ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 11, March 2017

PERFORMANCE AND EMISSION CHARECTERISTICS OF EUCALYPTUS OIL IN IC ENGINES

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ABSTRACT

An experimental investigation has been carried out to analyze the performance and emission characteristics of a compression ignition engine fuelled with biodiesel (make use Eucalyptus oil) and its blends 15%, 25%, and 30% in mineral diesel. The biodiesel making process is two major steps. First preheating process and second convert to biodiesel. Preheating is Eucalyptus oil to heat 60ºc. And convert the biodiesel by using transesterification method. Take methanol 30% and catalyst KOH is 14% of net amount of the Eucalyptus oil, mix this two chemicals in properly and this composition is add drop by drop in oil this process is maintain 60ºc at 850 rpm by using hot plate magnetic stirrer apparatus.The effect of temperature on the viscosity of Eucalyptus oil has also been investigated.The performance parameters evaluated include thermal efficiency, brake power, specific fuel consumption (SFC), and exhaust emissions include mass emissions of CO, CO_2, HC, NOx and smoke opacity. The results of the experiment in each case were compared with baseline data of mineral diesel (neat diesel).

Key words: EO, Methanol, KOH, Transesterification , Blending, Emissions

CHAPTER - 1

1.1 INTRODUCTION

Energy is one of the major inputs for the economic development of any country. In the case of the developing countries, the energy sector assumes a critical importance in view of the ever-increasing energy needs requiring huge investments to meet them.

Historically, any change in the prime energy source of a society has resulted in a revolution in the life style. Thus domestication of animals and resulting easy availability of draft animal power played a key role in transition from hunter-gatherer society, where human muscle power was the only source of energy to the agricultural society. Before the industrial revolution, which began around 200 years ago, people were essentially dependent on manual and animal labour. Energy requirements were met through food intake. Life was simple and unsophisticated, and the environment was relatively clean and pollution free. Then in 1785, the invention of steam engine by James Watt of Scotland brought industrial revolution. It was the beginning of the mechanical age or the age of machines. The advent of internal combustion engine in the late nineteenth century gave further momentum to the tread. Gradually industrial revolution spread to the whole world and the need for huge quantity of energy realized.

Discovery of large stocks of coal and steam engine heralded the industrial revolution with its mechanized production in eighteenth century. Slowly steam boilers and engines replaced animal draft power, wind mills and water wheels. Thus were sown the seeds of phenomenal increase in the carbon dioxide content of air, and in the economies of nations. The second industrial revolution of nineteenth century is usually associated with numerous discoveries resulting in technological advances, the two most important of these being the invention of electricity and modern usage of petroleum oil products in internal combustion engines.

Coal dominates the energy mix in India, contributing to 55% of the total primary energy production. Over the years, there has been a marked increase in the share of natural gas in primary energy production from 10% in 1994 to 13% in 1999. There has been a decline in the share of oil in primary energy production from 20% to 17% during the same period. Oil accounts for about 36 % of India's total energy consumption. India today is one of the top ten oil-guzzling nations in the world and will soon overtake Korea as the third largest consumer of oil in Asia after China and Japan. The country's annual crude oil production is peaked at about 32 million tonne as against the current peak demand of about 110 million tonne. In the current scenario, India's oil consumption by end of 2013 is expected to reach 136 million tonne(MT), of which domestic production will be only 34 MT. India will have to pay an oil bill of roughly $50 billion, assuming a weighted average price of $50 per barrel of crude. In 2003-04, against total export of $64 billion, oil imports accounted for $21 billion. India imports 70% of its crude needs mainly from gulf nations. The majority of India's roughly 5.4 billion barrels in oil reserves are located in the Bombay High, upper Assam, Cambay, Krishna-Godavari. In terms of sector wise petroleum product consumption, transport accounts for 42% followed by domestic and industry with 24% and 24% respectively. India spent more than Rs.1,10,000crore on oil imports at the end of 2013.

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ISSN (PRINT): 2454-9762
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1.2 INDIAN SCENARIO OF OIL CONSUMPTION

India's demand for petroleum products is likely to rise from 97.7 million tonnes in 2001-02 to around 139.95 million tonnes in 2012-13, according to projections of the Tenth Five-Year Plan.

The plan document puts compound annual growth rate (CAGR) at 3.6 % during the plan period. Domestic crude oil production is likely to rise marginally from 32.03 million tonnes in 2001-02 to 33.97 million tonnes by the end of the 10th plan period (2012-13). India's self sufficiency in oil has consistently declined from 60% in the 50s to 30% currently. Same is expected to go down to 8% by 2020. As shown in the figure 1.8, around 92% of India's total oil demand by 2020 has to be met by imports.

India is projected to become the third largest consumer of transportation fuel in 2020, after the USA and China, with consumption growing at an annual rate of 6.8% from 1999 to 2020. India's economy has often been unsettled by its need to import about 70% of its petroleum demand from the highly unstable and volatile world oil market (India, 2013). The acid rain, global warming and health hazards are the results of ill effects of increased polluted gases like SOx, CO and particulate matter in atmosphere.

Rising petroleum prices, increasing threat to the environment from exhaust emissions and global warming have generated an intense international interest in developing alternative non-petroleum fuels for engines. In recent years, research has been directed to explore plant-based fuels and plant oils and fats as fuels. Biodiesel is described as a fuel comprised of mono-alkyl esters of long chain fatty acids derived from Eucalyptus oils or animal fats. It is oxygenated, essentially sulfur-free and biodegradable.

The use of non-edible oils compared to edible oils is very significant because of the increase in demand for edible oils as food and they are too expensive as compared with diesel fuel.

1.3 ALTERNATIVE FUELS

Searching the alternate fuels for IC engine for the following reason:

- Depletion of fossil fuel
- Vehicular populations
- Increasing Industrialization
- Extra burden on home economy for developing countries like India
- Growing Energy Demand
- Explotion of population
- Environmental pollution
- Stringent emission norms like Bharat – I, II, III, IV and V

- Fuels that are derived from non-crude oil resources such as methanol, ethanol, bio-diesel, hydrogen and fuel cells are often included as alternate fuels.
- The other challenge is to study the compatibility of higher – levels blends into existing technology vehicles
- These challenges solve the question of energy independence.
- However there is still the question of environmental benefits that could be obtained from the use of alternate fuels.
- To determine the actual environmental benefit of these fuels, a lifecycle assessment of the associated energy use and emissions through all stages of production till it comes out, in the form of exhaust gas, through the vehicular exhaust is necessary.
- Bio-diesel is the diesel of the future. As diesel vehicles converted to bio-diesel do not require engine modifications, feasibility in terms of endurance, performance, fuel consumption and emissions in India conditions could be studied.

