ISSN 2310-4090

International Journal of Scientific Footprints Open Access

An Investigation of Performance and Emission Characteristic of Bio Diesel Additive Blends

Raju, N. S.[1] and Suchith, K. M.T.[2]

[1]M.Tech, Student Mechanical department AIT Chikmagalura Karnataka India
[2]Asst Professor, Mechanical department AIT Chikmagalura Karnataka India

Keywords:
Diesel engine; Biodiesel; Calophyllum Inophyllum Methyl Ester; Ethanol Additive.

Correspondence:
Raju N. S. M.Tech, student Mechanical department AIT Chikmagalura Karnataka India.
E-mail: rajugowda8@gmail.com

Funding Information:
No funding information provided.

Received:
June 2014; Accepted: July 2014

International Journal of Scientific Footprints 2014; 2(3): 46–62

Abstract

Petroleum sourced fuels is now widely known as non-renewable due to fossil fuel depletion and environmental degradation. Renewable, carbon neutral, transport fuels are necessary for environmental and economic sustainability. Biodiesel derived from oil crops is a potential renewable and carbon neutral alternative to petroleum fuels. Chemically, biodiesel is mono alkyl esters of long chain fatty acids derived from renewable feed stock like vegetable oils and animal fats. It is produced by trans-esterification in which, oil or fat is reacted with a monohydric alcohol in presence of a catalyst. The process of trans-esterification is affected by the mode of reaction condition, molar ratio of alcohol to oil, type of alcohol, type and amount of catalysts, reaction time and temperature and purity of reactants. We conducted the experiment for varying the injection pressure and the plunger diameter of the feed pump. In present work, calophyllum innophyllum seeds are used to produce biodiesel. In trans-esterification process, methanol and NaOH is used. The different blending of biodiesel, diesel and ethanol is tested in CI engine and also emission characteristics are studied. Further, additive ethanol is also used.

The main objective of this work is to study the effect of the fuel injection pressure on performance and pollution of the single cylinder diesel engine at different plunger diameter. From experiment it is found that engine at 9mm plunger dia at 200 bars has given efficient performance and less pollution.

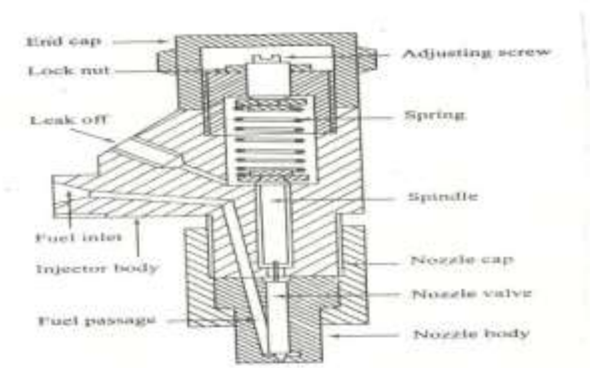
Introduction

Diesel engine plays a dominant role in the field of power, propulsion and energy. The diesel engine is a type of internal combustion engine ,more specifically it is a compression ignition engine ,in which the fuel ignited solely by the high temperature created by compression of the air-fuel mixture. The engine operates using the diesel cycle. The engine is more efficient than the petrol engine, since the spark ignition engine consumes more fuel than the compression –ignition engine. The fuel injection system is the most vital component in the working of CI engine. The engine performance, power output, economy etc. is greatly dependent on the effectiveness of the fuel injection system. The injection system has to perform the important duty of initiating and controlling the combustion process. When the fuel is injected in to the combustion chamber towards the end of compression stroke, it is atomized into very fine droplets. These droplets vaporize due to heat transfer from the compressed air and from an air-fuel mixture. Due to continued heat transfer from hot air to the fuel, the temperature reaches a value higher than its self- ignition temperature. This causes the fuel to ignite spontaneously initiating the combustion process. Quick and complete combustion is ensured by a well-designed fuel injector. By atomizing the fuel into very fine droplets, it increases the surface area of the fuel droplets resulting in better mixing and subsequent combustion. Atomization is done by forcing the fuel through a small orifice under high pressure. The injector assembly consists of;

1. A needle valve;
2. A compression spring;
3. A nozzle and,
4. An injector body

When the fuel is supplied by the injection pump it exerts sufficient force against the spring to lift the nozzle valve, fuel is sprayed into the combustion chamber in a finely atomized particles. After fuel from the delivery pump gets exhausted; the spring pressure pushes the nozzle-valve back on its seat. In present diesel engines, fuel injection systems have designed to obtain higher injection pressure. So, it is aimed to decrease the exhaust emissions by increasing efficiency of diesel engines. When fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase .This situation leads to increased pressure and the engine performance will decrease. When injection pressure increases fuel particle diameters will become small. Since the mixing of fuel and air becomes better during ignition period. Engine performance will increase if injection pressure is too high, ignition delay period becomes shorter. The fuel injection system must be able to meter the desired amount of fuel, depending on engine speed and load, and to inject that fuel at the correct time and with the desired rate. Further depending on the particular combustion chamber, appropriate spray shape and structure must be produced. usually, a supply pump draws the fuel from the fuel tank and carries its through a filter to the high-pressure injection pump, dependent on the area of application and engine size, pressures between 150 and 200 bar is generated.

Fig. 1: Fuel Injector

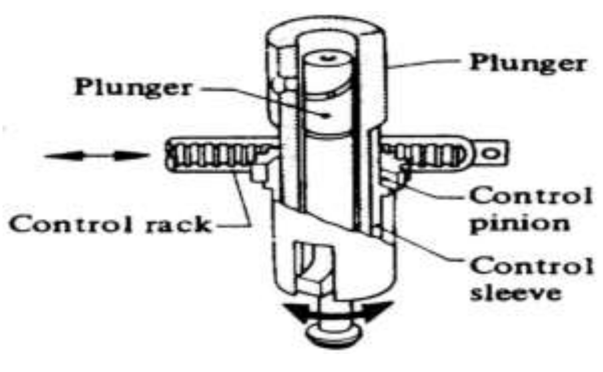


According to Heywood (1988) and Ganesan (1999), a wide variety of inlet port geometries, cylinder head and piston shapes, and fuel-injection patterns are used to accomplish this over the diesel size range. The engine ratings usually indicate the highest power at which manufacturer expect their products to give satisfactory of power, economy, reliability and durability under service conditions. Maximum torque and the speed at which it is achieved, is usually given also by Heywood (1988). The importance of the diesel engine performance parameters are geometrical properties, the term of efficiency and other related engine performance parameters. The engine efficiencies are indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, volumetric efficiency and relative efficiency (Ganesan, 1999). The other related engine performance parameters are mean effective pressure, mean piston speed, specific power output, specific fuel consumption, intake valve mach index, fuel-air or air-fuel ratio and calorific value of the fuel (Heywood, 1988; Ganesan, 1999; Semin et al., 2007).

