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Performance Test on CI Engine Fueled With Fish Oil Based Biodiesel

MAIN PROJECT

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ABSTRACT

The higher consumption of diesel oil have caused the scarcity of petroleum and increasing its cost. The efforts have been performed to develop alternative fuels especially, to the diesel oil for fully or partial replacement. Biodiesel has environmental benefits due to the neat or blends biodiesel can reduce carbon monoxide (CO) emissions, hydrocarbons (HC), particulate matter (PM), and increase nitrogen oxides (NOx) emissions compared with diesel fuel used in an unmodified diesel engine. Here we have used waste fish oil as the raw material for production of biodiesel. Biodiesel has been prepared by the process called transesterification. The blends of this biodiesel was made with pure diesel and had been tested in the single cylinder four stroke engine to find out various parameters. From the data obtained the biodiesel blends shows better fuel properties than the pure diesel.

CHAPTER-1

INTRODUCTION

1.1 MOTIVATION

Increasing worldwide concern over combustion-related pollutants, such as particulate matter (PM), oxides of nitrogen (NOx), carbon monoxide (CO), total hydrocarbon (THC), acid rain, photochemical smog and depletion of the ozone layer, has led regulatory agencies to implement stringent emission regulations. Diesel engines are one of the major contributors to the pollutant emissions since they are widely used due to high combustion efficiency, reliability, adaptability and cost effectiveness. Soot and NO x are formed during diesel combustion, the required levels of PM, NOx are difficult to achieve through the improvement of combustion chamber and injection design. It is commonly accepted that clean combustion of diesel engines can be fulfilled only if engine development is coupled with diesel fuel reformulation. In the name of energy security, regional air quality, greenhouse gas emission reduction and even economic savings, oxygenated fuels were advocated to reduce particulate emissions. .Alternative fuels, known as non-conventional or advanced fuels, are any materials or substances that can be used as fuels, other than conventionalfuels. Some well-known alternative fuels include biodiesel and bio alcohol.

Fuel is any material that stores potential energy in a form that can be practicably released and used as heat energy. The concept originally applied solely to those materials storing energy in the form of chemical energy that could be released through combustion. The reduction of particulate emissions due to the introduction of oxygenated compounds depends on the molecular structure, oxygen content of the fuel. And local oxygen in the fuel plume. Due to the increase and fluctuation in prices of diesel fuel and petrol a growing environmental conscience and the shortage of petroleum, an alternative to fossil fuels is needed. Government policies in different countries are motivating the use of substitute fuels for petroleum-based ones.

1.2 SIGNIFICANCE

Most of us know that transportation, though necessary, is also causing harm to the environment and to our health. The problem is that automobiles, buses, and trucks – the most commonly used forms of transportation – require gasoline for fuel. Gasoline is a refined by-product of oil, a fossil fuel. Diesel fuel, mainly used for heavy duty vehicles such as buses and trucks, is the cheapest and crudest form of gasoline, and is the most hazardous fuel because it emits a tremendously higher level of pollutants per mile than conventional gasoline. The danger in gasoline and diesel and other fossil fuels (except natural gas) is that they contain certain gases that, when released into the air negatively affect air quality and damage the environment. These particular gases are not compatible with the respiratory systems and processes of life on

Earth. As well, these gases are an unnatural addition to the delicate atmospheric balance of gases that work together to sustain and protect life on Earth. As a result, gases from fossil fuel emissions have caused and are continuing to cause great damage to the atmosphere.The most significant advantages of using alternative fuels is that it saves fuel prices, decreases global warming, and keeps the environment cleaner.

