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Experimentation on Performance of Preheating Bio Diesel Blends Using Exhaust Heat from VCR Engine

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ABSTRACT:

Fuels are the natural resources that are extracted from the earth and used as fuel energy in our daily life, such as Industries, Thermal power Station, Automobiles etc.

Depletion of these fuels is also a major problem in now-a-days. Hence the use of these fuels is replaced by the alternate fuels that are extracted from the plants, plant seeds and waste energy sources. These fuels have high viscosity and low calorific values compaired to the petroleum fuels. In this project we are trying to reduce these a little by using Preheating Technique. Due to Preheating the viscosity of fuel changes and gives better combustion results compaired to Diesel. For this purpose we have design a Preheating Fuel Storage tank (PFST) which is used to keep the fuel little warm below its preheating temperature. The PFST acts as heat exchanger, which exchanges heat from exhaust gases from the engine to fuel. The fuel enters in to the cylinder with little warm so that the pressure and temperature inside the cylinder is little high compared to normal fuel.

Pyrolysis plastic oil (PPO) is used as alternate fuel which is derived from the waste plastic material. Plastic waste material can be converted into liquid fuel by using pyrolysis process. The properties of PPO show the results nearly similar to that of Diesel fuel. The tests were conducted in the single cylinder four stroke variable compression ratio Engine running at various compression ratios. The engine combustion characteristics, performance and exhaust emissions are analysed at various loads by using preheating pyrolysis plastic oil blend (PPPOB) with Diesel and the results were compaired with diesel.

LITERATURE REVIEW

Plastic materials are light in weight, low in cost, do not rust and reusable. Plastic have become essential material in the field of industry. Plastics are produced from several polymers and are composed primarily of hydrocarbons but also contain additives such as antioxidants, colorants, and other stabilizers.

We have studied extensively the cracking nature of HDPE both under catalytic and non- catalytic methods with the application of some important catalysts. The cracking temperature of HDPE was very high. So the process takes place in the batch reactor of closed vessels. The pyrolysis process takes place in these reactors.

Many research persons have done experiments with different alternative fuels in the diesel engines.

Kalargaris and Tian [1] has reviewed in their work the usage of plastic waste is an ideal source of energy due high heating value and it can be converted into oil through the pyrolysis process and used in internal combustion engines to produce power and heat. Nitin et al, [2] has studied the effect of EGR and cotton seed B20 biodiesel blend on internal combustion engine performance and emission characteristics. Use of EGR (4 % and 6 % by volume) increase NOx and reduce the emission of CO and HC. K.J.Samuel et al. [3] has reviewed in his work the usage of preheated crude pongamia oil (CPO) and pongamia methyl ester (PME) and diethyl ether (DEE) biodiesel blends on a diesel engine. Preheating crude pongamia oil reduces its viscosity and increases the performance and emission parameters. Kareddula Vijaya Kumar [4] has reviewed

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in his work the use of plastic oil derived from waste plastic is used in SI engine. The performance and emissions of plastic oil blends at different proportions is compared with the base fuel gasoline in SI engine. 50% Distilled Plastic Pyrolysis Oil (50%DPPO) exhibits the substantial results in brake power, brake thermal efficiency and reduction in brake specific fuel consumption running at full load conditions. S. Ananthakumar et al.[6] was Investigation on waste plastics can be changed over into alternative fuel by pyrolysis which can supplant diesel in CI engine. He demonstrated that compression ratio and specific fuel consumption of mix and waste plastic pyrolysis was increment. Senthilkumar et al. [7] primary points were assessing the performance of bio oil acquired from pyrolysis as fuels in CI engine. He inferred that bio oil acquired diverse seeds can be utilized around 10% by volume as incomplete substitution of diesel by mix was lessening in smoke and NOx emission.

A Murugesan et al. utilized tire pyrolysis oil as an option fuel for diesel engine. He infer that the mix of pyrolysis oil of waste tire TF5, TF10, TF25 and TF35 can utilized as a part of engine with no change. CO, HC, SO2 and smoke emission were higher than the diesel for TF50 and TF75. Prof. R. J. Jani [8] is said in his work that plastic pyrolysis oil is used as a fuel with replacement of diesel. His research shows that the properties of plastic pyrolysis oil is nearly similar to the properties of diesel fuel and the performance of the engine can affects by changing the injection pressure. S. Navya Sree [9] reviewed in his work that waste plastics can be converted into oil by pyrolysis and it can be used as a fuel for internal combustion engine. The performance of the engine is calculated at various variable compression ratios. B. Srikanth [10] has done the experimental work by taking the pyrolysis plastic oil from the industry which is produced in a batch reactor consists of waste plastic materials. The pyrolysis plastic oil is blended with diesel in the ratio of B10, B20, and B30 and the performance characteristics and emissions were compaired with the base fuel. Ravi D Bumtariya and Manish K. Mistry et al [11] has reviewed that plastics from municipal solid waste is collected and is sent to the reactor is maintained at high temperature and high pressures. So that the vapours comes out of the reactor is collected and compared with petroleum products. K. Naima et al.[12] analysed to discover alternative fuel for internal combustion engines. He presumed that Engine could keep running with 100% waste plastic oil. Ignition delay was longer by around 2.5°CA on account of waste plastic oil compared with diesel. NOX is higher by around 25% for waste plastic oil operation than that of diesel operation. CO emission expanded by 5% in waste plastic oil compared with diesel operation. Unburned hydrocarbon emission is higher by around 15%. Engine run with fuel as waste plastic oil shows larger thermal efficiency up to 75% of the evaluated control. Harshal R et al.[13] concluded that the waste plastic pyrolysis oil represent to a good option fuel for diesel and along these lines must be thought about later on for transport reason. Likewise infer that Engine could keep running with 100% waste plastic oil. Engine run with waste plastic oil as fuel shows larger thermal efficiency up to 75% of the rated power. Miskolczi, et al.[14]investigated the pyrolysis of real waste plastics (high-density polyethylene and polypropylene) in a pilot scale horizontal tube reactor at 520 °C temperature in the presence and absence of ZSM-5 catalyst. He also concluded that the plastic wastes could be converted into gasoline and light oil with yields of 20–48% and 17 - 36% respectively depending on the used parameters Murugan et al.[15] led test to assess the performance, combustion and emission qualities of a single cylinder direct injection (DI) diesel engine run with 10%, 30%, and 50% of tire pyrolysis oil (TPO) mixed with diesel fuel (DF). Brake thermal efficiency of the engine expanded with increment in TPO Blend focus than Diesel fuel.

The waste plastic was subjected to various conditions of reactions of thermal cracking and catalytic cracking by using different catalysts.
From the recent literature survey, it is evident that the process of conversion of waste plastic to plastic oil and the preparation of blends of diesel with varying

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proportions. Plastic oil produced from the thermal pyrolysis and the viscosity, density of these blends is measured using various devices. Performance test on a single cylinder Kirlosker diesel engine equipped with electrical loading on the engine.

From the review of literature discussed above, it is clearly observed that many researchers has done experiments on alternate fuels and the optimum blends of diesel by adjusting required parameters of the diesel engine.

The crude waste plastic oil is prepared from the pyrolysis process was carried out the batch distillation apparatus. This distilled plastic oil blended with diesel at different volume fractions and the performance and emission characteristics was carried out on 4stroke single cylinder kerloskar diesel engine without any engine modifications.