Bosch Fuel Injection Pump

Fig. 2 shows the Bosch fuel injection pump .it consists of a barrel in which a plunger reciprocates when driven by a cam shaft. The plunger has a constant stroke and is single acting. Pump barrel and the plunger have between them a very small clearance of order of only 2 to 3 thousandths of a millimetre. Such a low clearance provides a perfect sealing without special packing even at very pressure and low speed. In order to vary he quantity of the fuel delivered per stroke, a vertical channel extending from top face of the plunger to an annular groove is provided on the upper part of the plunger. The upper end is also called control edge.

Fig. 2: Single Cylinder Bosch Injection Pump



We are varying the plunger diameter from 8mm to 9mm. for the optimum injection pressure i.e 2oo bar and conducting performance test for single cylinder CI engine and also recording the emission.

LITERATURE SURVEY

Avinash K Hegde and K N Sreenivas rao [1] conducted work on calophyllum innophyllum seeds are used to produce biodiesel. The different blending of biodiesel is tested in CI engine and also emission characteristics are studied. Further, additive SC5D is also used. It is evident from the experiment that additive will improve the thermal efficiency of the engine and also it influence on emission characteristic. Finally they conclude that Brake thermal efficiency of engine increases with addition of additives, Specific fuel consumption decreases with addition of additives, NOx emission is found to be marginally increases with the addition of more and more Additive to diesel. Hiraa and Singh [2]: In his research the blends of ethanol &

biodiesel with diesel in varying proportions are used. The performance& emission levels has been investigated under the various parameters like Brake Thermal efficiency, BSFC, BSEC, Smoke density, HC, CO & exhaust temperature. The experimental results show that the BE20 fuel gives the best performance in comparison to conventional diesel fuel along with fairly reduced exhaust emission. The main conclusion derived by this research is that using ethanol with biodiesel can potentially remove serious problem revealed with the use of high percentage of biodiesel in operation of unmodified diesel engine. The exhaust emission of BE20 and other biodiesel is reduced and the fuel blend BE20 is about 90% renewable and emission free. An experimental investigation is conducted to evaluate the effects of using diethyl ether and ethanol as additives to biodiesel/diesel blends on the performance and emissions of a direct injection diesel engine. The test fuels are denoted as DI (100%diesel), BD (20% biodiesel and 80% diesel in vol.), BDET (15% biodiesel, 80% diesel , and 5% diethyl ether in vol.) and BDE (15% biodiesel ,80% diesel and 5% ethanol, in vol.) respectively. D. D. Nagdeote & M. M. Deshmukh [3] concluded there is slightly lower brake specific fuel consumption (BSFC) for BDET compared to BD. Drastic reduction in smoke is observed with BDET and BDE at higher engine loads. BDET reflects better engine performance and combustion characteristics than BDE and BD**.** Jaydeep, A. Mevada [4] conducted the experiment on C.I. Engine using ethanol, biodiesel, diesel fuel blends. As fuel properties point of view density and pour point of all the fuel blends are under the standard limits for diesel fuel. Heat of combustion of all the blends is found to be lower than that of diesel fuel alone. However, the heating values of the blends containing ethanol lower than 10% are not much different from that of conventional diesel. D80B10E10 fuel blend gives minimum smoke density compared to the all fuel/fuel blends.

At medium load, CO emission for D80B10E10 fuel blend is observed lower than the other fuel blends.

Preparation of Calophyllum Inophyllum Biodiesel

Objectives

1. To extract the oil from the seeds of the *calophyllum inophyllum* plant.

2. Measuring the free fatty acid content in the oil and converting the extracted oil to Bio-Diesel by Transestrification process.

3. Measuring the various properties of the bio-diesel such as viscosity, density, flash point, fire point.

4. Conducting a performance test on diesel engine by using blend of *calophyllum inophyllum* Bio-diesel and Diesel with SC5D additive.

5. Measuring various parameters of the engine such as total fuel consumption, Brake power, brake thermal efficiency, effects of bio-diesel on engine.

6. Measuring the various emission characteristics such as HC, CO, CO2, and NOx etc.

The Schematic diagram of the engine test rig is shown in below Fig.5. The engine test was conducted on four-stroke single cylinder direct injection water cooled compression ignition engine connected to eddy current dynamometer loading. The engine was always operated at a rated speed of 1500 rev/min. The engine was having a conventional fuel injection system. The injection nozzle had three holes of 0.3 mm diameter with a spray angle of 120^{o}. A piezoelectric pressure transducer was mounted with cylinder head surface to measure the cylinder pressure. It is also provided with temperature sensors for the measurement of jacket water, calorimeter water, and calorimeter exhaust gas inlet and outlet temperatures. An encoder is fixed for crank angle record. The provision is also made for the measurement of volumetric fuel flow. The built in program in the system calculates brake power, thermal efficiency and brake specific fuel consumption. The software package is fully configurable and averaged P-Ө diagram, P-V plot and liquid fuel injection pressure diagram can be obtained for various operating conditions.