1.4 BIODIESEL AS A FUEL

Biodiesel is briefly defined as the mono alkyl esters of long chain fatty acids derived from renewable lipid sources. It is used as a direct replacement or blend stock component for petroleum based diesel. A 100% biodiesel fuel is referred to as B100. A biodiesel blend is pure biodiesel blended with petro diesel and are referred to as BXX. The XX indicates the amount of biodiesel in the blend (*i.e.*, a B80 blend is 80% biodiesel and 20% petro diesel).Biodiesel is derived from vegetable oils or animal fats through the process of transesterification. Direct use of vegetable oils and/or the use of blends of the oils have generally been considered to be not satisfactory and impractical for both direct and indirect diesel engines. The process of transesterification will reduce the kinematic viscosity and flash point of oil. Production of mono alkyl esters of long chain fatty acids requires the following.1) Source of triglycerides 2) an alcohol 3) catalyst. The commonly used sources of triglycerides are soya bean oil, cotton seed oil, palm oil, animal fats, waste cooking oil etc. The major disadvantages of biodiesel are its higher viscosity, lower energy content, higher cloud point and pour point, higher nitrogen oxide (NOx) emissions, lower engine speed and power, injector coking, engine compatibility, high price and greater engine wear. Biodiesel is renewable and eco-friendly and its emission profile is much lower than fossil fuels .Experts suggest that current oil and gas reserves would suffice to last only a few more decades. To meet the rising energy demand and replace reducing petroleum reserves, fuels such as biodiesel and bio-ethanol are in the forefront of alternative sources and hence renewed interest in research in the field of bio-fuels.

Biodiesel has about 90% of the energy content of petroleum diesel, measured on a volumetric basis. Due to this fact, on average the use of biodiesel reduces the fuel economy and power of an engine by about 10% in comparison with petroleum diesel. The reason for this reduction stems mainly from the oxygen content of biodiesel, ensuing better combustion process, and improved lubricity, which partly compensate for the impact of the lower energy content.

1.4 BIO DIESEL FROM FISH OIL WASTE

The fish oil was separated from fish wastes with the help of the designed oil extraction machine. Generally 50% of fish wastes were in liquid phase (mixture of water, oil and suspended solids) and the extracted oil was about 6% of the total weight of the fish wastes.

Biodiesel fuel was then produced from the extracted fish oil after the chemical reaction (transesterification, reaction between ethanol , potassium hydroxide and oil from fish waste). Important fatty acids like palmeitoleic , palmitic acid, stearic acid oleic acid , linoleic acid and linolenic acid, eicosapentaneoic acid and decosa hexanoic acid were identified for the extracted oil. These fatty acids affect the magnitude of the octane number of biodiesel fuel.

This by-product has similar calorific value to petroleum distillates and is a renewable energy sources. Several studies has been carried out for using fish oil as fuel for diesel engines ;the fish oil has lower content of carbon and slightly higher content of hydrogen. The fish oil has larger flash point but lower kinematic viscosity. As a result, the viscosity of the blend is much lower .this could reduce the requirement for preheating the fuel to make it flow easily, and reduce demands. Lower viscosity could also improve the atomization of the burner. According to Food and Agriculture Organization (FAO), in 2014 the estimated world fish production is about 164 MT. approximately. The volume of waste produced by processing plants is calculated to be around 50% of the total processed fish, for which the amount of oil varies from 40% to 65%. Bio-oil has a large variety of compositions as a function of the feedstock.

Transesterification:

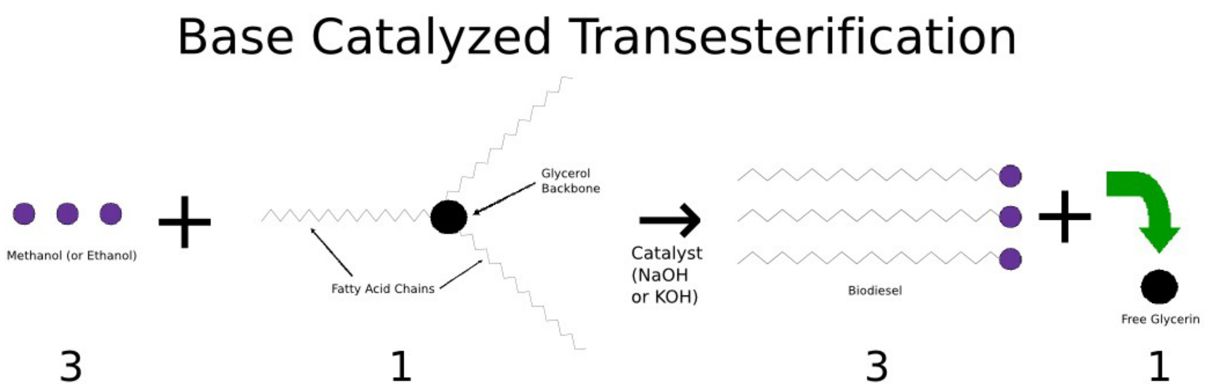

FIG NO.1.4.1 : TRANSESTERIFICATION PROCESS

3 alcohol + 1 triglyceride (fats/oils) → 3 methyl esters (biodiesel) + 1 glycerin