1.4 REQUIREMENTS OF ALTERNATE FULES

- Availability
- Better Performance
- Conformity to the environmental standards
- Competitive cost
- Safety in transportation

1.5 TRANSPORT FUEL CHARACTERISTICS

- It must be intrinsically safe for carriage, storage and handling
- Production of the fuel must be environmentally sound and produce no pollution
- Production of the fuel must be energy positive – that is, the production process should not consume more energy than that produce at the wheels, other than to utilize supply surplus.
- The energy density of the fuel must be such that sufficient quantity may be carried on the vehicle to achieve a reasonable travelling distance before refuelling.
- The fuel and its means of use should be cost – effective, comparable but not necessarily competitive with petroleum fuels at today's prices.
- The infrastructure required to deliver the fuel to point of use must be cost-effective.
- The fuel must be ecologically sustainable.

1.6 IMPORTANTS TO ALTERNATIVE FUEL BIODIESEL:

•The use of biofuels like alcohol, Eucalyptus oil and biogas in diesel engine could reduce the two major crises namely the fossil fuel depletion and environmental pollution.

•Eucalyptus oils have the greatest promise to be used as alternative fuels for diesel engines due to a very significant fact that they are renewable energy sources and could emit substantially less green house gases.

•The high viscosity and poor volatility are the major limitations of Eucalyptus oils for their utilization as fuel in diesel engine.

•The high viscosity of Eucalyptus oils creates operational problems like difficulty in engine starting, unreliable ignition and deterioration in thermal efficiency.

CHAPTER – 2

LITERATURE SURVEY

[1] D.Nandhakumar(2016)

'Eucalyptus Oil Biodiesel A Promising Fuel For The Near Future'.To reducing no_x and increasing the emission and efficiency of the bio diesel.

[2] N.Subramoniaillai, P.SeeniKannan, et.al.,(2016)

'A naturally aspirated ci engine,fuelled with 20% of rubber seed biodiesel blended with diesel(B20)was investigated alongwith three different proportions of combined additives. (pentanol and menthapipertialeaves extract).'

[3] A.Rajalingam, S.P.Jani, et.al.,(2016)

'Thermal cracking method: Thermal cracking is a process of convert the complex structure of hydrocarbons into its simplest structure with or without catalyst.due to this process the density and viscosity of oil will reduce. In Eucalyptus oil as an alternative fuel'

[4] D.Rachelevangelene tulip, K.V.Radha, et.al.,(2013)

'The crude ester was separated from glycerol using separating funnel.crude methyl ester containing excess alcohol,soap and glycerol was washed with water five times the amount of crude biodiesel,so that the molecules will move freely and separate easily and quickly.'

[5] Sri harshathirumala, A.V. Rohit, et.al.,(2012)

'The performances of this biodiesels have been tested by the performance parameters like torque,brakepower,brake thermal efficiency and brake specific fuel consumption'

[6] M.Thirumurugan, V.M.Sivakumar, et.al.,(2012)

'The proportions of methanol to potassium hydroxide used in the preparation of the reaction catalyst.

- Dissolve 1 gram of KOH in 1 liter of distilled water.
- Dissolve 1 ml of waste Eucalyptus oilinti 10ml isoprophyl alcohol'

[7] MdA.Hossain, Shabab, et.al.,(2012)

'one particular problem of biodiesel is its cold flow properties.neat biodiesel such as methyl soy ate has a poor point of -3℃.'

[8] N.Kanthavelkumaran, Dr.P.Seenikannan, et.al.,(2012)

'The most common blend is B20,a mix of 20% biodiesel with 80% petroleum diesel.biodiesel has 11% oxygen by weight and essentially contains no sulphur or aromatics.'

[9] S.Jaichandar, K.Annamalai, et.al.,(2011)

'Eucalyptus oils are chemically complex esters of fatty acids. these are the fats naturally present in oil seeds,and known as tri-glycerides.kinematicvicosity of Eucalyptus oil varies in the range of 30-40cSt at 38℃ '

[10] Hossain A.B.M.S, Nasrulhaqboyce. A, et.al.,(2010)

'The highest biodiesel yield was obtained(71.2%) under the conditions of 1:1 volumetric oil to methanol weight ratio, 0.5% NaOH catalyst at 50 ℃ reaction temperature and 320 rpm stirring speed at room temperature.also mixing time chosen such as 2 and 6hours'

[11] Avinash Kumar Agarwal, K.Rajamanoharan, et.al.,(2008)

'Using straight Eucalyptus oils in diesel engines is not a new idea.Rudolf Diesel first used peanut oils as a fuel in CI engine (1910).its a renewable fuel with short carbon cycle period((1-2 years compared to millions of years petroleum fuels) and is environment friendly.'

[12] AnhN.Phan, A.Salleh, et.al.,(2008)

'The transesterification was carried out in a 500ml three-neck glass flask connecting with a reflux condenser using a tap water to condense methanol vapour and a thermocouple probe.'

[13] Yusuf Chisti, MonzurUi Islam, et.al.,(2007)

'Transesterification requires 3 mol of alcohol for each mole of triglyceride to produce 1mol of glycerol and 3 mol of methyl esters. the reaction is on equilibrium.'

[14] M.Pugazhvadivu,K.Jeyachandran, et.al.,(2005)

'The performance and exhaust emissions of a single cylinder diesel engine was evaluated using diesel, waste frying oil (without preheating) and waste frying oil preheated to two different inlet temperatures (75 and 135℃)'

[15] Mustafa E.Tat, Jon H.VanGerpen, et.al.,(1997)

'Data are presented here for the kinematic viscosity of biodiesel and its blends with No.1 and No.2 diesel fuels over the temperature range from the onset of crystallization to 100℃.ASTM standard D445-88.'