Fig. 3:Transestrification Proces

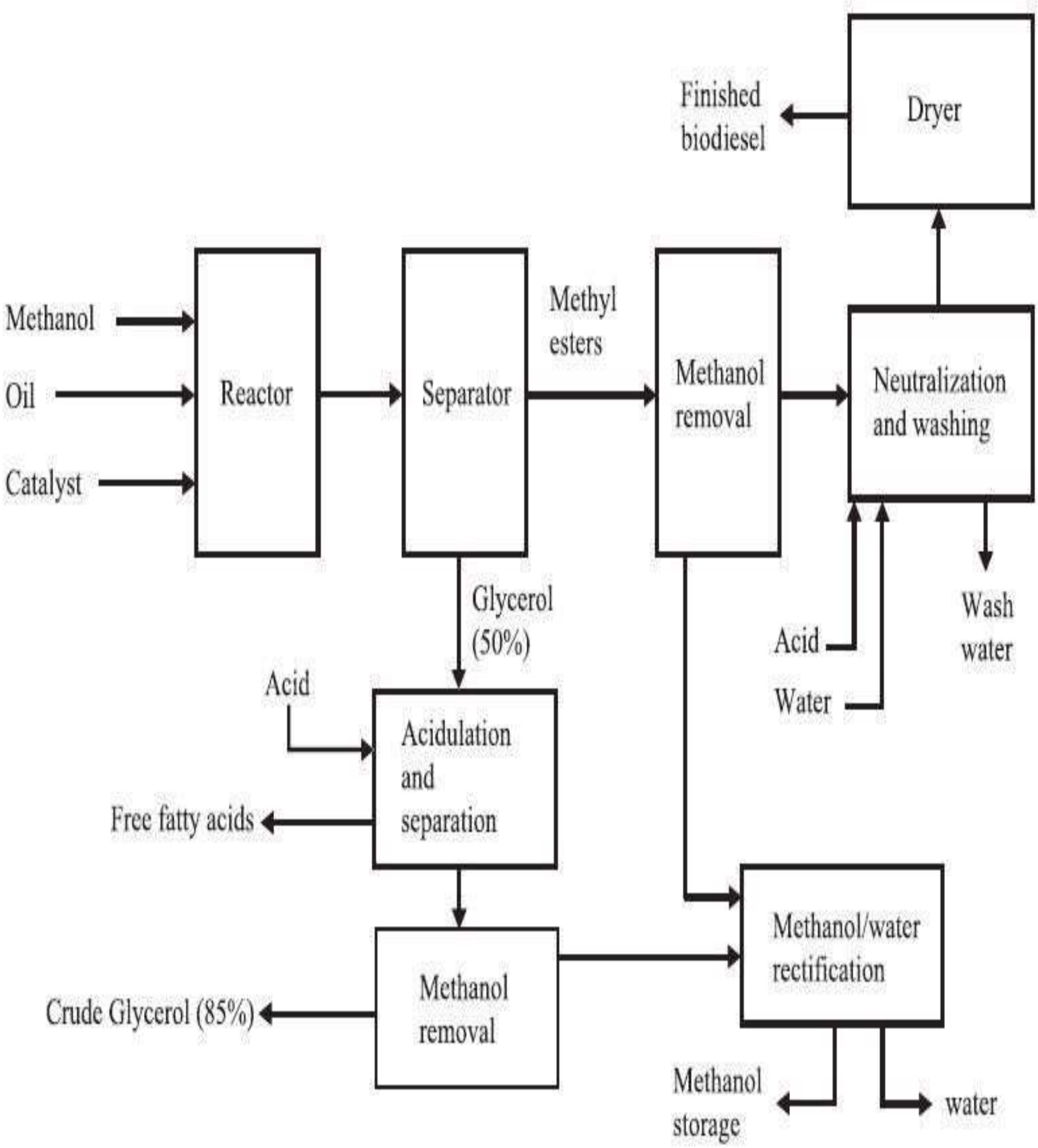


Fig. 4: Exipermental Setup

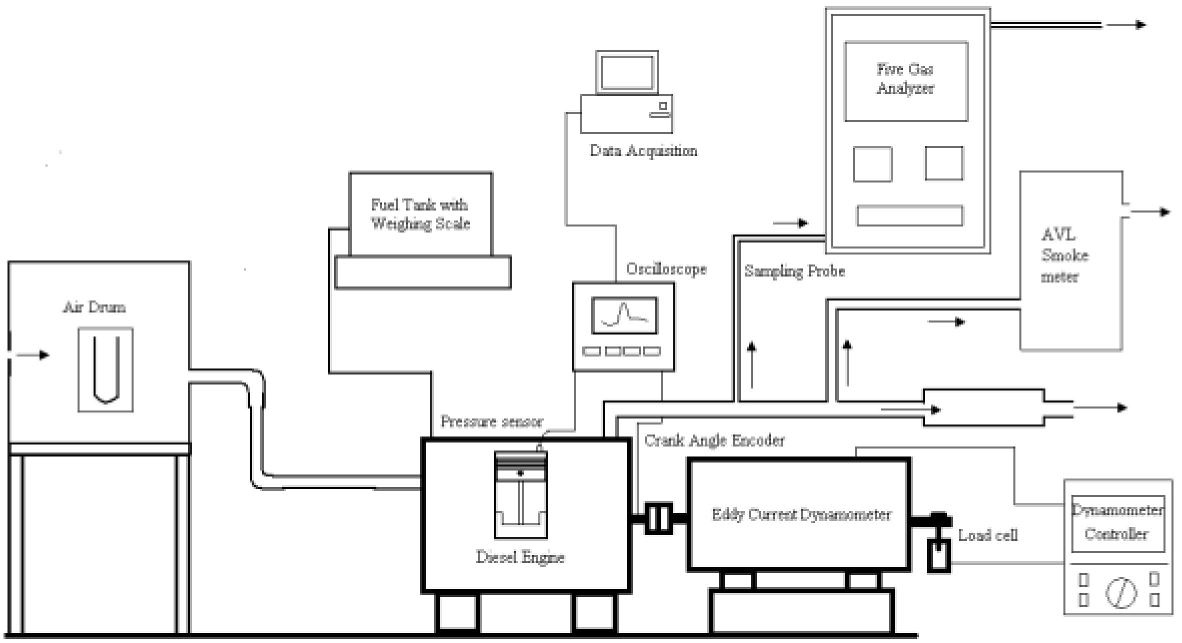


Table 1 : Property Table

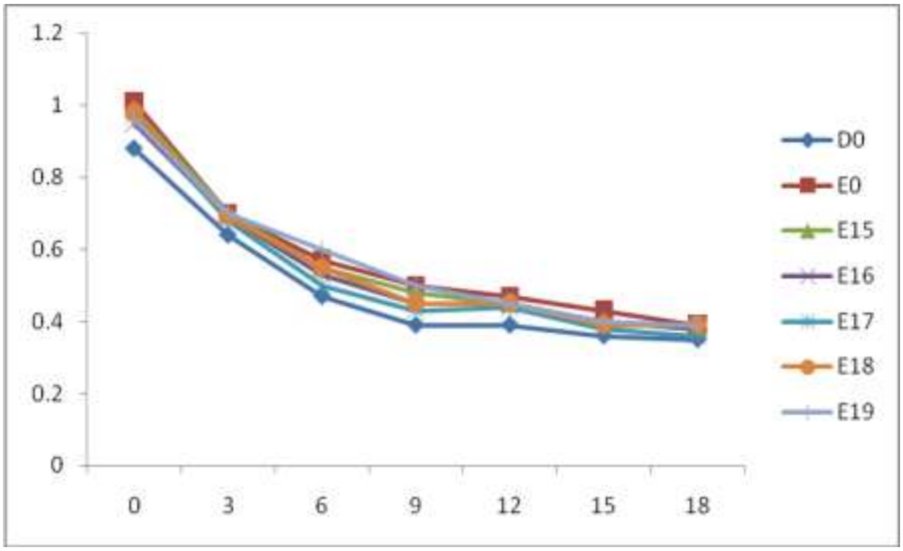
Property	**Unit**	**D100**	**B20E0**	**B19E1**	**B18E2**	**B17E3**	**B16E4**	**B15E5**
Density at 300c	Kg/m^3	813	845	843.3	841.6	839.9	838.5	836.6
Viscosity at 400c	Cst	2.0	2.26	2.14	2.14	2.14	2.14	2.14
Flash point	^{O}C	58	71	70	68	65	61	59
Fire point	^{O}C	62	76	74	71	68	64	61
Calorific value	kJ/kg	43200	42780	42295	42161	42028	41895	41762
Specific gravity	-	0.812	0.845	0.843	0.841	0.839	0.838	0.836