INTRODUCTION

In day to day life depletion of fossil fuels gradually increasing due to the necessity of requirement of these fuels increased. The usage of these fuels in industrial and non- industrial purposes is increased. In the world the population growth is also increased and their usage of fossil fuels increased. Hence scarcity of fossil fuel occurs, and the demand for the fossil fuels gradually increasing. Therefore the price of fossil fuels is randomly increasing. In order to control this, there is necessity to reduce the usage of these fossil fuels. Reduce the usage of fossil fuels that occurs by replacing with alternate fuels.

Alternate fuels are the natural fuels that are derived from the natural resources that are available on the earth.

VARIOUS ALTERNATIVE FUELS:

1. SOLID FUEL 2. LIQUID FUEL and 3. GASEOUS FUELS

SOLID FUEL:

Solid fuels refer to solid material that is used as fuel for the production of energy. Energy is released after combustion of fuel by providing external heat. Solid fuels are not suitable for the internal combustion engines.

CHARCOAL:

Charcoal is one of the important solid fuel is used for the combustion process. It can be produced from the thermo-chemical transformation of biomass in the absence of oxygen (pyrolysis). The charcoal produced from this processes is used as fuel for the combustion due to its lower heating value and high release of energy.

WOOD:

Wood is the first energy source used by the mankind in the form of cut logs, wood chips etc. It is used as fuel for the production of heat energy and it has low ash content and sulphur content.

LIQUID FUELS:

ETHANOL:

Ethanol is an alcohol – based fuel which is produced from the fermentation and distilling crops such as corn, barley or wheat and sugar cane.

BIODIESEL:

Biodiesel is an alternative fuel which is produced from vegetable oils and animal fats or algae by transesterification process. Biodiesels is used in boilers as a heating fuel source. During the transesterification process, the by-product formed is glycerol; 100 kg of glycerol is produced with production of 1 ton of biodiesel. Biodiesel is safe, reduces air pollution associated with the emission of vehicles, such as particulate matter, hydro carbons and carbon monoxide.

GASEOUS FUELS:

NATURAL GAS:

Natural gas is a fuel that is obtained from oil refineries that occurs naturally. Natural gas contains 65% methane and small amounts of ethane and hydrocarbon. Natural gas operating engine consists of a lean air fuel mixture.

HYDROGEN:

In CI engine hydrogen can be directly used and can be mixed with natural gas, CNG and LPG etc. Hydrogen is produced from fossil fuel that is available renewable energy sources. 1 kg of

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hydrogen contains approximately same energy as 1 gallon of gasoline. Hydrogen is compressed at very low temperature in a pressure vessel. Hence great care is required.

BIOGAS:

Biogas is produced from the anaerobic digestion of an organic matter, which consists of cow dung, plants and municipal wastes etc. Biogas consists of methane and carbon dioxide.

ENERGY CONVERSION FROM WASTE:

Energy from waste can be produced from direct combustion, pyrolysis, gasification and fermentation etc. Energy from waste is a potential method to produce useful amount of energy. Plastic oil has low heating value and low sulphur content than that of diesel and the blends of plastic oil and diesel can be used directly in IC engine. The various methods have done on conversion of waste plastics to liquid based fuels.

PYROLYSIS PROCESSES:

Pyrolysis is a process of conversion of thermo-chemical transformation of materials in the absence of oxygen.

PYROLYSIS PLASTIC OIL:

A plastic consists of long hydrocarbon chains. Plastic oil is produced by liquefying in the absence of oxygen in tubular continuous reactor. The plastic oil blend and diesel can be used in the diesel engines directly without any modification. The efficiency of the engine increases with the pyrolysis plastic fuel and its blend with diesel.

PLASTIC:

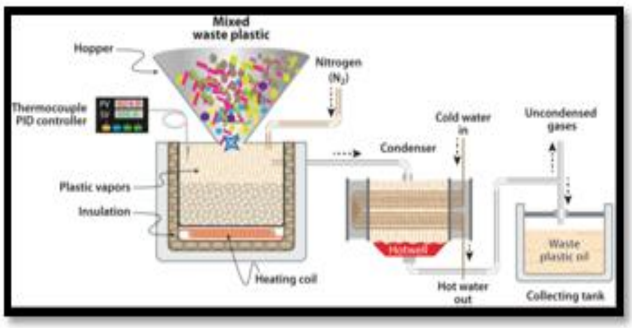
The word plastic is derived from the Greek (plastikos) meaning "capable of being shaped or molded", from (plastos) meaning "molded". Plastics are the synthetic organic materials produced from the polymerization of materials, they are typically high molecular mass and the other polymers improve performance. Plastics are ‘‘one of the greatest innovations of the millennium’’. Plastic material is lightweight, does not rust or rot, low cost, reusable and conserves natural resources. Hence it is the reason for which plastic has gained this much popularity.

WASTE PLASTICS AND THEIR TYPE OF PRODUCTION:

S.No	Type	Recyclable	Abbreviation	Description & Common Uses
1	Type 1	Yes	PET	Polyethylene Terephthalate Beverages.
2	Type 2	Yes	HDPE	High-Density Polyethylene Milk, detergent & oil bottles, toys, containers used outside, parts and Plastic bags.
3	Type 3	Yes, But not common	PVC	Vinyl/Polyvinyl Chloride Food wrap, vegetable oil bottles, blister packages or automotive parts.
4	Type 4	Yes	LDPE	Low Density Polyethylene, Many plastic bags, shrink-wraps, garment Bags or containers.
5	Type 5	Yes	PP	Poly Propylene. Refrigerated containers, some bags, most bottle tops, some carpets, and Some food wrap.
6	Type 6	Yes, But not common	PS	Polystyrenes. Through away utensils, meat packing, protective packing.
7	Type 7	Some	--------------	Other. Usually layered or mixed plastic.

PYROLYSIS PLASTIC FUEL CONVERSION FROM WASTE PLASTIC MATERIAL:

The production method for the conversion of plastics to liquid fuel is based on the pyrolysis of the plastics and the condensation of the resulting hydrocarbons. Pyrolysis refers to the thermal decomposition of the matter under an inert gas like nitrogen. For the production process of liquid fuel, the plastics that are suitable for the conversion are introduced into a reactor where they will decompose at 450°C to 550°C.



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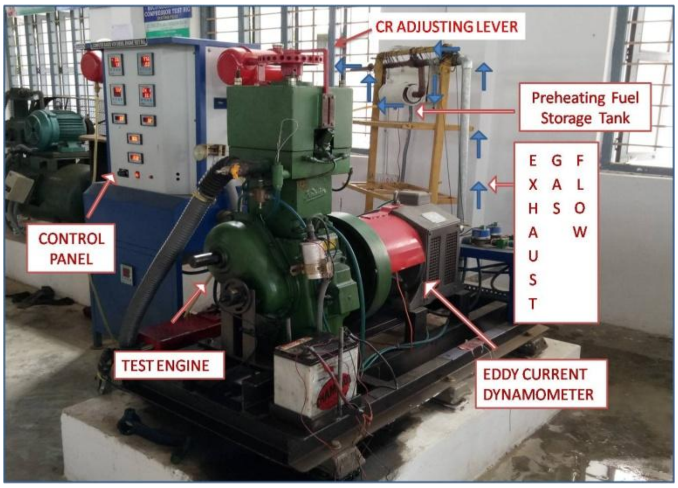
SCHEMATIC LINE DIAGRAM OF PYROLYSIS PLASTIC OIL EXTRACTION UNIT.