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
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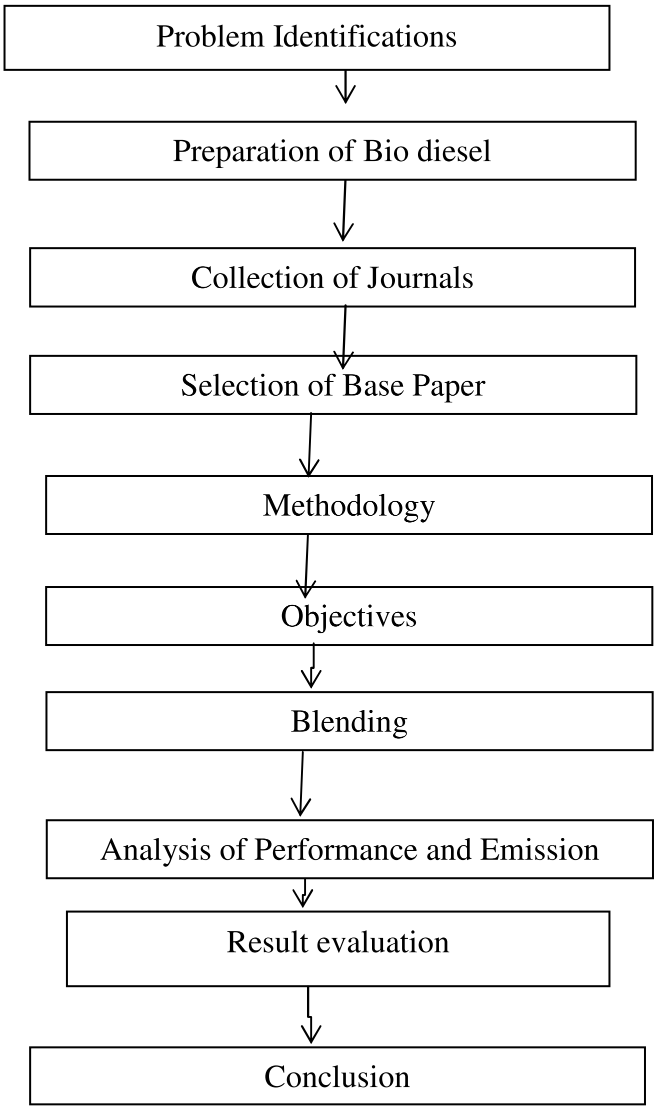
International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 11, March 2017

CHAPTER -3

WORK PLAN



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ISSN (PRINT): 2454-9762
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International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 11, March 2017

CHAPTER – 4

PROBLEM IDENTIFICATION AND OBJECTIVE

4.1 PROBLEM IDENTIFICATION

- While using commercial diesel in IC engine result in low performance.
- which will emit co_2 and Nox in higher amount.
- In future demand of diesel may occur.

4.2 OBJECTIVE

- Selecting suitable biodiesel for replacing diesel.
- Conversion of eucalyptus oil into bio-fuel by Tranesterification process.
- To increase the performance of IC engine.
- To decrease the emission from the IC engine.

CHAPTER – 5

EUCALYPTUS OIL

5.1 INTRODUCTION:

The fuels currently used in internal combustion engines are nonrenewable. The resources of the fossil fuels will get exhausted. The fossil fuels during combustion produce harmful emissions which is toxic to environment.

It is the need of hour to find out alternate energy sources which has advantages over the conventional fossil fuels. Many experiments were conducted on internal combustion engines using fuel derived from nature friendly resource.

Eucalyptus leaf tests is a waste product in eucalyptus tree. Biodiesel have to prepare from Eucalyptus oil using transesterification reaction.

This work aims at the evaluation of the engine performance and emission characteristics of a compression ignition engine when fuelled with eucalyptus biodiesel.

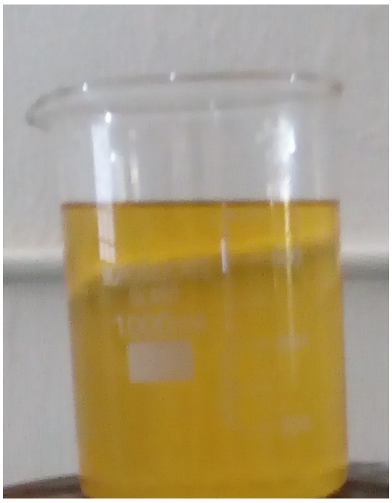

Fig 5.1 Eucalyptus oil

CHAPTER – 6

VISCOSITY REDUCTION TECHNIQUES

High viscosity of Eucalyptus oils has been reported by almost all researches as the major bottleneck in their use as fuel. To overcome this problem, various techniques have been successfully tried and the advances in this area are summarized below:

6.1 PREHEATING

- Since high viscosity is a major problem with Eucalyptus oils, one possible solution is to heat the oils in order to reduce their viscosity or to heat the intake air in order to accelerate the evaporation of the Eucalyptus oil in the engine.
- The oil viscosity was determined by using a redwood viscometer and density of the soil was calculated by a hydrometer.

6.2 BLENDING

- Blending refers to mixing of Eucalyptus oil with other low viscosity fuels like Diesel, alcohol and others and it result in the reduction of the viscosity of the blends.

6.3 TRANSESTERIFICATION

Transesterification is most commonly used and important method to reduce the viscosity of Eucalyptus oils. In this process triglycerides of five non-edible oils react with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acids, alkyl ester and glycerol. The process of removal of all the glycerol and the fatty acids from the Eucalyptus oil in the presence of a catalyst is called esterification. This esterified Eucalyptus oil is called bio-diesel. Biodiesel

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ISSN (PRINT): 2454-9762
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properties are similar to diesel fuel. After esterification of the Eucalyptus oils its density, viscosity, cetane number, calorific values are improved more. So these improved properties give good performance in CI engine. Physical and chemical properties are more improved in esterified Eucalyptus oil because esterified Eucalyptus oil contains more cetane number than diesel fuel.

Fig 6.1 Transesterification process

6.4 BENEFITS OF TRANSESTERIFICATION

- Reduces the high viscosity of the oil
- Increases the volatility
- High cetane number
- No sulphur, No aromatics
- Best emission with oxidation catalysts
- High oxygen content (1%)
- Exorbitant lubricity
- Winter operability (-22C)

CHAPTER-7
METHODOLOGY

7.1 INTRODUCTION

Most of the alternative bio fuels identified today is proved to be a partial substitute for existing one due to its undesirable fuel characteristics. However, the various admission techniques experimented earlier are giving good solution to apply larger fraction of replacing fuel in the existing engine. This chapter deals the methodology of some suitable techniques to apply large fraction of Eucalyptus oil in the existing DI diesel engine

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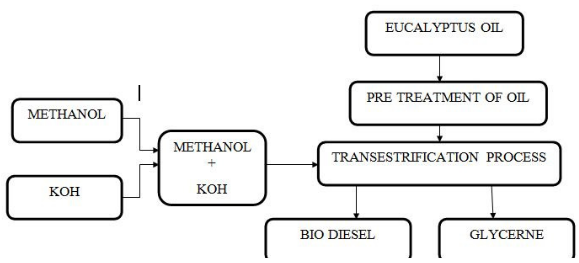
7.2 EUCALYPTUS OIL

Eucalyptus oil in neat form is one of the best substitutes for the diesel fuel, better lubricity and abundant availability. However studies conducted with Eucalyptus oil showed that, Eucalyptus oil in neat form are not suitable for long term engine application due to its high viscosity, poor volatility and high molecular weight. Hence, the Eucalyptus oils are admitted into the engine either in the form of blended Eucalyptus oil (diesel and alcohol) or esterified Eucalyptus oil (biodiesel). The former is simple and cheap and latter is cumbersome and expensive.