TABLE NO 2: ENGINE SPECIFICATION

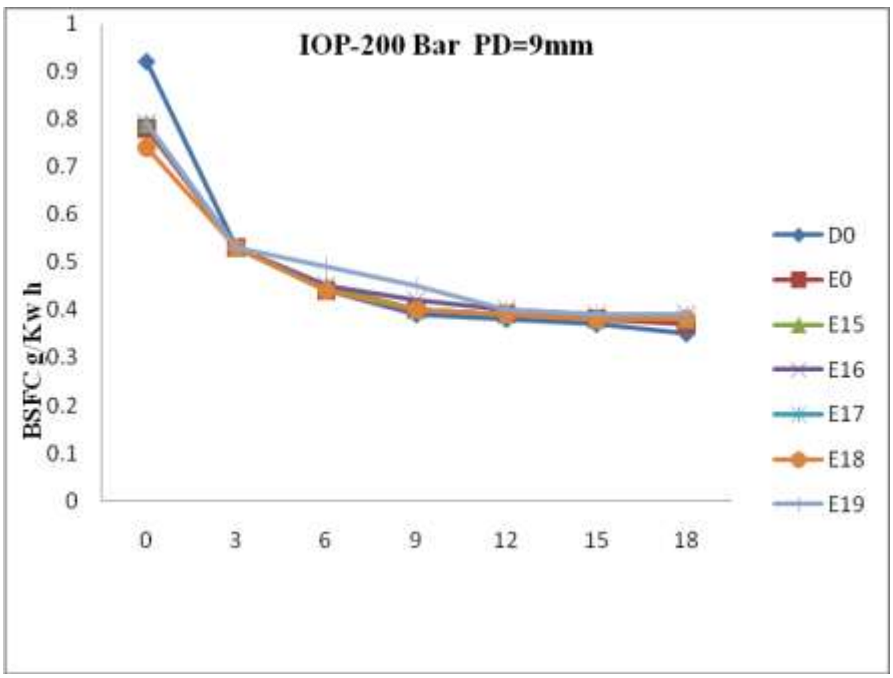
SL.NO	Engine parameter	Specifications
1	Rated power	3.7 KW(5HP)
2	Compression ratio	16.5:1
3	Bore	80mm
4	Stroke	110mm
5	Cylinder capacity	553 CC
6	Cooling	Water cooled
7	Loading	Eddy current dynamometer
8	Speed	1500 RPM
9	Fuel	Diesel

This paper compares specific fuel consumption, brake thermal efficiency and exhaust emissions of blends of calophyllum inophyllum and ethanol Additive with those of diesel.

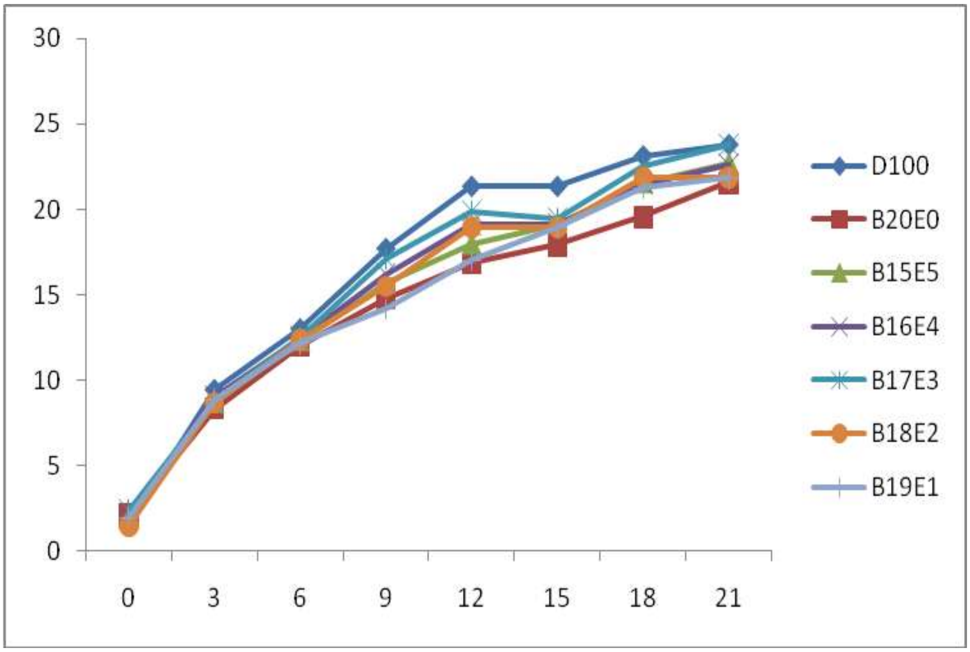
GRAPH V/S 1: BSFC LOAD FOR IOP-200 BAR PD-8MM