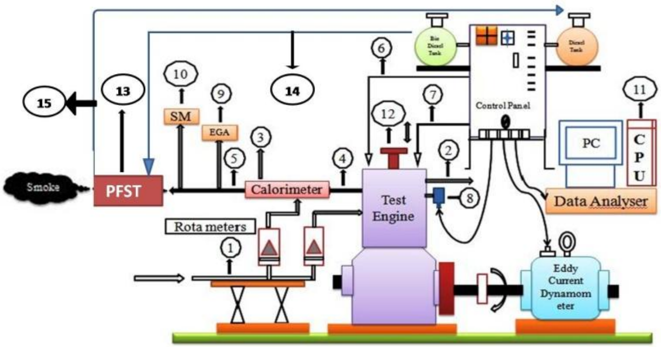
PROPERTIES OF FUELS:

SL. NO	PROPERTY	DIESEL PROPERTIES	PYROLYSIS PLASTIC OIL Blend with Diesel
1	CALORIFIC VALUE	43,200 kJ/kg	42,636 kJ/kg
2	FLASH POINT	51	48
3	FIRE POINT	59	54
4	POUR POINT	3 to 7	Above -2
5	CARBON RESIDUE	0.20% wt	0.001% wt
6	SULPHUR CONTENT %	<0.032	<0.002
7	DENSITY	0.824 gm/cc	0.798 gm/cc
8	KINEMATIC VISCOCITY 30 (cst)	1.2 to 3	2.147
9	CETANE NUMBER	55	52
10	ASH CONTENT (%)	0.043	<1.01% wt

EXPERIMENTAL SETUP:

The experimental is carried out on the computerized variable compression ratio multi fuel direct injection water cooled (MFVCR) engine. The experiment is done at variable compression ratio of the engine. Initially we have done the base line test with diesel, and then diesel blends with PPO. After that we have to done the test with preheating fuels. Now compare the obtained combustion, performance, emission values with base line values. For preheating purpose a preheating fuel storage tank (PFST) is designed. PFST acts as a heat exchanger, which exchanges partial heat from the exhaust gases which comes out from the engine after the combustion to fuel that is passed through the device





Schematic Line Diagram of Experimental setup.

LAYOUT:

1. Water inlet to the Rotameter and Engine.
2. Air inlet to the engine.
3. Calorimeter.
4. Exhaust gas pipe from Engine to Calorimeter.
5. Exhaust gas pipe connected to calorimeter to Exhaust Gas Analyser (EGA).
6. Fuel inlet Pipe to the Fuel pump of the Engine.
7. Thermocouple to measure the temperature.
8. Combustion sensor to measure pressure.
9. Exhaust gas analyser.
10. Smoke Meter.
11. Central processing unit (CPU).
12. Compression ratio adjustment lever.
13. Preheating Fuel storage tank (PFST).
14. Fuel pipe to the PFST.
15. Fuel pipe from PFST to the fuel tank of engine.

DETAILS OF TEST RIG AND IT'S SPECIFICATIONS:

The MFVCR engine test rig is a computer based analysis engine by using different sensors and thermocouples. The sensors are used in the present test rig that are used to find the speed, torque, fuel consumption etc… 6 thermocouples are used in the test rig to measure the temperature at various points.

ENGINE SPECIFICATIONS:

- Engine: 4 stroke computerized variable compression ratio multi fuel direct injection water cooled engine
- Make: TECH-ED

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- Basic engine: Kirloskar
- Rated power: 5 HP (DIESEL)
- Rated power: Up to 3 HP (PETROL)
- Stroke length: 110mm
- Connecting rod length: 234mm
- Swept volume: 551cc
- Bore diameter: 80mm
- Rated speed: 1500 rpm
- Compression ratio: 5:1 to 20:1

During the running of the engine the performance analysis is done with different flow rates at various loads. The emission analysis is done by using INDUS SIX GAS SMOKE ANALYZER & SMOKE METER. The six gas smoke analyser gives the percentage of CO (carbon monoxide) ,NOx (nitrogen oxide), SOx (sulphur oxide), oxygen (O2), carbon dioxide (CO2), HC(hydro carbons) and smoke meter will gives the amount of smoke coming from the engine.

In the present project we have used Multi Fuel Variable Compression (MFVCR) Engine. The total test rig is accumulated with sensors to know the required values from the experiment. The test is integrated with sensors to know the properties like Temperature, Fuel consumption, Pressure, Heat release, Water flow, Air flow etc…

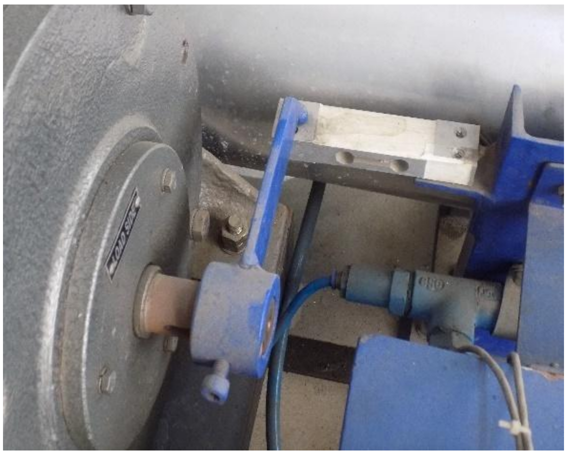
SENSORS:

The complete MFVCR engine is completely integrated with sensors to know the different characteristics during running of the engine. Sensor is an electronic device that senses the anything and converts that into electric signal form. The following are the sensors that are used in the present test rig.

- Torque measuring sensor.
- Speed measuring sensor (tachometer).
- Thermocouples.
- Combustion sensor.
- Fuel consumption measuring sensor.
- Water flow measuring sensor.

TORQUE MEASURING SENSOR:

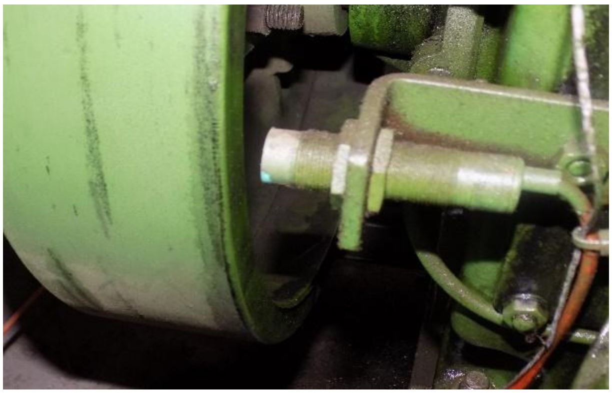
Torque sensor is an electronic device that converts torque with respect to the load application into the digital form by using electric current.



TORQUE MEASURING SENSOR

SPEED MEASURING SENSOR:

Speed sensor is an electronic device that converts speed of the engine into digital form. The speed sensor is placed near the flywheel, based on the fly wheel revolutions it will convert that into digital form. By using this sensor no need any manual speed measuring devices like tachometer etc.



SPEED MEASURING SENSOR

THERMOCOUPLES:

Thermocouples are the electronic devices that convert heat energy into digital form. The thermocouple is worked on the principle of SEEBECK effect. In the present test rig 6 thermocouples are used for measuring required temperatures.