Triglycerides (aka fats/oils):

Fish oil is composed of triglycerides. The basic components of the triglyceride molecule are 3 fatty acid chains and a glycerol backbone (described in the above diagram). It is the type of fatty acid which defines the variability in cold flow, viscosity, and stability between different fats and oils.

Alcohol: (ethanol) -

A significant excess of ethanol is used to help push the reaction towards the production of more biodiesel. Generally, a 5:1 alcohol to oil molar ratio is used. In layman's terms, this means that about twice as much alcohol is used by volume as is theoretically needed in the reaction. The excess ensures no unconverted glycerides (a term which includes monoglycerides, diglycerides, and triglycerides) remain in the finished product.

Catalyst –

The most commonly available catalysts for transesterification are sodium hydroxide (NaOH) or potassium hydroxide (KOH). When mixed with methanol, KOH and NaOH react to form methoxide (sometimes called methylate), which actually catalyzes the reaction. Other catalysts exist, but none have found extensive commercial application as of the writing of this study. KOH and NaOH are difficult to reuse, and are usually not recovered. Instead they are removed from the finished product by washing with water.

The catalyst acts to accomplish two things: to sever the connection between the fatty acid chain and the glycerol backbone, and to connect the fatty acid chain to a methanol molecule, forming one molecule of biodiesel.

Under ideal conditions and assuming no loss during the reaction, the amount of biodiesel produced should be equal to the amount of oil inputted. When using sodium or potassium catalysts, the separated biodiesel will have some amount of residual catalyst remaining. It will also contain varying levels of soap, a byproduct of undesirable side reactions, a portion of the excess alcohol which was not consumed in the reaction, and a small amount of water (created during the formation of both methoxide and soap). These unwanted products are removed.

CHAPTER-2

LITERATURE SURVEY

2.1. BIODIESEL

NATIONAL BIODIESEL BOARD, USA

This is a case study prepared by NBB, USA showing the importance of biodiesel and its application in various areas. Biodiesel can be prepared from various sources such as animal fats, vegetable oils etc. also there are various methods discussed for the production of biodiesel. It also discusses the current situation of the environment in using the conventional fuels and need of using alternate fuels such as biodiesel. It also discusses the advantages and disadvantages of the biodiesel.

2.2. PRODUCTION AND APPLICATION OF BIODIESEL-A CASE STUDY

PRABHU.A, ANAND.R.B

In this journal various they have discussed the history of biodiesel, biodiesel cultivation and harvesting methods etc. It also discusses the various production techniques involved in the production of biodiesel. They discussed about three methods for the production of biodiesel and also the feasibility of production by different techniques. It also discusses about the application and need of using biodiesel in the current situation in various areas such as automobiles, boilers etc. It also gives an introduction in the application of nano particles in biodiesel production.

2.3. RECENT TRENDS AND APPLICATION OF BIODIESEL

N.KANTHAVELKUMARAN, Dr. P. SEENIKANNAN

In this journal the technological requirements for process and production of biodiesel is discussed. Apart from that the possibility of using biodiesel in automobile as an alternate fuel is also discussed. The slight modifications in biodiesel make it easier to use this in automobile. This also covers the attributes like emissions, feed, stocks, production, method, and also the advantages and disadvantages is discussed.

2.4. PROPERTIES AND SUSTAINABILITY OF BIODIESEL FROM ANIMAL FATS AND FISH OIL

TERESSA. M. MATA, ADELLO M. MENDES

This journal analyses the fat and fuel properties and methyl ester profile of biodiesel from animal fats and fish oil. Also they presented the sustainability of this biodiesel with the rapeseed biodiesel and fossil diesel. From their analysis results it is known that it can be used for the production of biodiesel. Also the properties of various biodiesels are also discussed.