Eucalyptus oil is not a complete solution for the fossil fuel replacement. In addition, alcohol Eucalyptus oil possesses fewer disadvantages like cetane suppression, phase separation and sedimentation. Hence in this work Eucalyptus oil is considered for reducing viscosity of Eucalyptus oil as it hold good fuel properties.

An equal proportional of Eucalyptus oil and diesel is prepared on volume basis and admitted into the engine through regular diesel injection system to study the feasibility, performance and emission characteristics of 100% bio fuel operation.

7.3EXPERIMENTAL PROCEDURE



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ISSN (PRINT): 2454-9762
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International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 11, March 2017

Fig 7.1 Experimental procedure

various steps involved in carrying out this project work are listed below.

- Preparation of Eucalyptus oil
- Performance test on engine using mineral diesel at constant speed of 1500rpm under natural aspirated condition.
- Performance test on the same engine using bio diesel of Eucalyptus oil and blends consisting of 15%, 25%, 30% of Eucalyptus oil and diesel respectively.
- Comparison of these three performance using graphs.

CHAPTER-8

PREPARATION OF BIODIESEL

8.1 OIL PREHEATING:

- We taken 500ml of Eucalyptus oil.
- Initiallypreheat theEucalyptus oil at 60ºc in heating chamber.
- Since high viscosity is a major problem with Eucalyptus oils, one possible solution is to heat the oils in order to reduce their viscosity or to heat the intake air in order to accelerate the evaporation of the Eucalyptus oil in the engine.
- The oil viscosity was determined by using a redwood viscometer and density of the soil was calculated by a hydrometer.

Fig 8.1 Oil measuring

Fig 8.2 Preheating the Eucalyptus oil

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ISSN (PRINT): 2454-9762
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8.2MIXING THE ALCOHOL AND CATALYST:

- Take 30% of methanol in net amount of Eucalyptus oil, so take 150 ml of methanol and take the 14% of KOH catalyst.
- .
- Weighted the KOH – 6.6grams by using electronic balance

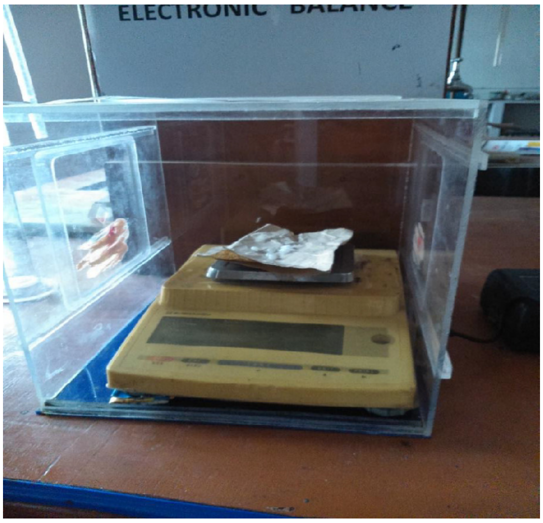

Fig 8.3 Weighted the KOH

- Mixing the 150ml methanol and 6.6grams of KOH.

Fig 8.4 Mixing process

8.3 TRANSESTERIFICATION:

- To adding the methanol and KOH solution into preheated Eucalyptus oil at 900 rpm at maintain 60°C by using magnetic stirrer apparatus.
- This method is the best method of making biodiesel because this method is decrease the viscosity of the Eucalyptus oil.

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ISSN (PRINT): 2454-9762
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International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 11, March 2017

Fig 8.5 Before the transesterification process

Fig 8.6 During and complete the transesterification process

8.4BIODIESEL FILTRATION:

- After the transesterification process the oil is transfer to the separating funnel or pouring the separating funnel.
- After one hour the biodiesel is change the colour in the separating funnel.
- After the ten hours in the biodiesel is separating the biodiesel and glycerine is separately filter inside the separating funnel.

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ISSN (PRINT): 2454-9762
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Fig 8.7 Biodiesel filtration

8.5SEPARATING PROCESS:

- Filtration process is completed the after ten hours to separating the biodiesel and glycerine in separate bottles.

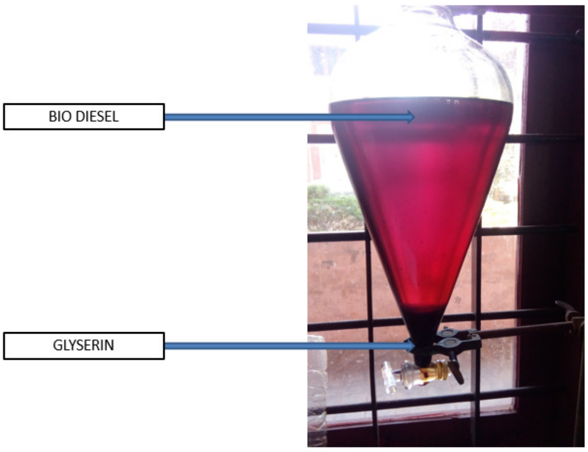

Fig 8.8 Separating process

CHAPTER-9
BLENDING

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9.1BLENDING PROCESS:

- To blend the biodiesel to diesel adding drop by drop at 900 rpm by using magnetic stirrer apparatus.
- The blending biodiesel with diesel in different ratios, to blend take 15% of biodiesel and 85% of diesel in E-15 blend.
- And next blend 25% of biodiesel and 75% of diesel in E-25 blend, another blend is 30% of biodiesel and 70% of diesel in E-30blend.
- This different ratio blends are called E-15, E-25 and E-30 respectively.
- This blending process is maintain in room temperature only.

