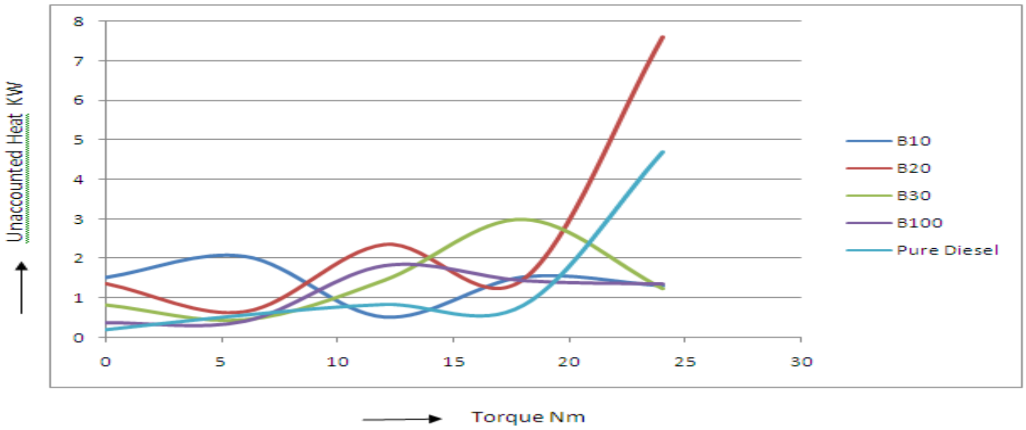
Graph: 3.7.Exhaust emissions of NOx

The exhaust emissions of CO and Nox emissions are slowly gradually decreasing as the combustion rate of the fuel is used in the combustion chamber. In this Palm sterin biodiesel the decrease of emissions is observed**.**

3.8. Comparisons of Heat carried away and load:



Graph: 3.8.Comparisons of Heat carried away and load:



Graph:3.8.Comparisons of Unaccounted Heat carried away and load:

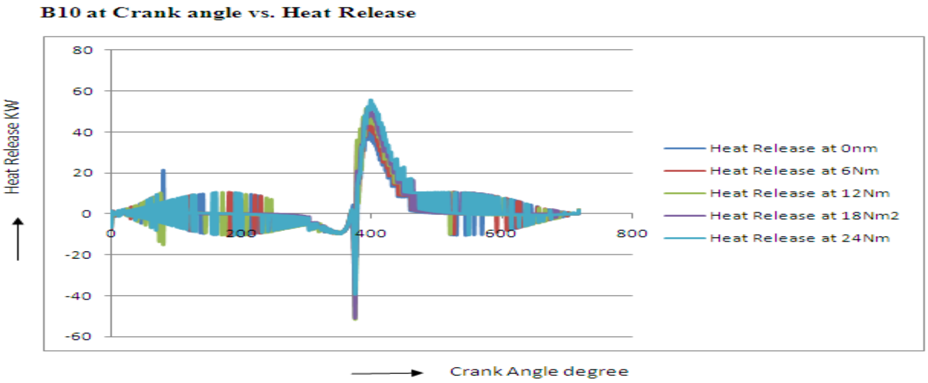
Energy supplied to engine is heat value of fuel consumed is heat value of fuel consumed. As it is known that of the energy produced only a part is transformed in to useful work and rest is wasted.

However it may be stated that some amount of frictional power is accounted in raise of cooling water temperature and lubricating oil temperature, so FP is taken in to account to show that frictional losses also include blow down and pumping losses so it is not appropriate to show them in heat balance sheet so they are termed as un accounted losses.

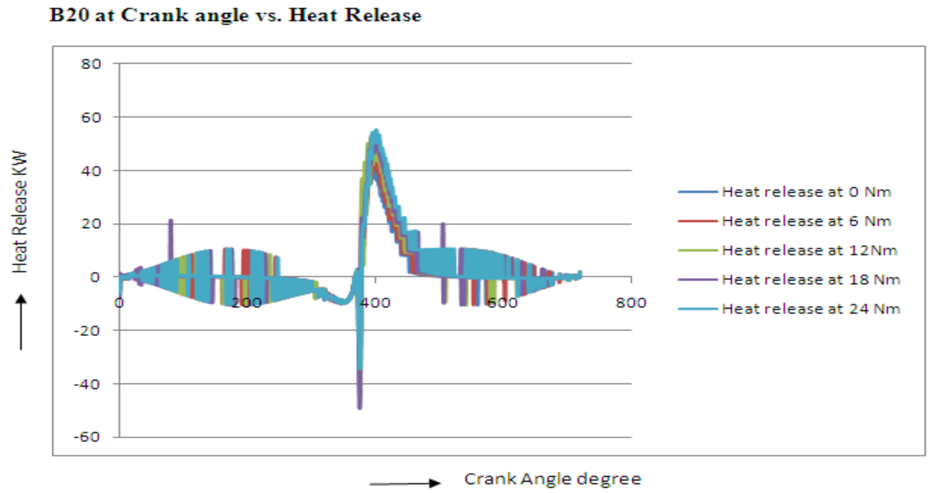
3.9. Combustion Graphs:

The Below four graphs represents the cumulative heat release rate vs. crank angle for B10,B20,B30 and B100 since it is a cumulative heat release, the graph showed a progressive increase in heat release.