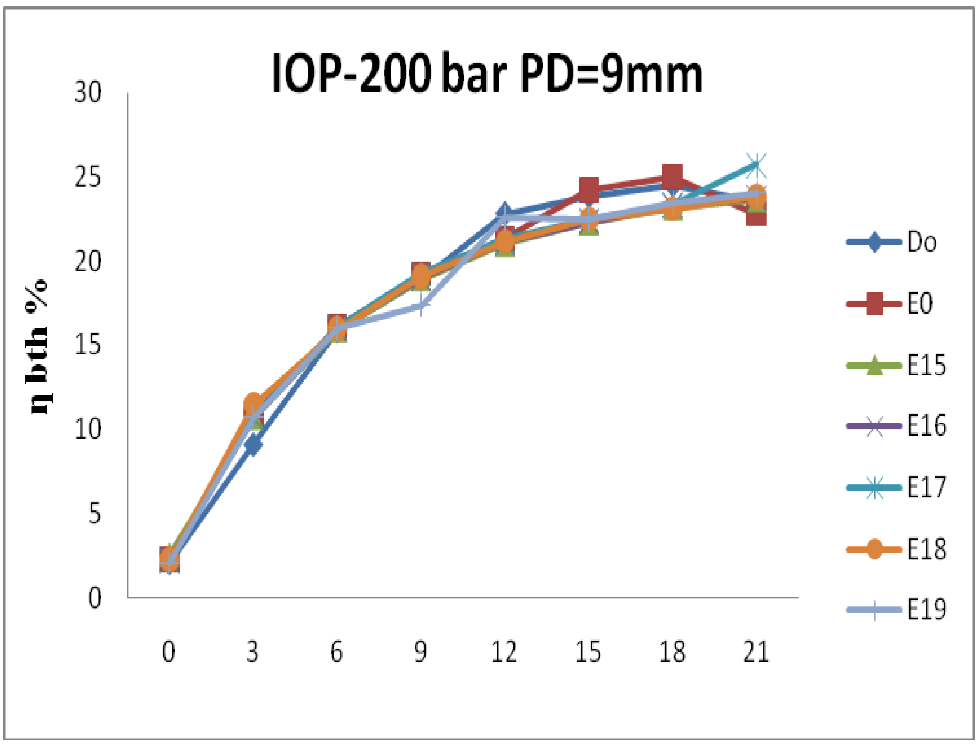
GRAPH 2: BSFC V/S LOAD FOR IOP-200 BAR PD-9MM



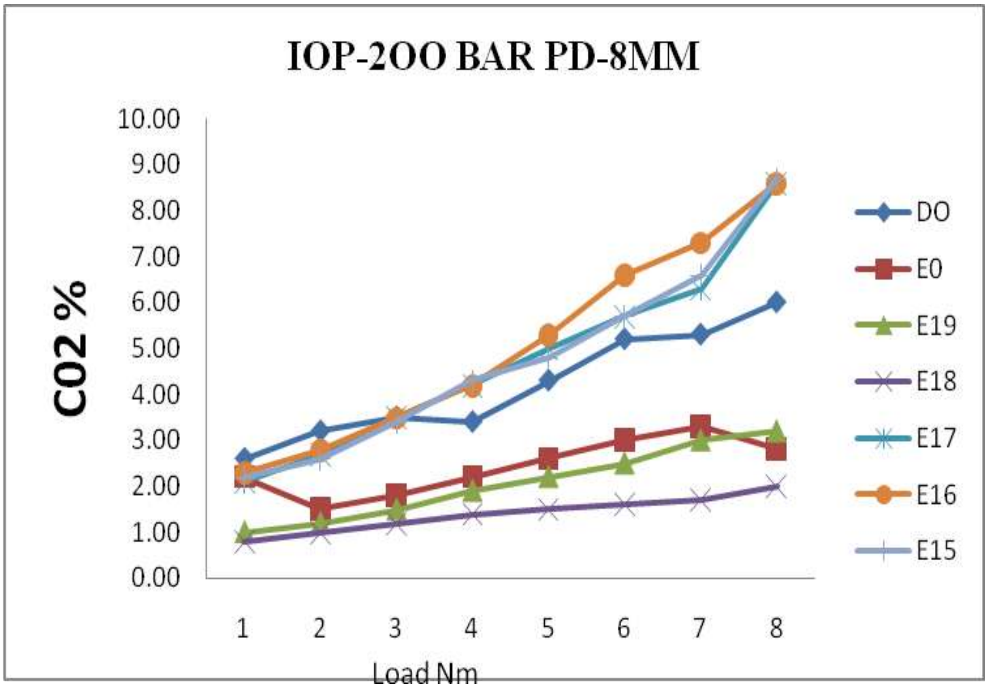
GRAPH 3: BRAKE THERMAL EFFICIENCY V/S LOAD IOP-200 BAR PD-8MM



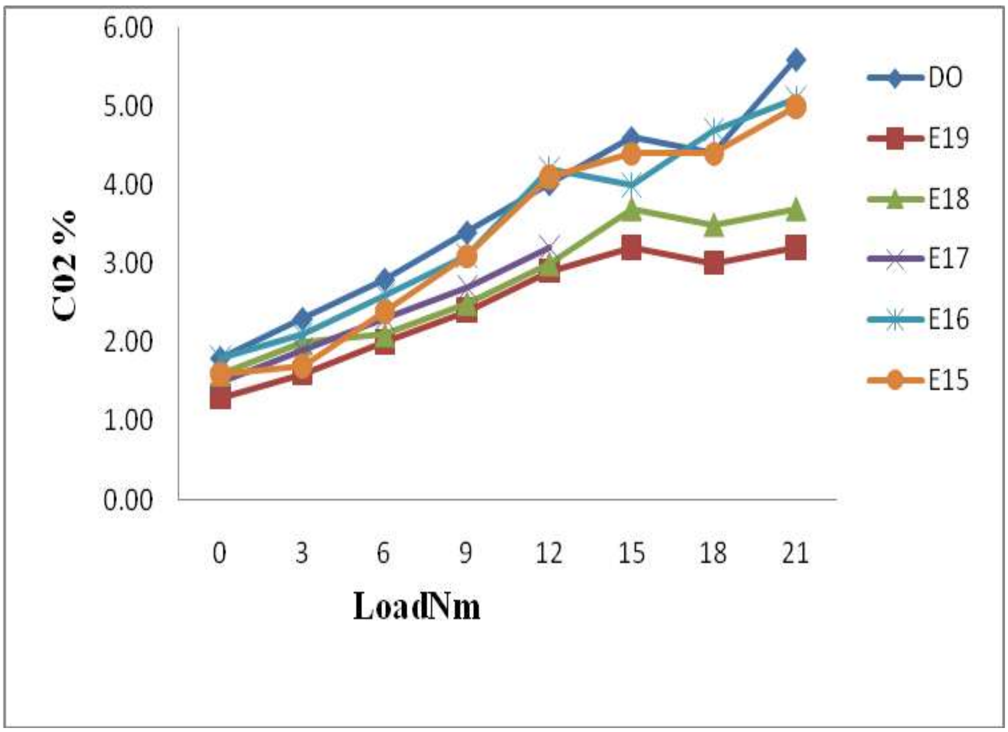
GRAPH 4: BRAKE THERMAL EFFICIENCY V/S LOAD IOP-200 BAR PD-9MM