2.5. HOW TO UTILIZE FISH WASTE IN A SUSTAINABLE AND ECO-EFFICIENT WAY

AQUAREL

In this it have been discussed about the pollution caused by depositing fish waste in soil or in any other places. It mentions about the effective utilization of fish waste for various purposes mainly it includes the production of biodiesel from fish waste.

2.6. FRAMEWORK ANALYSIS OF FISH WASTE TO BIODIESEL PRODUCTION

TONY PICCOLO

In this journal he discussed about the adaptability of producing biodiesel from fish waste. Since waste is a residue from the fish oil processing units it is favorable to produce biodiesel from these waste in order to use this purposes like heating boiler, electricity generation etc. It also gives the framework for the production of biodiesel from fish waste.

2.7. THE POTENTIAL OF FISH PROCESSING WASTES FOR BIODIESEL PRODUCTION

DEEPAK DAVE, HEATHER MANUAL

This journal deals with the development of an economically viable and environmentally sustainable biodiesel production system for rural communities in Newfoundland and Labrador and to help marine processing plants cut down their operating cost, by diminishing the problem of fish waste disposal and by providing alternative fuel for the operation of feed barges, marine vessels and generators located at their remote locations. They also checked the chemical and physical properties of fish oil based biodiesel thus help us to compare our values with it.

2.8. BIODIESEL FUEL PRODUCTION BY METHANOLYSIS OF FISH OIL DERIVED FROM THE DISCARED PARTS OF FISH

P.PINYAPHONG, P. SRIBURI, S. PHUTRAKUL

In this paper biodiesel production from discarded parts with carica papaya lipase is used as catalyst. In this refined fish oil was used as a starting material for biodiesel production. From this paper we understood the economical method for the production of biodiesel. This also discusses about the method to enhance the yield of production of bio diesel.

2.9. FAST SYNTHESIS OF HIGH QUALITY BIODIESEL FROM WASTE FISH OIL BY SINGLE STEP TRANSESTERIFICATION

YOGESH SHARMA, BHASKER SINGH, ZAHIRA YAAKOB

In this journal they have discussed about the single step transesterification using a alkaline catalyst(CH_3ONa). By using this catalyst the process become fast and can produce a biodiesel of high fame content. It also gives information about the coastal resources of India and the method collection fish waste and using it for the production of high quality biodiesel production.

2.10. WASTE FISH OIL BIODIESEL AS ASOURCE OF RENEWABLE FUEL IN IRAN

R. YAHAEE, B. GHOBADIAN, G. NAJAFI

In this paper it has been mentioned about the country Iran were they uses biodiesel, bio fuels in alternative for conventional fuels. They have been producing biodiesel from various sources now they have been found that biodiesel can be produced from aquatic waste and they mention that it is highly renewable source of energy. They have checked the various chemical and physical properties of the biodiesel produced. From this paper we understood the maximum amount of fish oil that can be extracted from the certain amount of waste. It also mentions the procedure for extraction and also the catalyst to be used.

2.11. INTEGRATED RENEWABLE ENERGY SOLUTIONS FOR AQUACULTURE PROCESSING

HIDDLE RONDE, ERIC PEIRRANO, IAN BRUYNE

This paper discusses about the poly generation application with renewable energy sources for the fishery industry. They intended to produce biodiesel from fish waste and this fish waste can be utilized for the freezing or heating purposes. In addition they also mentions about the production of electricity by using a cogeneration plant.

2.12. AN EXPERIMENTAL STUDY ON THE APPLICATION OF FISH OIL AS FUEL

BJORN MIKKEL RYGH

In this paper they have been said about the test they have been carried out with the blends of two fish oils with marine gas oil in the constant volume combustion chamber. They checked the combustion characteristics of the blends. They also checked the blends with various injection pressures. They have tested both the biodiesel and crude oil of fish oil. Also they have calculated the properties such as density, viscosity etc from this we are able to

CHAPTER-3

EXPERIMENTAL INVESTIGATION

3.1. LOAD TEST ON SINGLE CYLINDER FOUR STROKE DIESEL ENGINE

The specification of the selected diesel engine is shown in Table 3.1. Single cylinder four-stroke water cooled diesel engine running at constant speed of 1500 rpm was used for this work. The engine consists of an electric loading arrangement for measuring net load and fuel consumption.