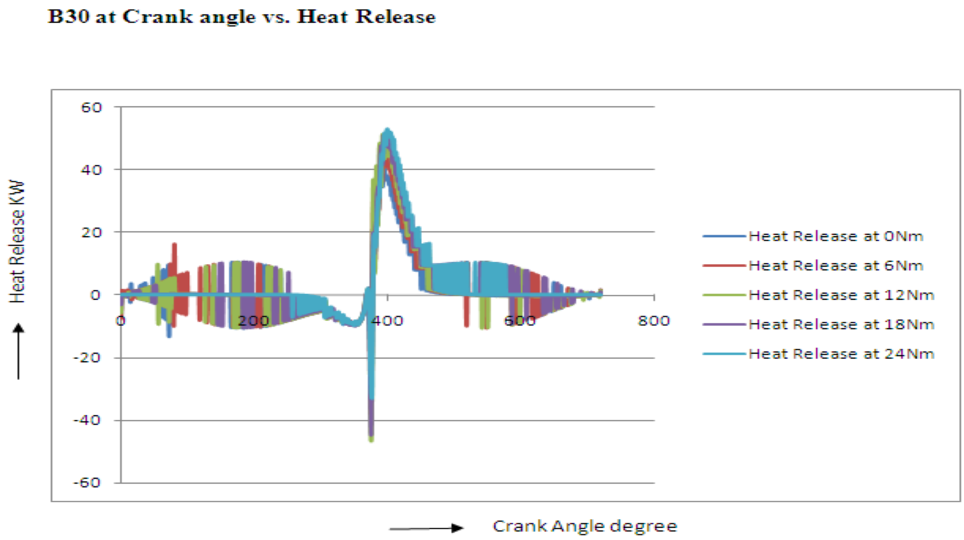
3.9.1. Comparison of heat release and crank angle:



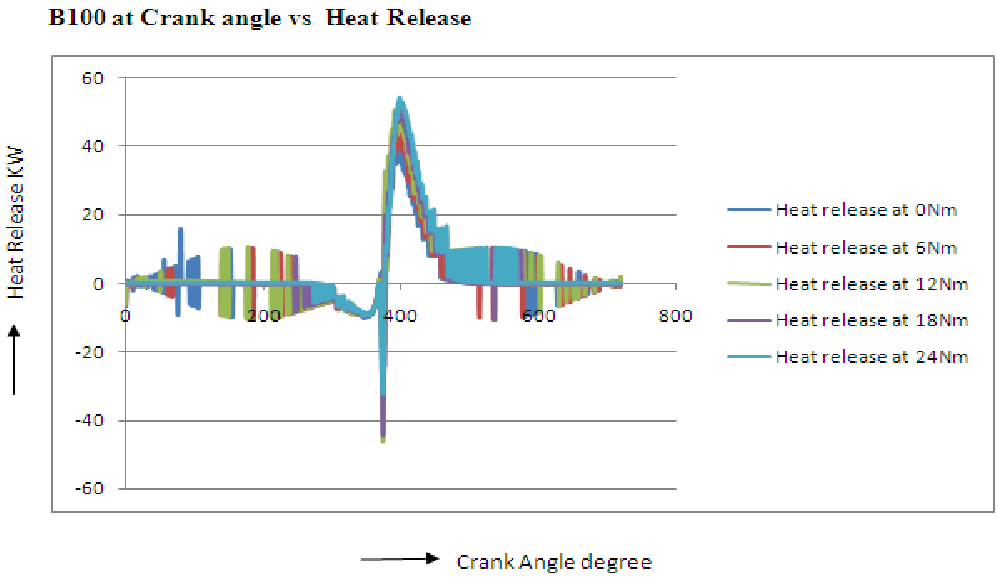
Graph: 3.9.1.Comparison of heat release and crank angle at B10



Graph: 3.9.1.Comparison of heat release and crank angle at B20



Graph: 3.9.1.Comparison of heat release and crank angle at B30



Graph: 3.9.1.Comparison of heat release and crank angle at B100

IV. CONCLUSION

The evaluation and comparison of the various types of fuels that have been experimented with in the single cylinder diesel engine, it is inferred that the palm sterin oil is suitable for running compression ignition engines. To be more specific, the methyl ester of palm sterin oil (which is obtained upon the trans-esterification of pure palmsterin oil) is the most suitable for running automobiles in day to day life. This is due to the fact that performance of the methyl ester of palm sterin oil is on the same lines as that of diesel. So methyl ester of palmsterin oil can be used as an automotive fuel for the following reasons.

- BTHE was found to be more for bio diesel when compared to diesel because they are oxygenated fuels.
- IMEP was more for bio diesels when compared to diesel.
- EGT was low for bio diesels when compared to diesel, so less emissions from it.
- Combustion was low for bio diesels so amount of energy consumed is less.
- Low rate of fuel consumption.
- Heat release rate was more.
- Cumulative heat release was more for bio diesels so it best suits as alternative fuel.

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