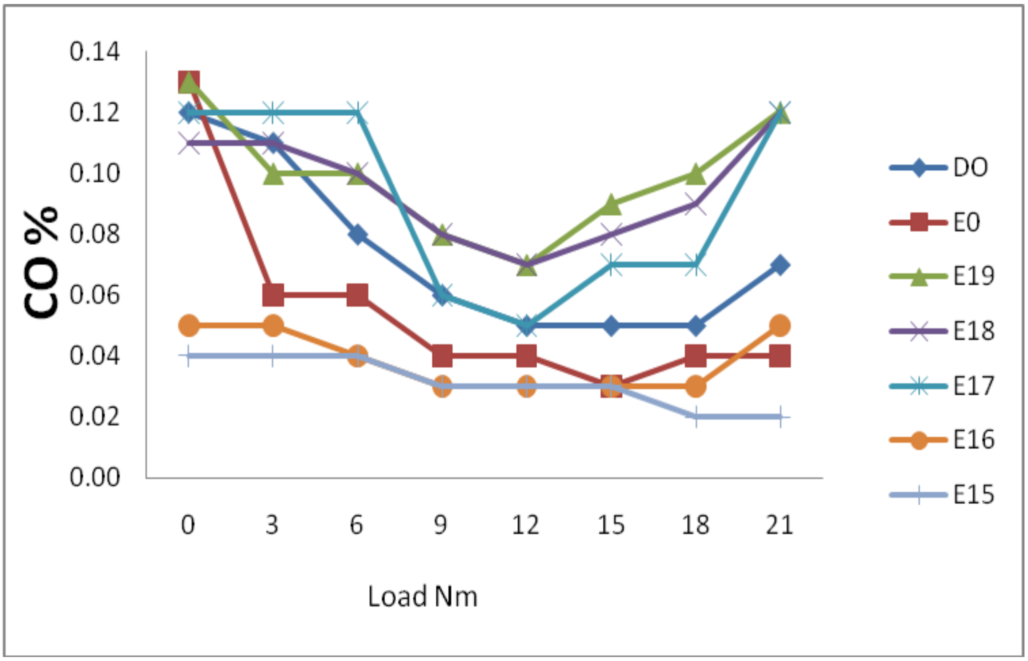
GRAPH 5: CO2 V/S LOAD IOP-200 BAR PD-8MM



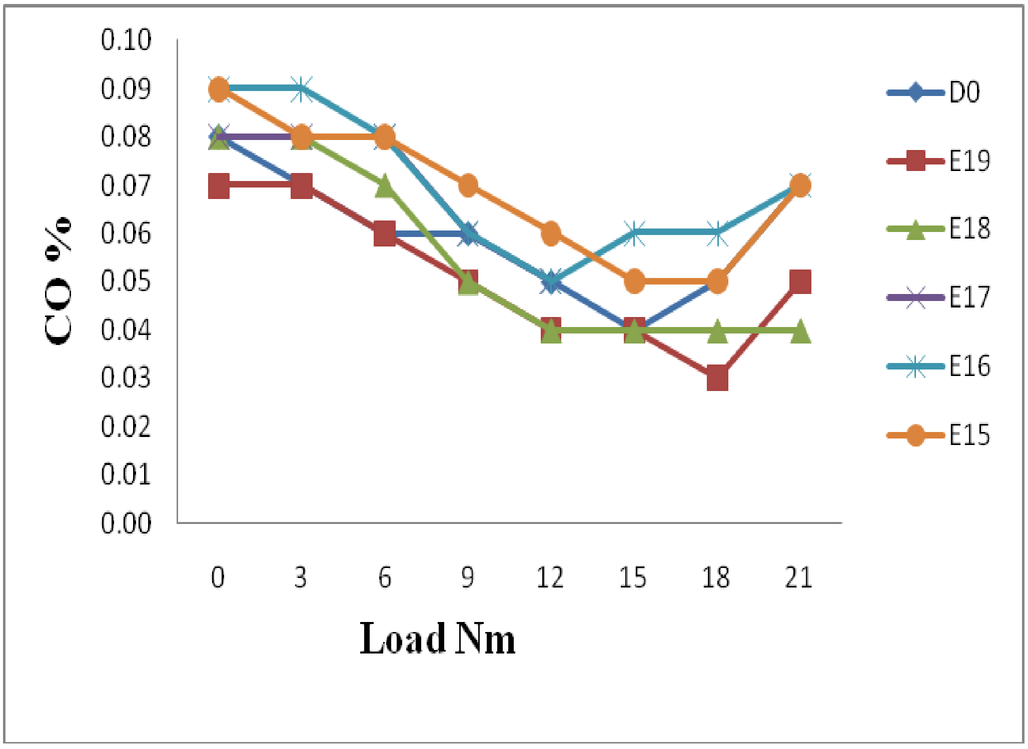
GRAPH 6: CO2 V/S LOAD IOP-200 BAR PD-9MM