BORE DIAMETER	80 mm
STROKE LENGTH	110mm
No. OF STROKES	4
No. OF CYLINDERS	1
RATED POWER	5 hp (3.73 KW)
RATED SPEED	1500 rpm
TYPE OF COOLING	WATER COOLED
TYPE OF LOADING	ELECTRICAL TYPE
ALTERNATOR EFFICIENCY	80%
ENERGY METER CONSTANT	300rev/kWhr

TABLE 3.1 : ENGINE SPECIFICATION

Load test is conducted on the above specified engine and parameters such as brake power (BP),total fuel consumption (TFC), specific fuel consumption (SFC), frictional power, indicated mean effective pressure (IMEP), brake mean effective pressure (BMEP), and also the efficiencies such as brake thermal efficiency (η_{bth}), indicated thermal efficiency (η_{ith}), mechanical efficiency (η_{mech}) and also the graphs such as SFC vs BP, IMEP vs BP, BMEP vs BP, η_{bth} vs BP, η_{bth} vs BP ,η_{mech} vs BP.

PROCEDURE:

The maximum load that can be applied so as to not overload the engine was calculated. The engine was started after taking all precautions mentioned above. The engine was made to run for some time to attain the steady state. At no load time for 10 cc fuel consumption was noted. The clutch was engaged and the engine was loaded with the hydraulic dynamometer. The time for 10 cc diesel consumption was noted. The experimental was repeated by increasing the load in equal steps to maximum load. The engine was then brought to no load and was stopped by cutting off fuel supply. The observations are tabulated.

CALCULATIONS:

- Max.Load (kg) P_{max} =3730×Alternator Efficiency
- Brake power (kw) BP = (n×3600)/(k×t×alternator efficiency)

  BP = brake power in kW

  n = No. Of revolutions of the energy meter

  t = Time taken for n revolutions of the energy meter (s)

  k = Energy meter constant
- Total fuel consumption,TFC = (V×ρ_d×3600)/t (kg/h)

  ρ_d =specific density of fuel
- Specific fuel consumption, SFC = TFC/BP (kg/kwh)
- Brake thermal efficiency(%) η_{bth} = {(BP ×3600) / (TFC × C_v)}×100
- Frictional power
  - Graph between BP and TFC is plotted. From which the BP corresponding to zero. TFC is noted and it's equal to FP

- Brake mean effective pressure (KN/m^2)

  BMEP = (BP ×60000) / (L ×A ×(N/2) × n)

  L= stroke A= area of cylinder = $\pi/4 \times (D^2)$ m^2 n=4
- Indicated Power (IP) = BP + FP
- Indicated Mean Effective Pressure

  IMEP = (IP ×60000) / (L ×A × (N/2) × n)
- Indicated thermal efficiency (η_{ith}) (%)

  (η_{ith}) = (IP × 3600) / (TFC × C_v) (%)
- Mechanical efficiency (%) η_{mech} = (BP/IP) ×100

FIG NO.3.1 : SINGLE CYLINDER FOUR STROKE ENGINE

Using the above relations, the parameters are calculated for pure diesel, and Biodiesel-diesel blends. The obtained values are then plotted graphically to get a pictorial view of the performances. The blends used for the experimental analysis in single cylinder four stroke diesel engine are prepared by mixing various percentage of ethanol and biodiesel with the diesel. The blends used for the experimental analysis are B5 (biodiesel 5% and diesel 95%), B10 (biodiesel 10% and diesel 90%), B15 (biodiesel 15% and diesel 85%), B20 (biodiesel 20% and diesel 80%). The load test and heat balance test are carried out in the engine by using the above mentioned blends.