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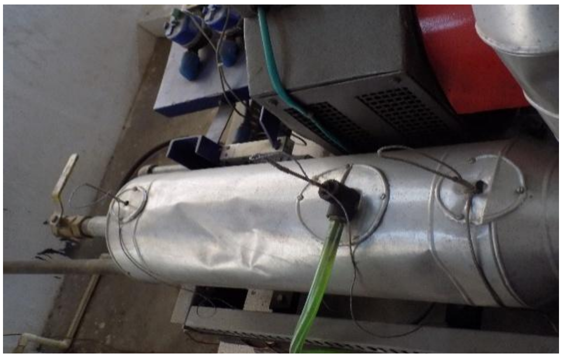


THERMOCOUPLES

T_1= INLET WATER TEMPERATURE TO ENGINE

T_2= OUTLET WATER TEMPERATURE OF THE ENGINE

T_3= INLET WATER TEMPERATURE TO THE CALORIMETER

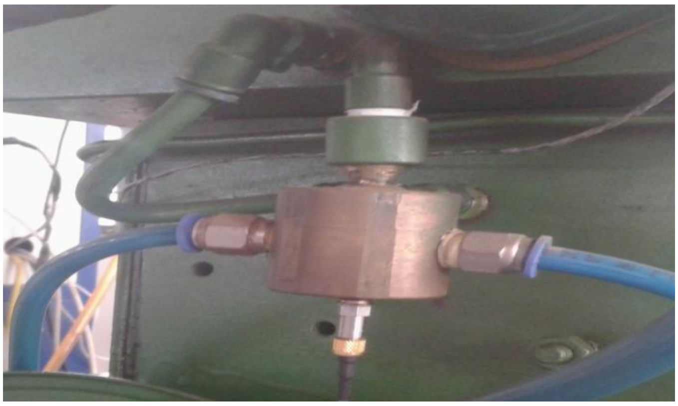
T_4= EXHAUST GAS TEMPERATURE BEFORE CALORIMETER

T_5= EXHAUST GAS TEMPERATURE AFTER CALORIMETER

T_6= AMBIENT AIR TEMPERATURE

COMBUSTION SENSOR:

Combustion sensor is the one of the heart part of our test rig. The combustion test rig is used to find the pressure variation, heat release rate at inside the combustion chamber. This sensor will give the required values at each and every crank angle.



COMBUSTION SENSOR

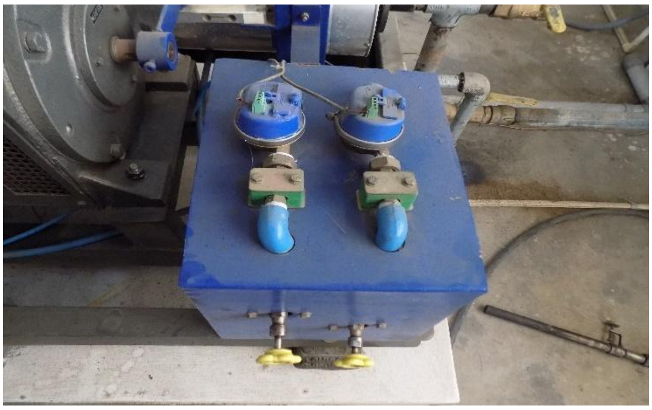
FUEL CONSUMPTION MEASURING SENSOR:

Fuel consumption measuring sensor is a device that will gives the readings BSFC (break specific fuel consumption), ISFC (indicated specific fuel consumption).

FUEL CONSUMPTION MEASURING SENSOR

WATER FLOW MEASURING SENSOR:

Water flow measuring sensor is an electronic device that convert flow of the water into digital form. This sensor will measures the water into the engine water jacket and water flow in calorimeter.



WATER FLOW MEASURING SENSOR

APPARATUS REQUIRED FOR EMISSION ANALYSIS:

The emission analysis is done by using **INDUS SIX GAS SMOKE ANALYZER & SMOKE METER.**

INDUS SIX GAS SMOKE ANALYSER:

The six gas smoke analyser gives the percentage of CO (Carbon monoxide), NOx (nitrogen oxide), SOx (sulphur oxide), oxygen (O2), Carbon dioxide (CO2), HC (hydro carbons) and smoke meter will gives the amount of smoke coming from the engine.

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INDUS SIX GAS SMOKE ANALYSER

SMOKE METER:

Smoke meter will gives the intensity of smoke coming from the engine.

SMOKE METER

PERFORMANCE CHARACTERISTICS:

INDICATED THERMAL EFFICIENCY (H_T):

Indicated thermal efficiency is the ratio of energy in the indicated power to the fuel energy.

$$\eta_t = \text{Indicated Power / Fuel Energy}$$

$$\eta_t\,(\%) = \frac{\text{IndicatedPower (KW)} \times 3600}{\text{FuelFlow (Kg / Hr)} \times \text{CalorificValue (KJ/Kg)}}\ \text{X}\ 100$$

BRAKE THERMAL EFFICIENCY (H_{BTH}):

Brake thermal efficiency is the ratio of energy in the brake power to the fuel energy.

$$\eta_{bth}\,(\%) = \frac{\text{BrakePower (KW)} \times 3600}{\text{FuelFlow (Kg / Hr)} \times \text{CalorificValue (KJ / Kg)}}\ \text{X}\ 100$$

MECHANICAL EFFICIENCY (H_M):

Mechanical efficiency is the ratio of brake horse power (delivered power) to the indicated horsepower (power provided to the piston).

$$\eta_m = \text{Brake Power / Indicated Power}$$

Frictional power = Indicated power – Brake power.

VOLUMETRIC EFFICIENCY (H_V):

The engine output is limited by the maximum amount of air that can be taken in during the suction stroke, because only a certain amount of fuel can be burned effectively with a given quantity of air.

Volumetric efficiency is defined as the ratio of the air actually induced at ambient conditions to the swept volume of the engine.

$$\eta_v\,(\%) = \frac{\text{Mass of air consumed}}{\text{Mass of flow of air to fill swept volume at atmospheric conditions}}$$

$$\eta_v = \frac{\text{AirFlow (Kg / Hr)}}{\frac{\pi}{4}\,\text{X}\,D^2L(m^3)\,\text{X}\,\frac{N\,(RPM)}{n}\,\text{X}60}\ \text{X}\ 100$$

Where n= 1 for 2 stroke engine and n= 2 for 4 stroke engine.

SPECIFIC FUEL CONSUMPTION (SFC):

Brake specific fuel consumption and indicated specific fuel consumption, abbreviated BSFC and ISFC, are the fuel consumptions on the basis of Brake power and Indicated power respectively.

MEAN EFFECTIVE PRESSURE AND TORQUE:

Mean effective pressure is defined as a hypothetical pressure, which is thought to be acting on the piston throughout the power stroke.

Power in kW = (P_m LAN/n X100)/60 in bar where P_m = mean effective pressure

L = length of the stroke in m

A = area of the piston in m^2

N = Rotational speed of engine RPM

n= number of revolutions required to complete one engine cycle

n= 1 (for two stroke engine) n= 2 (for four stroke engine)

Thus we can see that for a given engine the power output can be measured in terms of mean effective pressure. If the mean effective pressure is based on brake power it is called brake mean effective pressure (BMEP) and if based on indicated power it is called indicated mean effective pressure (IMEP).