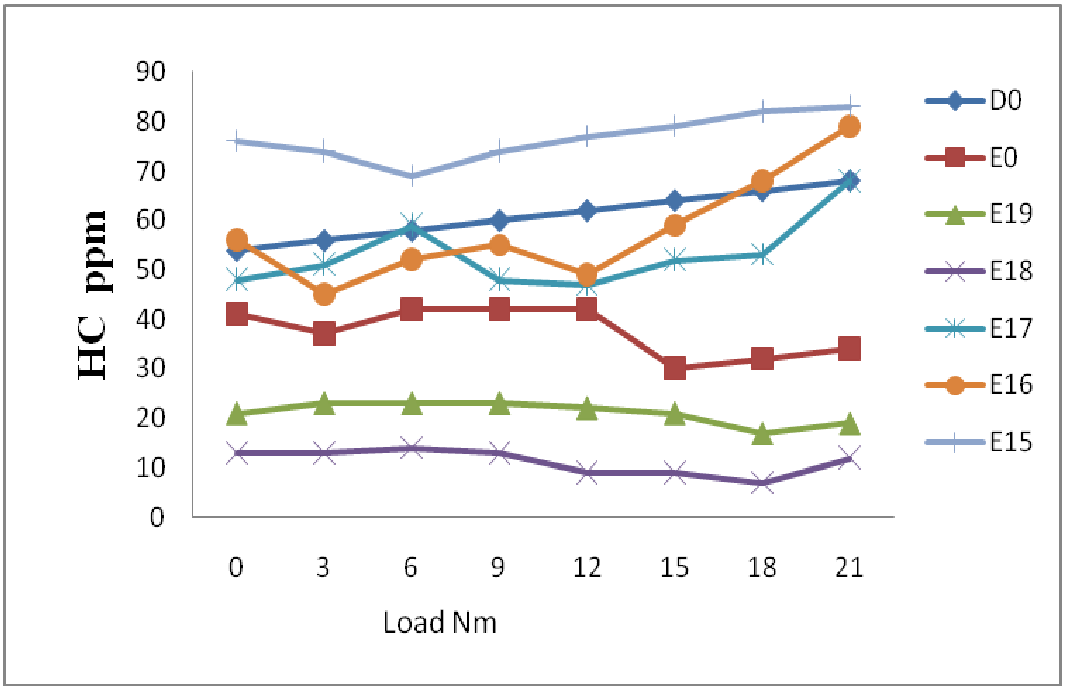
GRAPH 7: CO V/S LOAD FOR IOP-200 BAR PD-8MM



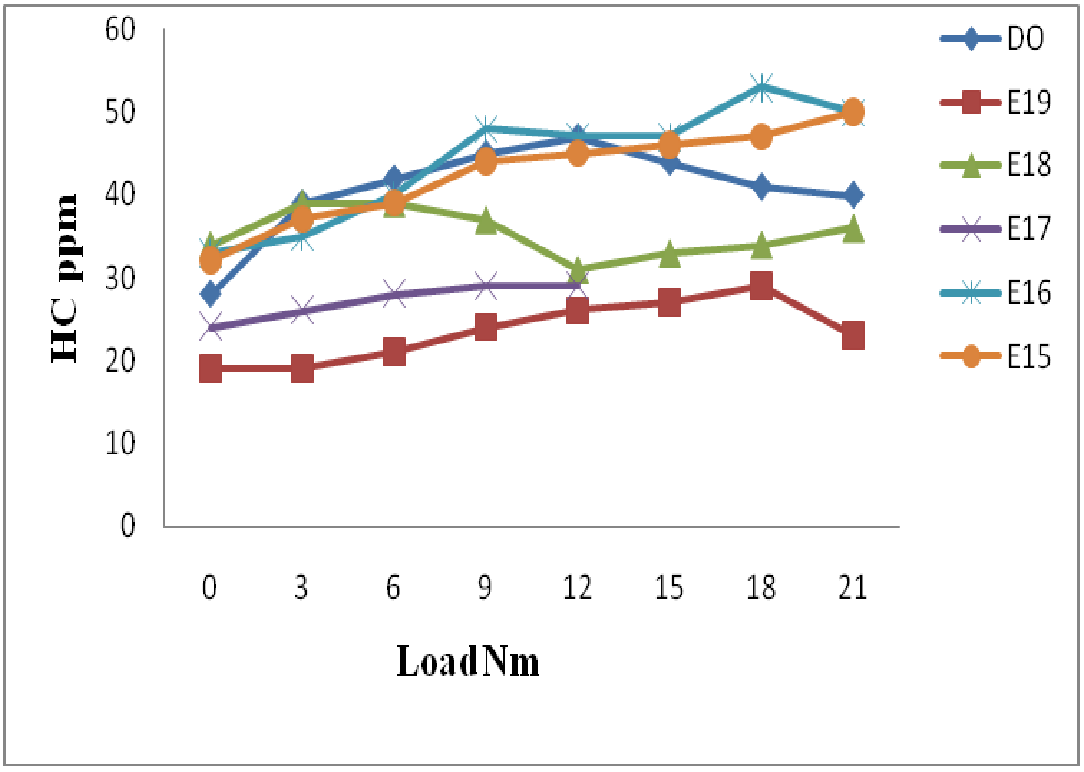
GRAPH 8: CO V/S LOAD FOR IOP-200 BAR PD-9MM



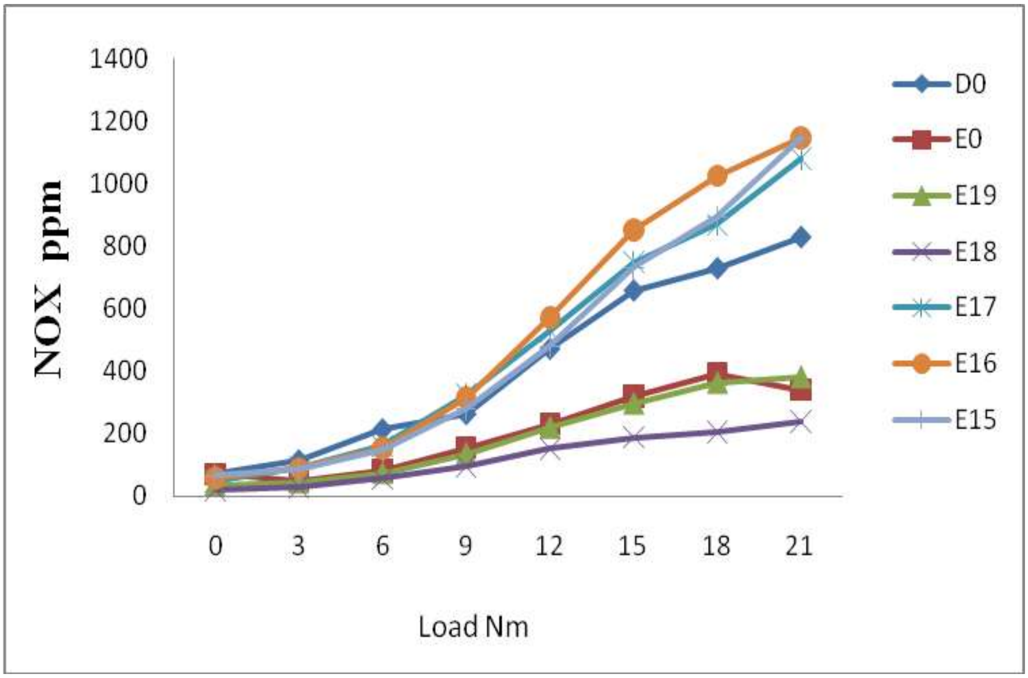
GRAPH 9: HC V/S LOAD FOR IOP-200 BAR PD-8MM