The maximum load that can be applied so as to not overload the engine was calculated. The engine was started after taking all precautions. The engine was made to run for some time to attain the steady state. At no load time for 10 cc fuel consumption was noted.. The setup used for the testing consists of a single cylinder, four-stroke engine, an alternator and an electrical loading arrangement. The alternator is connected to the output shaft of the engine. Bulb type loading was used in the loading arrangement. The time for 10 cc diesel consumption was noted.

The experimental was repeated by increasing the load in equal steps to maximum load. The engine was then brought to no load and was stopped by cutting off fuel supply. The experiment is carried out in two stages. The single cylinder four stroke diesel engine is tested by using the engine is tested by using biodiesel blends such as B5, B10, B15 and B20.

The relative densities of all the blends were found to be lower than that of diesel fuel alone. The relative density was dependent on temperature. Calorific values of the blends were lower than that of diesel but the deviation from the calorific value of diesel is approximately less than 5%, which is in acceptable

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range.

3.2. BOMB CALORIMETER

In bomb calorimeter, there is a sealed container capable of holding several atmospheres of gas pressure. A weighed sample of substance is placed in contact with an ignition wire inside the bomb. The bomb is filled to about 20 atm of pressure with O_2, sealed, and placed in a known amount of water. An electric current is passed through a wire to ignite the mixture. As the combustion takes place, the heat evolved raises the temperature of the calorimeter and its surrounding water. In order to prevent heat loss from the calorimeter system, it is surrounded by a second water bath, whose temperature is continuously adjusted to match that of th calorimeter. Thus, the heat transfer between the system and the surroundings is zero, making the process adiabatic.

FIG NO.3.2 :BOMB CALORIMETER

<u>Calculations</u>

Mass of water = 1200 grams

C of water = 4.184 J/g°C

Change in temperature of water $\Delta T = T_1 - T_2$

Heat absorbed by water, $Q_w = (m)(c)(\Delta T)$kJ

Heat capacity of the calorimeter, C_{cal} = 837 J/°C

Change in temperature of calorimeter $\Delta T = T_1 - T_2$

Heat absorbed by calorimeter = $(C_{cal})\ (\Delta T)$ kJ

Calorific value of the given fuel = $(m)\ (c)\ (\Delta T) + (C_{cal})(\Delta T)$ kJ

3.3. REDWOOD VISCOMETER

The redwood viscometer consists of vertical cylindrical oil cup with an orifice in the centre of its base. The orifice can be closed by a ball. A hook pointing serve as a guide mark for filling the oil. The cylindrical cup is surrounded by the water bath. The water bath maintains the temperature of the oil to be tested at constant temperature. The oil is heated by heating the water bath by means of an immersed electric heater in the water bath. The provision is made for stirring the water to maintain the uniform temperature in the water bath and to place the thermometer it record the temperature of oil and water bath. The cylinder is 47.625mm in diameter and 88.90mm deep. The orifice is 1.70mm in diameter and 12mm in length. This viscometer is used to determine the kinematic viscosity of the oil. From the kinematic viscosity the dynamic viscosity and density is determined.

Viscosity is the property of fluid. It is defined as “the internal resistance offered by the fluid to the movement of one layer of fluid over an adjacent layer”. It is due to the cohesion between the molecules of the fluid. The fluids which obey the Newton law of viscosity are called as Newtonian fluid.The dynamic viscosity of fluid is defined as the shear required to produces unit rate of angular deformation.

FIG NO.3.3. VISCOMETER

3.4. CLEVELAND OPEN CUP APPARATUS

The flash and fire point of the lubricating oil is defined as the lowest temperature at which it forms vapors and produces combustible mixture with air. The higher flash point temperature is always desirable for any lubricating oil. If the oil has the lower value of flash point temperatures, it will burn easily and forms the carbon deposits on the moving parts. The minimum flash temperature of the oil used in IC engines varies from 200^0 C to 250^0 C. when it is tested by open cup apparatus the temperature is slightly more than the above temperatures. The flash and fire point temperatures may differs by 20^0 C to 60^0 C when it is tested by open cup apparatus. However a greater difference may be obtained if somr additives are mixed with oil. The flash and fire point temperatures depends upon the volatility of the oil.