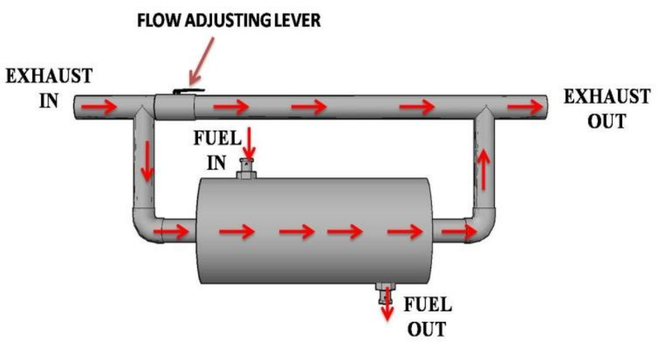
$$\text{BMEP (bar)} = \frac{\text{Brake Power (KW)X60}}{\text{LXAX}\left(\frac{N}{n}\right)\text{XNo of cyl}}$$

$$\text{IMEP (bar)} = \frac{\text{IndicatedPower (KW)}\times 60}{\text{LXAX}\left(\frac{N}{n}\right)\text{XNo of cyl}}$$

Friction means effective pressure (FMEP) can be defined as FMEP= IMEP – BMEP

DESIGN OF PREHEATING FUEL STORAGE TANK:

The exhaust gases from the engine is passed through the copper tubes, so that the heat from the exhaust gases exchanges the partial heat to the fuel in the shell which is surrounded by the copper tubes. Initially the fuel in the tank is passed through the PFST and then to the diesel tank and then to the engine.



PREHEATING FUEL STORAGE TANK

Design specifications:

Outer shell diameter (D_o) = 101.6 mm Inner shell diameter (D_i) = 93 mm.
Outer tube diameter (d_o) = 7.94mm. Inner tube diameter (d_i) = 6.94.
Length of copper tube (l) = 228 mm. Length of shell (L) = 279.4 mm.
Cross sectional area of the shell is (A_S) = 7760.718 mm^2. No .of tubes (n) = 7.
Capacity or volume of tank (V) = 1.76 lit. Area of tube (A_T) = 49.514 mm^2.

EXHAUST GAS ANALYSIS:

CALORIFIC VALUE OF DIESEL = 43200 KJ/Kg.
Coefficient of discharge C_d = 0.62.
Specific heat of exhaust gases = 1.063nKJ/Kg.
Density of air (ρ_a) = 1.225 Kg/m^3.
Density of water (ρ_w) = 1000 Kg/m^3.
Density of diesel (ρ_d) = 0.82 Kg/m^3.
Volume flow rate of air (V_a) =20.5 m^3/hr = 5.694x10^{-3} m^3/s.
Mass flow rate of air (M_a) = density of air x volume flow rate of air.
= 6.975x10^{-3} Kg/s.
Mass of exhaust gases (M_{Eg}) = mass of air + mass of fuel
= 7.266x10^{-3} Kg/s.
Heat energy at exhaust gases (Q_{eg}) = M_{eg} x C_{peg} x(T_{eg}-T_{amb}).
= 1982 watts = 1.982 KW.
Gas flow through one tube = volume flow rate / no of tubes = 8.134x10^{-4} m^3/s.
Velocity of gas in one tube = Gas flow through one tube/ Area of tube = 16.54 m/s.
Fuel inlet temperature = 30°c.
Fuel outlet temperature = 37.5°c.

EXPERIMENTATION AND TABULATION OF RESULTS

Initially the experiments were conducted using diesel at constant speed in the multifueled variable compression ratio engine. The tests were conducted at the compression ratio 16.5 and the results are tabulated by varying the loads on the engine. Smoke meter and gas analyzer is adjusted the engine to calculate the emission parameters.

Sl.No.	LOAD (%)	BP (kW)	IP (kW)	FP (kW)	BSFC (kg/kWh)	BMEP (bar)	IMEP (bar)	SV (m3/h)	VE (%)	BThE (%)	IThE (%)	ME (%)
1	0	0.39	2.11	1.72	0.84	1.0	3.07	25.2	87.31	10.1	54.8	18.4
2	20	0.76	2.49	1.73	0.72	1.1	3.57	25.08	85.33	11.84	38.61	30.66
3	40	1.47	2.99	1.52	0.46	2.12	4.32	24.91	84.69	18.5	37.67	49.11
4	60	2.06	3.21	1.15	0.39	2.99	4.67	24.78	83.93	21.85	34.11	64.07
5	80	2.76	3.63	0.88	0.38	4.04	5.32	24.58	83.39	22.24	29.32	75.83
6	100	3.49	4.13	0.65	0.33	5.14	6.09	24.43	81.45	26.06	30.88	84.4

EXPERIMENTAL PERFORMANCE OF BASE FUEL (DIESEL):

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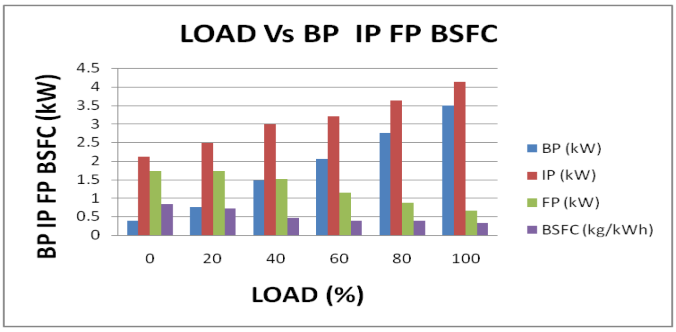
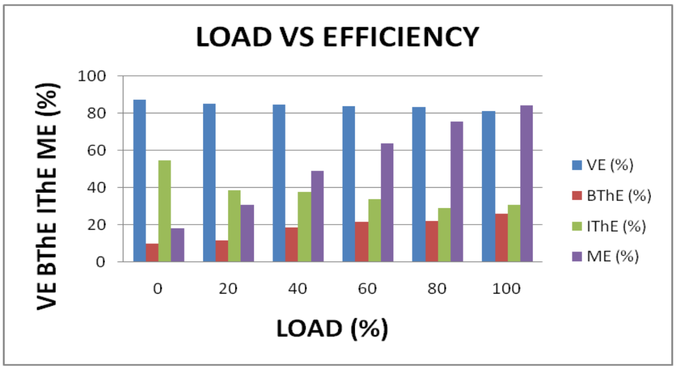
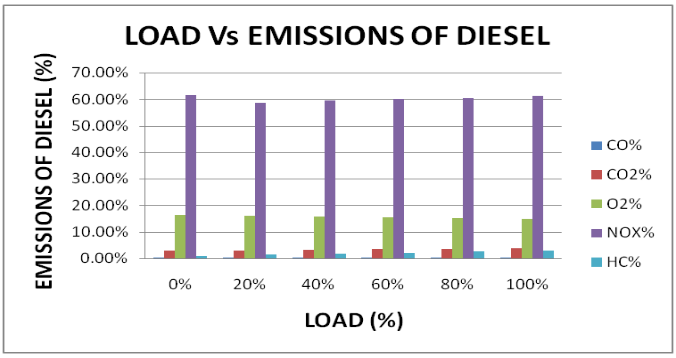
GRAPHS:



GRAPH OF LOAD VS BP, IP, FP, BSFC GRAPH OF DIESEL.



GRAPH OF LOAD VS PERFORMANCE OF DIESEL.

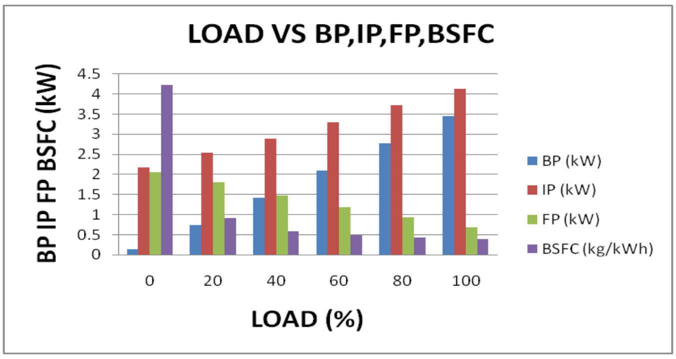


GRAPH OF LOAD VS EMISSION OF DIESEL.