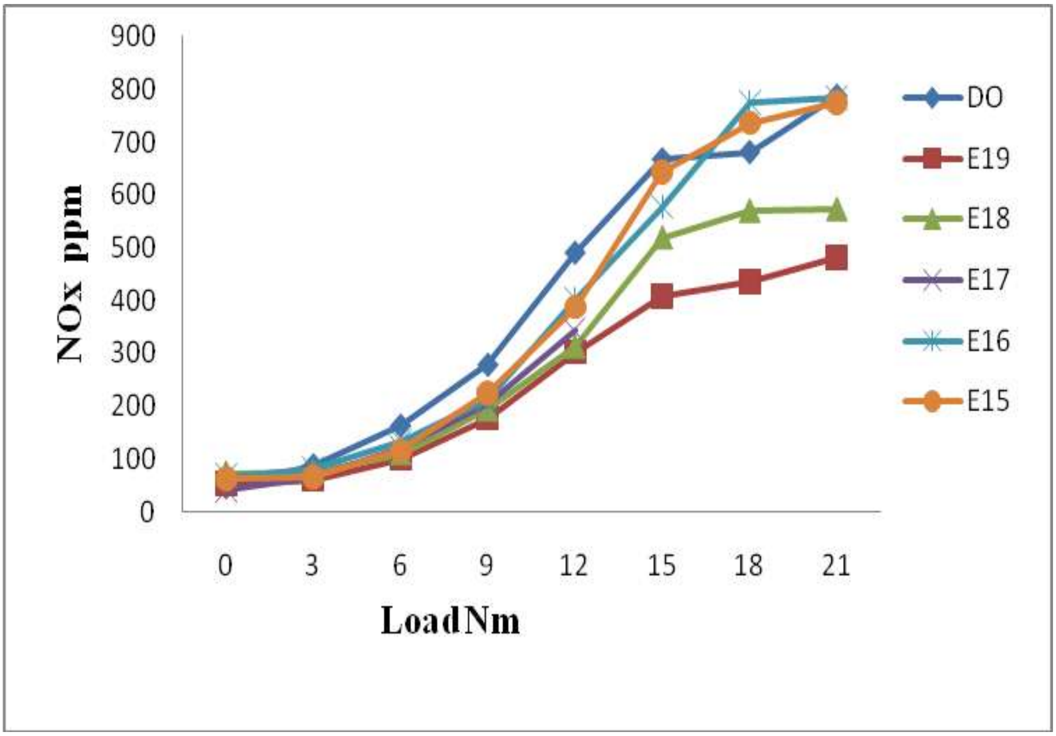
GRAPH 10: HC V/S LOAD FOR IOP-200 BAR PD-9MM



GRAPH 11: NO_X V/S LOAD IOP-200BAR PD-8MM



GRAPH 12: NO_X V/S LOAD IOP-200BAR PD-9MM



D100 (D0) = DIESEL, E0= 80% DIESEL+20% BIO DIESEL, E15=80% DIESEL +15% BIO DIESEL+5% ETHANOL, E16=80% DIESEL +16% BIO DIESEL+4% ETHANOL, E17=80% DIESEL +17% BIO DIESEL+3% ETHANOL, E18=80% DIESEL +18% BIO DIESEL+2% ETHANOL.

Conclusion

1. From the experimental results, the following conclusions are drawn:
2. Brake thermal efficiency of engine increases with addition of additives in the pd of 8mm. Specific fuel consumption decreases with addition of additives in the pd 0f 8mm.
3. Co_2 is lower than the diesel in pd 9mm compared to the pd 8mm
4. HC is minimum at the medium load then the diesel in 9mm pd compared to 8mm pd.
5. NOX is minimum than the diesel in the 9mm pd compared to 8mm pd

Acknowledgement

I would like to express my profound gratitude to my research guide Mr. Suchith Kumar M.T, Asst. Professor, department of Mechanical Engineering, Faculty of AIT College of Engineering. My sincere thanks to the director of Bio park in Hassan Dr. Balakirshana sir for his help in providing the Bio diesel and all his help and also thanks for all the staffs of the Bio Park. I would like to express thank to Principle and HOD of the mechanical department for all helps and also thanks for Mr. Vishvanath staff of Mechanical Department –REVA College

References

1. Avinash, K. H. & K. V. S. Rao. (2012). Performance and Emission Study of 4S CI Engine using Calophyllum Inophyllum Biodiesel with Additive. International Journal on Theoretical and Applied Research in Mechanical Engineering, Vol. 1(1):1-4.

2. Hiraa, A. and S. Singh. (2012). Performance & emission characteristics of CI engine using blends of ethanol and biodiesel with diesel. International Journal of Engeenring Research and Technology, Vol. 1(5): 1-12.

3. Nagdeote1, D. D. and M. M. Deshmukh. (2012). Experimental Study of Diethyl Ether and Ethanol Additives with Biodiesel-Diesel Blended Fuel Engine. International Journal of Emerging Technology and Advanced Engineering, Vol. 2(3): 195-199.

4. Jaydeep, A. M., D. R. Shah and J. K. Modh. (2013). The Effect of Ethanol and Biodiesel Blended Diesel Fuels on Performance from a Single Cylinder Direct Injection Engine. International Journal of Research in Modern Engineering and Emerging Technology, Vol. 1(2): 13-19.

5. Kumar, M. L. S. D., S. Drakshayani, K. V. K. Reddy. (2012). Effect of Fuel Injection Pressure on Performance of Single Cylinder Diesel Engine at Different Intake Manifold Inclinations. International Journal of Engineering and Innovative Technology, Vol. 2(4): 20-28.