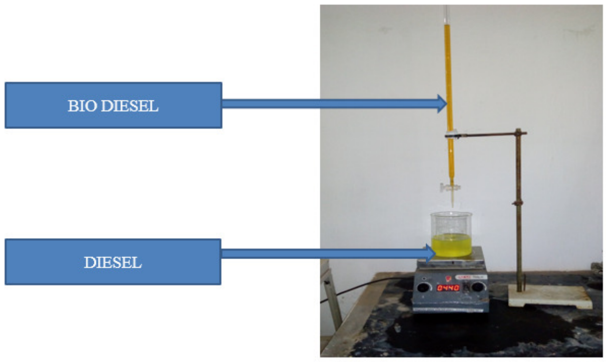

Fig 9.1 Blending process

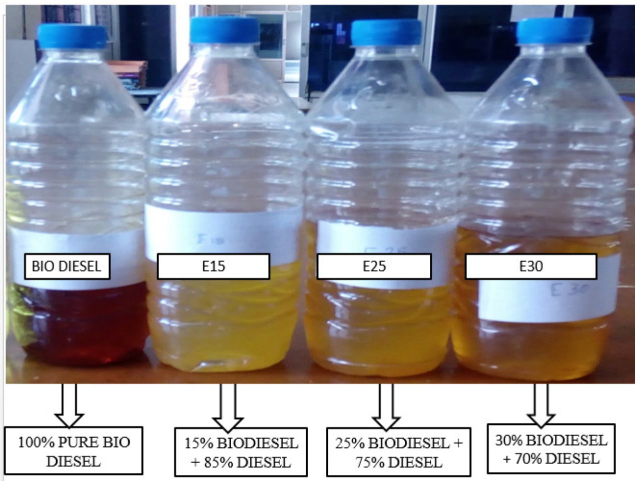

Fig 9.2 Different blending ratios

CHAPTER - 10

EXPERIMENTAL SETUP AND MEASUREMENTS

10.1 DETAILS OF EXPERIMENTAL SETUP

The schematic diagram and photographic of the experimental setup are shown below.

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International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 11, March 2017

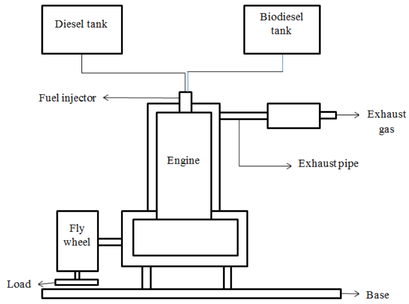

Fig 10.1 Schematic diagram

A single cylinder, 4-stroke, water cooled, diesel engine coupled with electrical dynamometer as shown in figure 2 was used for the present work. The specification of engine & dynamometer are given in table 3.1 & 3.2. The measuring instruments used in this project are listed in table 3.3.

The suction side of the test engine is attached with anti-pulsating drum to measure air inflow quantity. The inlet temperature of air is measured with inlet air thermometer. The exhaust side of the engine consisting of series of devices such as Exhaust Gas Thermometer (EGT), gas analyzer probe and smoke meter probe. A combustion analyzer is also attached with the test rig to study the combustion behavior of engine.

The set-up also consists of fuel flow measuring device to measure the fuel consumption of the engine. The output side of the engine consists of an electrical dynamometer and followed by a loading rheostat. The output is measured in terms of watts using digital wattmeter mounted in the panel. An 8 bit Data Acquisition system (DAS) is also connected with test rig to acquire the combustion pressure and crank angle, pressure –volume, MFB and HRR data for a stipulated number of cycles.

To run the IC engine by using neat diesel and different biodiesel ratios (E15,E25,E30).

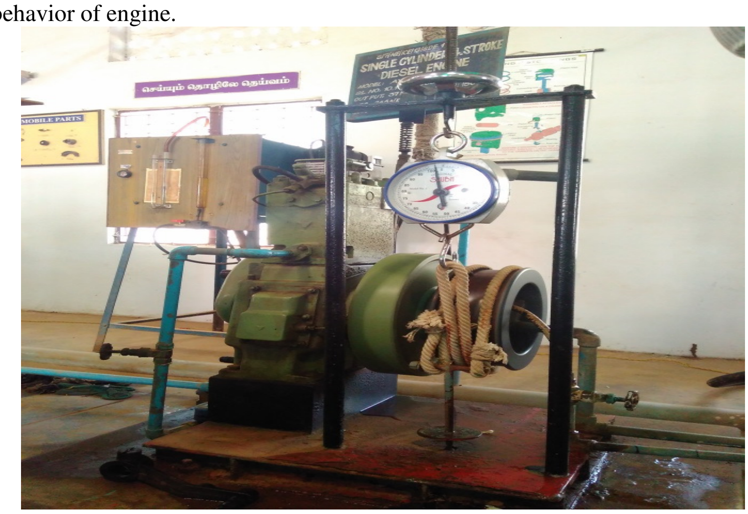

Fig:10.2 Run the IC engine

TABLE 10.1 :ENGINE SPECIFICATION

Type of Engine	Vertical, 4-Stroke cycle, single acting, High speed, DI, diesel engine.
Number of Cylinder	One
Speed	1500rpm
Maximum power output	5Hp(=3.7 kW)

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Bore diameter	80mm
Length of Stroke	110mm
Cubic Capacity	0.553 liters
Normal compression ratio	17.5:1
Fuel timing by spill	23 Deg. BTDC
Lubrication	Forced Full Pressure lubrication
Type of cooling	Water cooled
BMEP at1500 rpm	5.42 bar
Radius of brake drum	162 mm
Diameter of orifice	20 mm
Orifice constant	0.6
Rope diameter	20 mm

TABLE 10.2 :MEASURING INSTRUMENTS USED

MEASURING PARAMETERS	INSTRUMENTS USED
HC, CO, NO_x, CO_2 and O_2	Exhaust gas Analyzer
Smoke	Bosh smoke meter
Air flow rate	Orifice & manometer

10.2 EXHAUST EMISSION MEASUREMENTS

Five-gas analyzer is used to measure the quantity of emission constituents such as CO, CO_2, O_2, UBHC, and NO_xpresent in the exhaust gas. HC and NO_xwere measured in ppm and CO, O_2 and CO_2 measured in percentage (%) by volume. The measurement of exhaust gases was carried out by placing the probe into the exhaust pipe. The probe can be pulled out after taking reading. Similarly measurements were made for all trials. The printout can be obtained from the analyzer for each trial.