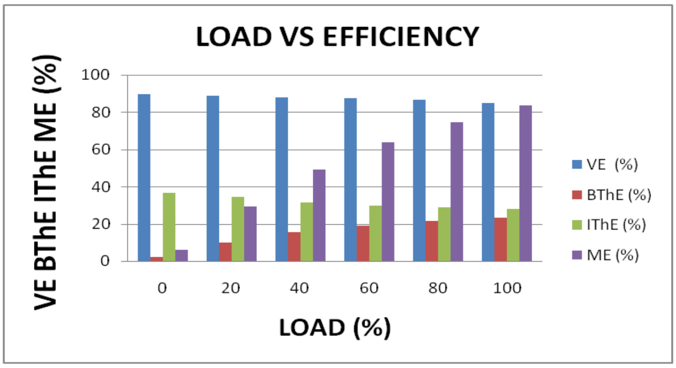
Sl. No.	LOAD (%)	BP (kW)	IP (kW)	FP (kW)	BSFC (kg/kWh)	BMEP (bar)	IMEP (bar)	SV (m3/h)	VE (%)	BThE (%)	IThE (%)	ME (%)
1	0	0.13	2.18	2.05	1.43	0.18	3.1	25.33	89.62	2.17	36.44	5.95
2	20	0.74	2.55	1.81	0.91	1.06	3.64	25.16	88.62	10.09	34.64	29.12
3	40	1.42	2.89	1.47	0.59	2.05	4.17	24.96	88.13	15.43	31.42	49.11
4	60	2.1	3.29	1.19	0.48	3.04	4.77	24.83	87.39	19	29.83	63.69
5	80	2.77	3.72	0.94	0.42	4.05	5.43	24.67	86.76	21.55	28.89	74.59
6	100	3.46	4.13	0.68	0.39	5.08	6.08	24.47	85.01	23.49	28.1	83.6

EXPERIMENTAL PERFORMANCE OF PREHEATING PYROLYSIS PLASTIC OIL BLEND (DIESEL 75% AND PPO 25%) AT CR 16.5.

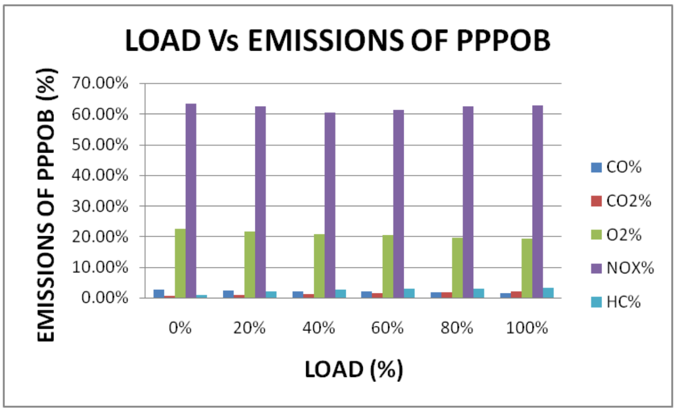
GRAPHS:



Graph of Load Vs BP, IP, FP, BSFC OF PPPOB



Graph of Load Vs Performance of PPPOB.



Graph of Load Vs Emission of Preheating Pyrolysis Plastic Oil Blend

Sl.No.	LOAD (%)	BP (kW)	IP (kW)	FP (kW)	BSFC (kg/kWh)	BMEP (bar)	IMEP (bar)	SV (m3/h)	VE (%)	BThE (%)	IThE (%)	ME (%)
1	0	0.361	2.34	1.98	1.3	0.8	3.32	25.33	85.67	5.9	38.48	15.4
2	20	0.74	2.7	1.97	0.8	1.05	3.86	25.2	84.93	10.61	38.95	27.24
3	40	1.4	3	1.6	0.45	2.02	4.32	25.01	84.35	18.88	40.39	46.73
4	60	2.12	3.5	1.39	0.4	3.06	5.07	24.86	82.45	21.34	35.3	60.44
5	80	2.72	3.78	1.06	0.35	3.97	5.51	24.72	82.94	23.89	33.15	72.07
6	100	3.49	4.27	0.78	0.34	5.13	6.27	24.52	81.17	25.15	30.74	81.81

Experimental Performance of Preheating Pyrolysis plastic Oil Blend (Diesel 75% and PPO 25%) at CR 17.5.

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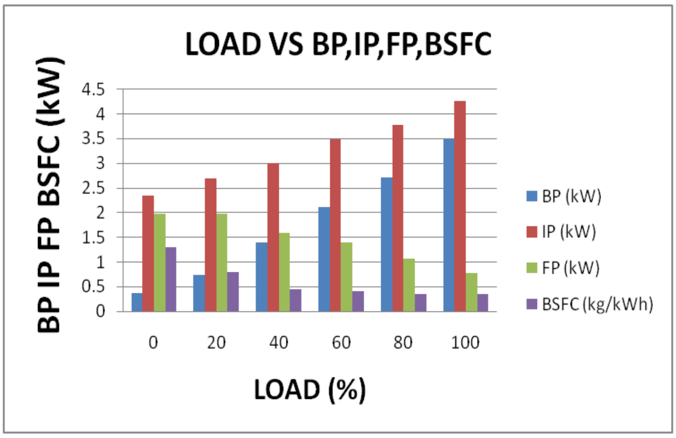
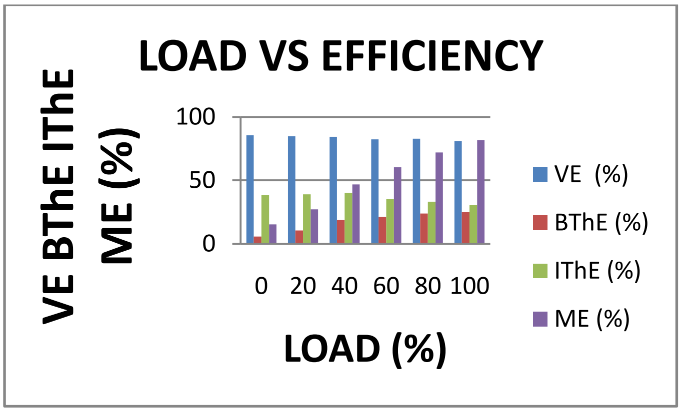
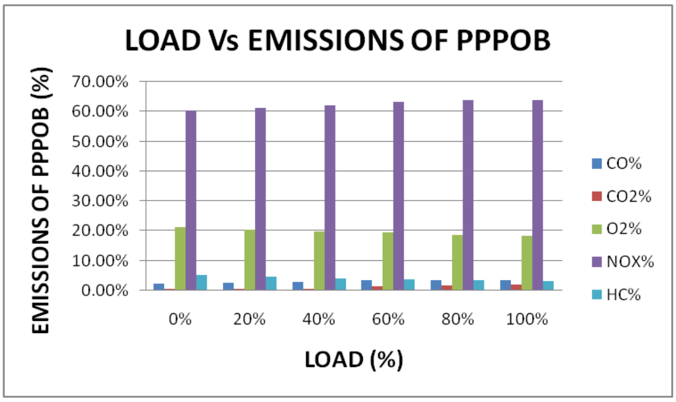


Graph of Load Vs BP, IP, FP, BSFC of PPPOB



GRAPH OF LOAD VS PERFORMANCE OF PPPOB.