10.3 FUEL FLOW MEASUREMENTS

This device consists of graduated burette, fuel tank and two-way cock. During measurement, the two-way cock is arranged in such a way that the fuel descends from burette alone. Then the time taken for specific quantity of fuel consumption was found out using the stopwatch and the fuel consumption rate was evaluated.

10.4 SMOKE MEASUREMENTS

Smoke intensity is measured by means of a Bosch type smoke meter. Gas sample is drawn through a Watt man᾽s filter paper fitted in the smoke sampler pump. The intensity of smoke is measured on a scale of a 10 arbitrary units called Bosch smoke number (BSN), in which full white is assigned a number of 10 and full black is assigned

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10.5 EMISSION TEST APPARATUS:

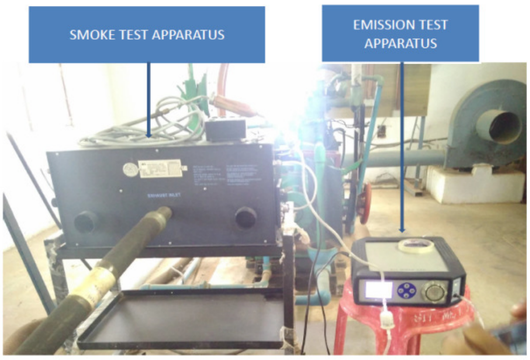

Fig:10.3 Emission test apparatu

CHAPTER - 11

OBSERVATION AND ANALYSIS

11.1 MASS VALUES:

1. BIODIESEL - 5.07×10^{-3} kg
2. NEAT DIESEL - 7.75×10^{-3} kg
3. E 15 - 4.84×10^{-3} kg
4. E 25 - 4.83×10^{-3} kg
5. E 30 - 4.91×10^{-3} kg

11.2PERFORMANCE AND EMISSION TEST FOR VARIOUS BLENDS IN CI ENGINE

TABLE 11.1:OBSERVED READINGS FOR NEAT DIESEL

S.NO	LOADW (kg)	TIME TAKEN FOR 10CC FUEL CONSUMPTION (sec)	SMOKE OPACITY (%)	CO (% OF VOLUME)	CO_2 (% OF VOLUME)	HC (PPM)	NO_χ (PPM)
1.	0	75	19	0.04	2.30	9	64
2	2.	70	20	0.05	2.70	1	84

.	5					1	
3 .	5	64	32	0.06	3.40	1 0	127
4 .	7. 5	53	38	0.07	4.00	1 2	212
5 .	1 0	44	44	0.08	4.60	1 3	260

TABLE11.2 : OBSERVED READINGS FOR E15

S.NO	LOAD W(kg)	TIME TAKEN FOR 10CC FUEL CONSUMPTION (sec)	SMOKE OPACITY (%)	CO (% OF VOLUME)	CO_2 (% OF VOLUME)	HC (PPM)	NO_x (PPM)
1.	0	44.93	14.3	0.06	2.20	17	118
2.	2.5	41.21	15.0	0.07	2.60	18	134
3.	5	32.11	17.2	0.07	3.20	17	193
4.	7.5	29.45	24.0	0.07	3.90	18	230
5.	10	25.37	21.0	0.08	4.60	14	300

TABLE 11.3 : OBSERVED READINGS FOR E25

S.NO	LOAD W(kg)	TIME TAKEN FOR 10CC FUEL CONSUMPTION (sec)	SMOKE OPACITY (%)	CO (% OF VOLUME)	CO_2 (% OF VOLUME)	HC (PPM)	NO_x (PPM)
1.	0	48.1	12.9	0.07	2.10	23	62
2.	2.5	41.2	13.2	0.08	2.50	21	81
3.	5	32.0	15	0.07	3.10	19	125
4.	7.5	30.7	16	0.07	3.90	16	200
5.	10	23.4	21	0.05	4.10	14	260

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ISSN (PRINT): 2454-9762
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TABLE 11.4 : OBSERVED READINGS FOR E30

S.NO	LOAD W(kg)	TIME TAKEN FOR 10CC FUEL CONSUMPTION (sec)	SMOKE OPACITY (%)	CO (% OF VOLUME)	CO_2 (% OF VOLUME)	HC (PPM)	NO_x (PPM)
1.	0	47.02	14.3	0.07	2.10	25	62
2.	2.5	41.27	16.2	0.08	2.50	28	82
3.	5	34.19	13.7	0.07	3.30	22	134
4.	7.5	28.60	14.0	0.07	4.00	24	202
5.	10	24.25	23.0	0.06	4.70	19	264

CHAPTER – 12

RESULT EVALUATION

12.1 MODEL CALCULATION:

FOR E15

0 KG

1) TORQUE (T):

$W = ((w_1 - w_2) + w_0) \times 9.81$

$= ((0-0)+1) \times 9.81$

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W = 9.81

T = 9.81× (0.162+0.010)

= 9.81× (0.172)

T = 1.687 N-m

2) BRAKE POWER (BP):

$$BP = \frac{2\pi NT}{60}$$

$$BP = \frac{2\times\pi\times1500\times1.687}{60}$$

BP = 0.2649 kW

3) SPECIFIC FUEL CONSUMPTION (SFC):

Time for 10cc of FC , t = 72.24 sec

$$mf = \frac{10}{t} \times \frac{specific\ gravity\ of\ B20}{1000} \times 60 \ \text{(kg/min)}$$

$$\text{SPECIFIC GRAVITY (SG)} = \frac{\text{DENSITY OF BIODIESEL}}{\text{DENSITY OF WATER}} = \frac{\rho_{biodiesel}}{\rho_{Water}}$$

DENSITY OF BIODIESEL:

$$\rho_{biodiesel} = \frac{\text{mass}}{\text{volume}}$$

$$= \frac{0.7862}{10\times10^{-6}}$$

$$= 786.2 \frac{kg}{M^3}$$

$$SG = \frac{786.2}{1000}$$

SG = 0.7862

$$m_f = \frac{10}{72.24} \times \frac{0.7862}{1000} \times 60 \text{ kg/min}$$

m_f = 0.00534/min

(where (mf)-mass fuel consumption)

TFC = mf× 60

= 0.00534× 60

TFC = 0.3916 kg/hr

$$SFC = \frac{TFC}{BP}$$

$$= \frac{0.3916}{0.2649}$$

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FC $= 1.4786\ {Kg}/{kW - hr}$

4)HEAT INPUT (HI):

$$HI = \frac{TFC \times CV}{60 \times 60}\ (kW)$$

$$= \frac{0.3916 \times 37550}{60 \times 60}$$

HI = 4.0846kW

5)BRAKE THERMAL EFFICIENCY:

$$\eta_{Bth} = \frac{BP}{HI} \times 100$$

$$= \frac{0.2649}{34.0846} \times 100$$

$\eta_{Bth} = 6.48\%$

Where

CALORIFIC VALUE OF DIESEL (CV) = 45,350 ${KJ}/{kg}$

CALORIFIC VALUE OF BIODIESEL = 37550 ${KJ}/{kg}$

DENSITY OF WATER = 1000

12.2 TEST RESULT:

TABLE 12.1 TEST RESULT FOR NEAT DIESEL

TABLE 12.2 TEST RESULT FOR E15

	BP (kw)	TFC (kg/hr)	SFC (kg/kw-hr)	HI (kw)	ηBth (%)
0 KG	0.264	0.328	1.224	3.374	07.05
2.5 KG	0.927	0.354	0.381	4.095	22.64
5 KG	1.590	0.452	0.284	3.291	28.30
7.5 KG	2.252	0.493	0.219	5.706	39.48
10 KG	2.915	0.572	0.196	6.617	44.57

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	BP (kw)	TFC (kg/hr)	SFC (kg/kw-hr)	HI (kw)	ηBth (%)
0 KG	0.264	0.311	1.940	3.601	07.36
2.5 KG	0.927	0.354	0.382	4.103	22.60
5 KG	1.590	0.428	0.269	4.951	32.11
7.5 KG	2.252	0.511	0.227	5.291	38.04
10 KG	2.915	0.603	0.207	6.981	41.76

TABLE 12.3 TEST RESULT FOR E25

	BP (kw)	**TFC (kg/hr)**	**SFC (kg/kw-hr)**	**HI (kw)**	**ηBth** (%)
0 KG	0.264	0.302	1.141	3.498	07.51
2.5 KG	0.925	0.354	0.379	4.380	21.31
5 KG	1.590	0.483	0.285	5.234	30.32
7.5 KG	2.252	0.472	0.209	5.465	41.20
10 KG	2.915	0.618	0.212	7.149	40.77

TABLE 12.4 TEST RESULT FOR E30

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12.3 GRAPHS:

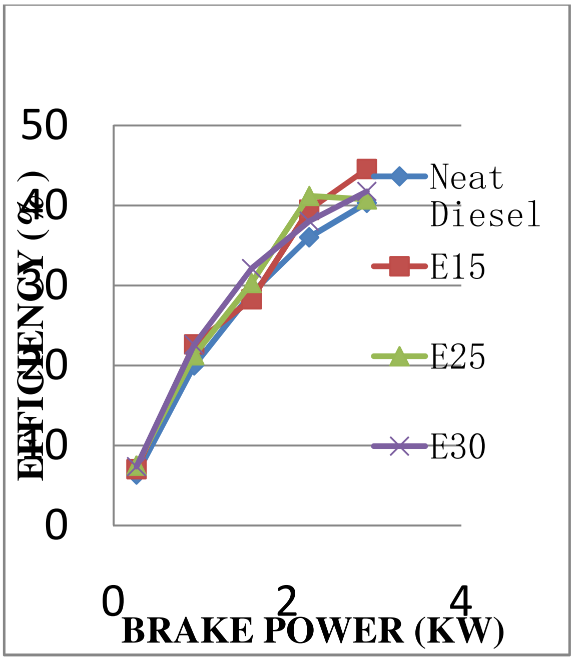

Fig 12.1 BRAKE POWER Vs EFFICIENCY

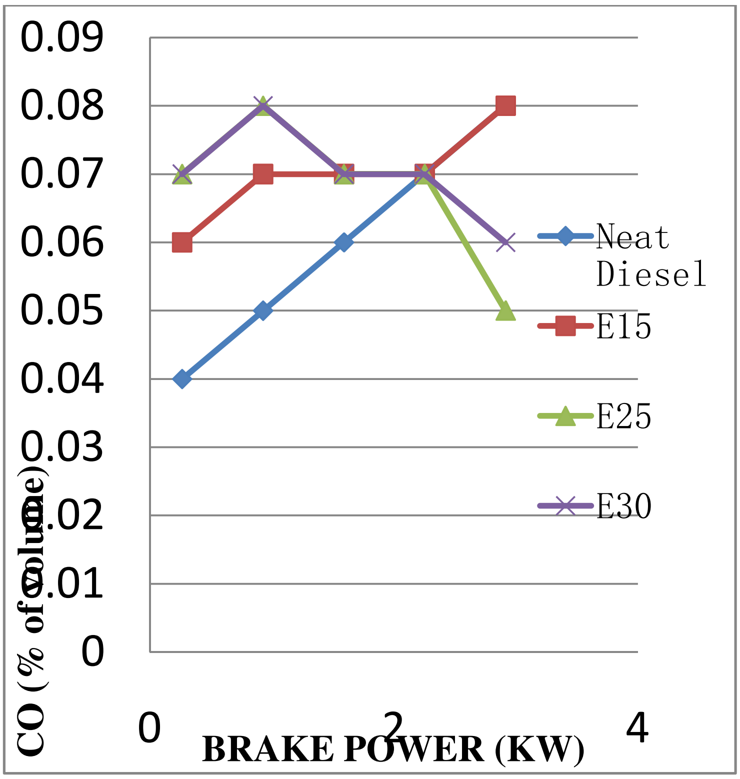

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Fig 12.2 BRAKE POWER Vs CO

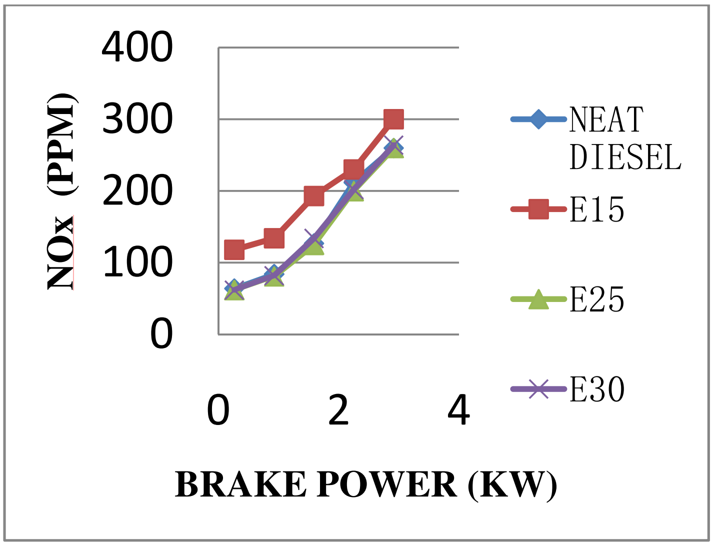

Fig 12.3BRAKE POWER Vs NOx

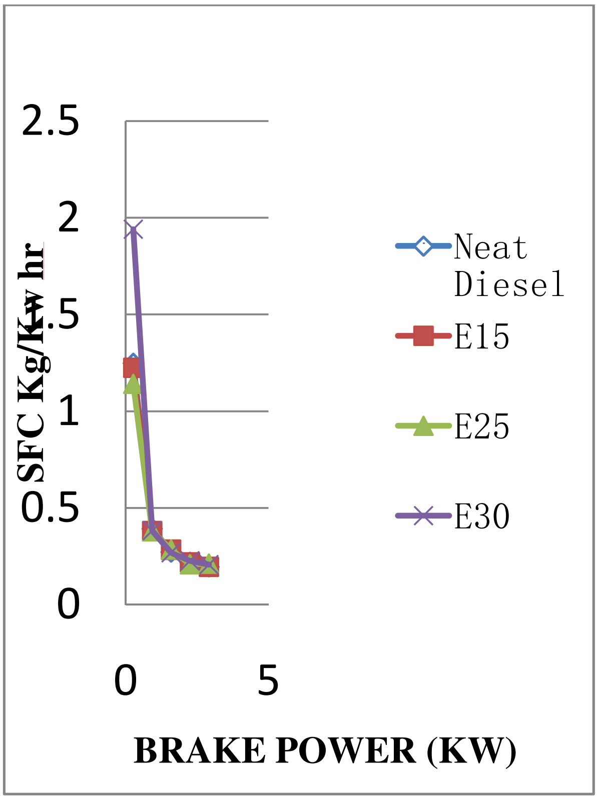

Fig 12.4BRAKE POWER Vs SFC

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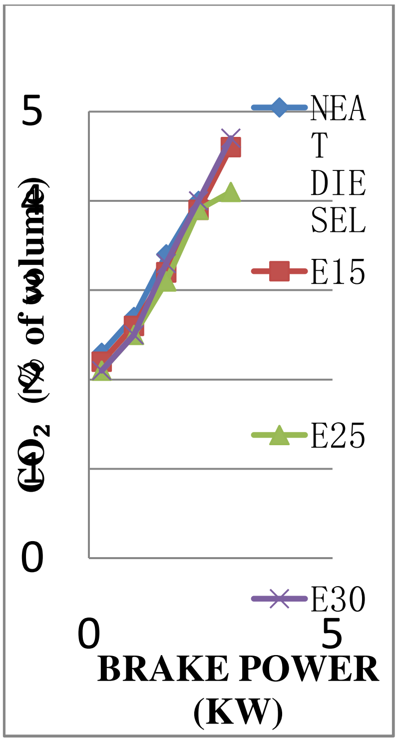

Fig 12.5 BRAKE POWER Vs CO2

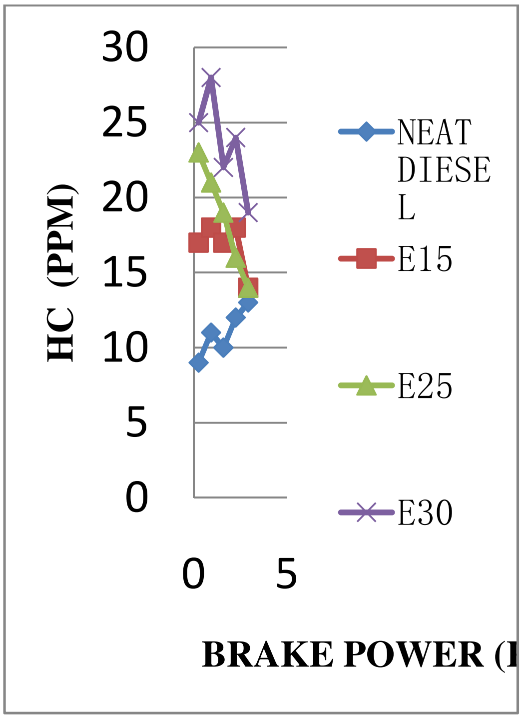

Fig 12.6BRAKE POWER Vs HC

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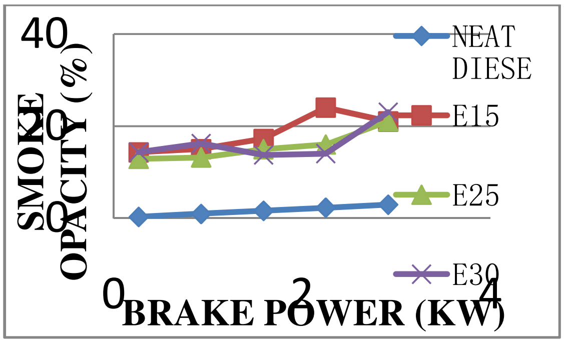

Fig 12.7BRAKE POWER Vs SMOKE OPACITY

CHAPTER - 13
CONCLUSION

Single cylinder diesel engine ran successfully during tests on Eucalyptus oil and its blends even without preheating and require no modification in engine hardware. However while using pre- heated fuel, engine efficiency improved slightly. Performance and emission characteristics of Eucalyptus oil and its blends were found to be comparable to that of mineral diesel.

The brake thermal efficiency was slightly lower in biodiesel blends when compared with diesel fuel.The SFC increases with increase in biodiesel content in the fuel blend due to lesser calorific value in the blend.But in terms of emission HC and co emission was found to be less in biodiesel blends when compared with diesel due to its oxygen content The NOx emission was found to be higher in biodiesel blends when compared with diesel due to rise in operating temperature of the engine when biodiesel was used as fuel.

The smoke density from exhaust gas of preheated lower blends as well as unheated lower blends was almost similar to that of diesel fuel. The emission of NO from all blends with and without preheating are lower than mineral diesel at all load conditions.This is a significant advantage over mineral diesel while using Eucalyptus oil and their blends. Hence it can be concluded that the Eucalyptus oil blends with diesel up to 50% (v/v) without preheating as well as with preheating would replace diesel for running the CI engine for lower emissions and improved performance.

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