Experimental Observation of Exhaust Gases for Preheating Pyrolysis Plastic Oil Blend (PPPOB) at CR 17.5:



GRAPH OF LOAD VS EMISSIONS OF PREHEATING PYROLYSIS PLASTIC OIL BLEND AT CR 17.5.

MODEL CALCULATIONS AT MAXIMUM LOAD (load at 80 %):

1. BRAKE POWER in KW (BP) :
   BP= (2πNT)/ (60 X 1000)
   N= 1482 rpm, T= 17.76 N-M
   BP = (2 x π x 1482 x 17.76) / 60000 = 2.756 KW
2. INDICATED POWER in KW (IP) :
   IP= $P_m$lan/60
   IP= (532 x 0.11x5.026x10^3x1482) / (2x60)
   IP=3.63 KW.
3. FRICTION POWER (FP):
   FP = IP-BP
   FP = 3.63-2.76 = 0.87 KW.
4. BRAKE SPECIFIC FUEL CONSUMPTION (BSFC):
   BSFC = MFC / BP
   = 1.05/2.76 = 0.38 kg/kw hr.
5. INDICATED SPECIFIC FUEL CONSUMPTION (ISFC):
   ISFC = MFC / IP
   =1.05/3.63 = 0.099 kg/kw hr.
6. BRAKE THERMAL EFFICIENCY (B.ThE):
   B.ThE = (BP X 3600 X 100) / (MFC X CV)
   = (2.76 X 3600 X 100) / (1.05 X 42,000) = 22.5 %.
7. INDICATED THERMAL EFFICIENCY (I.ThE):
   I.ThE = (IP X 3600 X 100) / (MFC X CV)
   = (3.63 X 3600 X 100) / (1.05 X 42,000) = 29.63 %
8. MECHANICAL EFFICIENCY (ME):
   ME = (BP/IP) X 100
   = (2.76/3.63) X 100 = 76 %
9. HEAT INPUT = (MFC X CV) / 3600
   = (1.05 X 42000) / 3600 = 12.25 KW.

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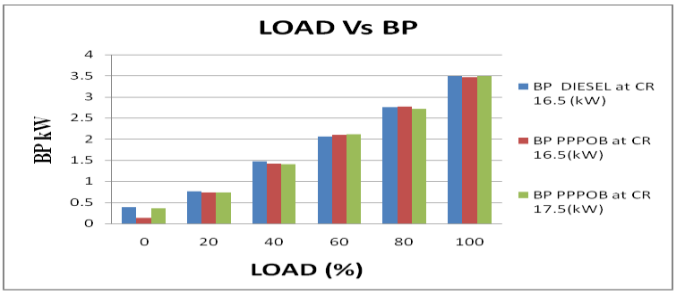
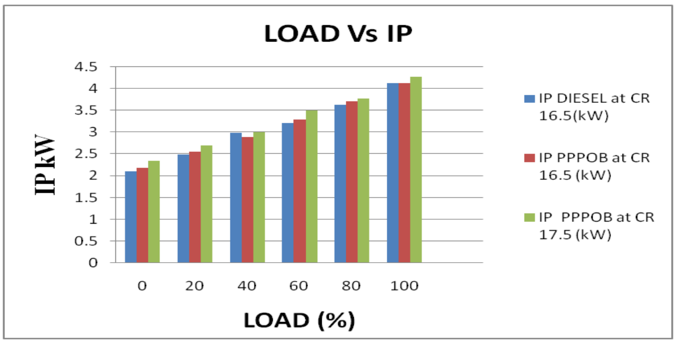
RESULTS AND DISCUSSION

The experiments were conducted on the computerised variable compression ratio four stroke single cylinder water cooled engine with eddy current dynamometer. The engine running at constant speed of nearly 1500 rpm .The performance tests conducted on the engine with the Diesel, Pyrolysis plastic oil blends and the characteristics of brake power, indicated power, friction power, mechanical efficiency, brake thermal efficiency, indicated thermal efficiency and volumetric efficiency etc., are to be observed.

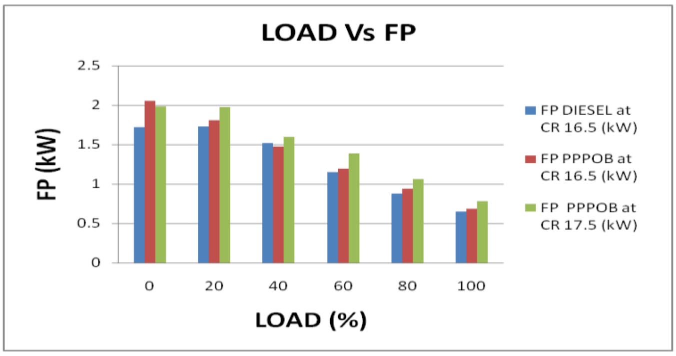
The following graphs give variation of performance of the engine running on diesel, PPPOB at CR 16.5 and PPPOB at CR 17.5.



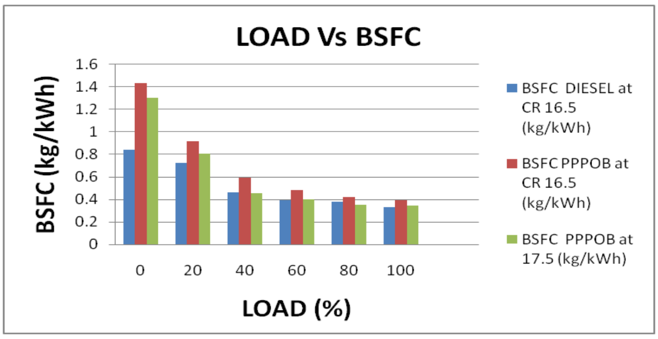
GRAPH OF LOAD VS BRAKE POWER



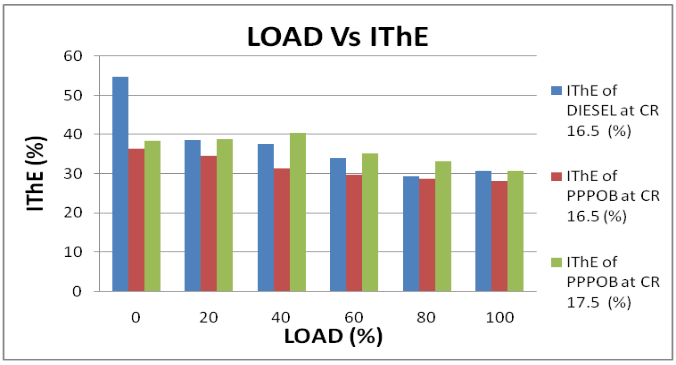
GRAPH OF LOAD VS INDICATED POWER



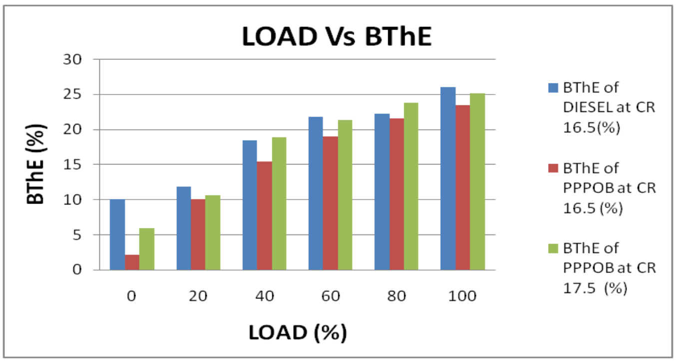
GRAPH OF LOAD VS FRICTION POWER.



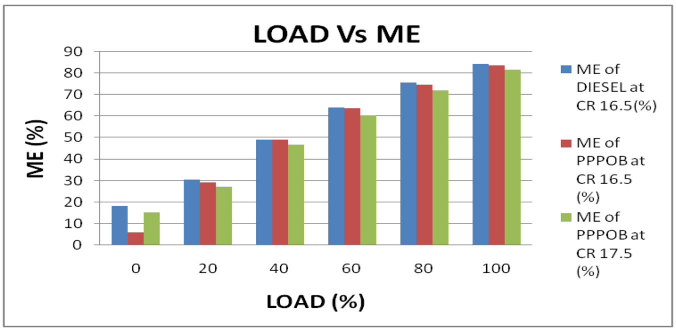
GRAPH OF LOAD VS BRAKE SPECIFIC FUEL CONSUMPTION.



GRAPH OF LOAD VS INDICATED THERMAL EFFICIENCY.



GRAPH OF LOAD VS BRAKE THERMAL EFFICIENCY.



GRAPH OF LOAD VS MECHANICAL EFFICIENCY.

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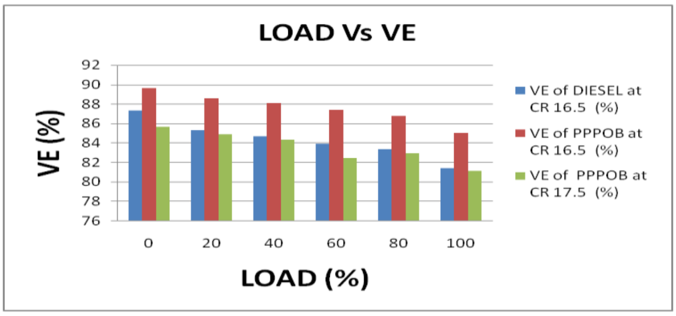
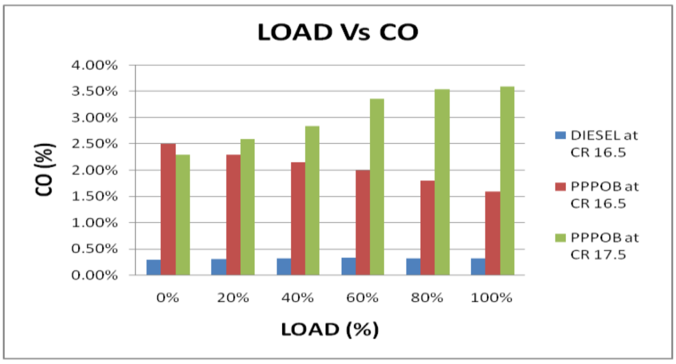
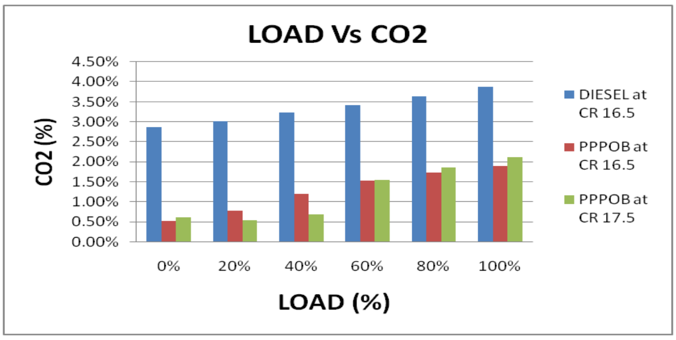


GRAPH OF LOAD VS VOLUMETRIC EFFICIENCY.

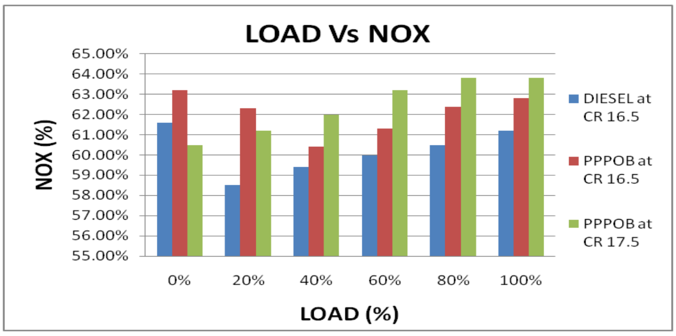
The following graphs give variation of emissions of the engine running on diesel, PPPOB at CR 16.5 and PPPOB at CR 17.5.



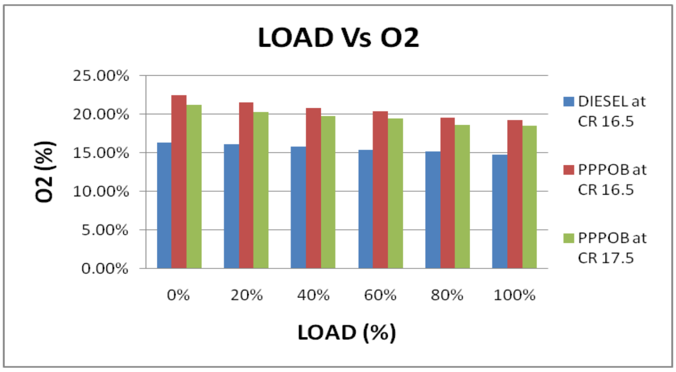
GRAPH OF LOAD VS CARBON MONOXIDE



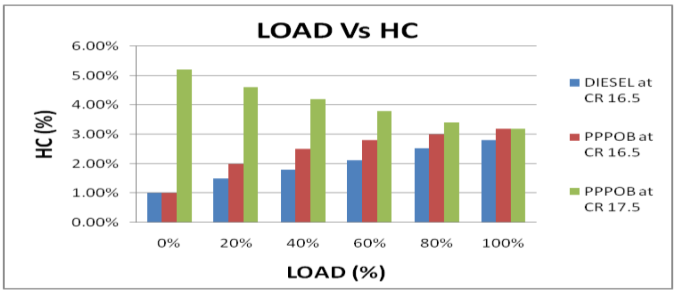
GRAPH OF LOAD VS CARBON DIOXIDE



GRAPH OF LOAD VS NITROGEN OXIDES



GRAPH OF LOAD VS OXYGEN



GRAPH OF LOAD VS HYDRO CARBON.

From the graphs we can observe that the performance parameters slightly changed initially and remains uniform when compaired to the base fuel. Brake specific fuel consumption is reduced slightly compaired diesel and brake thermal efficiency is high at CR 17.5 and nearly similar at CR 16.5 compaired to diesel.

The emission parameters of CO increases with the base fuel.

CO2 emission is reduced with the base fuel and O2 emissions slightly increase as compared to base fuel.

NOx emissions are increases more compared to the base fuel.

CONCLUSION AND FUTURE SCOPE

The properties of fuel pyrolysis plastic oil that is density, flash point, fire point, kinematic viscosity were tested and the flash point, fire point and calorific values are less compaired to diesel. Brake thermal efficiency increases slightly, and indicated thermal efficiency and mechanical efficiency is slightly decreases with preheating pyrolysis plastic oil blend when compared to the diesel.

The emissions of CO increased and CO2 decreased with PPPO and NOx increases when compared to diesel.

Future scope:

In the present investigation the performance and emission are evaluated at constant operating parameters such as speed, injection timing and injection pressure.
In the future work, the investigation will be carried out by changing the operating parameters like injection pressure, compression ratios and various types of blends, so that the performance and emission parameters of the engine will be enhanced and to protect the environment.

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