The Cleveland open cup apparatus consists of cylindrical cup of standard size. It is held in position in the metallic holder which is placed on a wire gauge. It is heated by means of an electric heater housed inside metallic holder. A provision is made on the top of the cup to hold the thermometer. A standing filling mark is done on the inner side of the cup and the sample of oil is filled up to the mark. This apparatus will give more accurate results than any other type.

FIG NO.3.4. CLEVELAND OPEN CUP APPARATUS

CHAPTER-4

SAMPLE CALCULATION

Calculation of values based on B5 readings:

1. BRAKE POWER, BP = (n* 3600)/(K*alternator efficiency*t)
= (5*3600)/(300*0.8*41)
= 1.867kW

2. TOTAL FUEL CONSUMPTION, TFC = (v*ϱ*3600)/T
= (0.01*0.82075*3600)/44.1
= 0.67kg/hr

3. SPECIFIC FUEL CONSUMPTION, SFC = TFC/BP
= 0.67/1.867
= 0.358 kg/kWhr

4. INDICATED POWER ,IP = BP+FP
= 1.867+1.299
= 3.167kW

5. BRAKE THERMAL EFFICIENCY, η_{bth} = (BP*3600)/(TFC*CV)
= (1.867*3600)/(0.67*44095.13)
= 22.75%

6. INDICATED THERMAL EFFICIENCY,η_{ith} = (IP*3600)/(TFC*CV)
= (3.167*3600)/(0.67*4405.13)
=38.59%

7. BRAKE MEAN EFFECTIVE PRESSURE, B_{mep}= (BP*60000)/(L*A*$N_{/2}$*n)
= (1.867*60000)/(0.11*0.00502*750*1)
= 270.16 kN/m^2

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8. INDICATED MEAN EFFECTIVE PRESSURE, I_{mep}=(IP*60000)/(L*A*$N_{/2}$*n)

= (3.17*60000)/(0.11*0.00502**750*1)

= 458.25 kN/m^2

9. MECHANICAL EFFICIENCY, η_{mech}= (BP/IP)*100

= (0.67/3.17)*100

= 21.13%

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CHAPTER-5

EXPERIMENTAL RESULTS

5.1. PROPERTIES OF BIODIESEL-DIESEL BLENDS

Some fuel properties of local biodiesel blended with diesel were experimentally determined to establish their suitability for use in compression ignition engines.

FUEL	**DENSITY (kg/m^3)**	**DYNAMIC VISCOCITY (Ns/m^2)**	**FLASH POINT (^0C)**	**CALORIFIC VALUE (kJ/kg)**
Diesel	820	0.00167	92	44514
Biodiesel	805	0.00157	170	41266
B5	819.25	0.00153	98	44188.3
B10	817.84	0.00149	105	43862.6
B15	816.69	0.00143	114	43536.9
B20	814.16	0.00139	126	43211.2

TABLE NO. 5.1 : PROPERTIES TABLE

The results show that both the relative density and viscosity of the blends decreased as the biodiesel content in the blends were increased. It can be observed that as the percentage of biodiesel in the blends was increased, the relative densities decreased. This is due to the fact that oil has lower density and as such will lower the density when mixed with diesel.

5.2. LOAD TEST RESULTS

Blends used in experiment are prepared by mixing diesel with biodiesel in various percentages in concentration. The engine speed was fixed at 1500rpm.The setup used for the testing consists of a single cylinder, four-stroke engine, an alternator and an electrical loading arrangement. The alternator is connected to the output shaft of the engine. Bulb type loading was used in the loading arrangement.

The performance characteristic of a single cylinder four stroke diesel engine at various loads from no load to full load fueled with biodiesel and its diesel are discussed below as per the results obtained. The blends used for the performance tests are B5, B15, B15, and B20.

5.2.1 BRAKE POWER

Engine power is mainly classified into brake power and indicated power, generally represented as bp and ip. Indicated power is based on indicated net work and is thus a measure of forces developed within the cylinder. More practical is the rotational force available at the delivery point, at the engine crankshaft and the power corresponding to it. This power is interchangeably referred to as brake power, shaft power or delivery power. In general only the term brake power bp, has been used. The bp is generally measured by attaching a power absorption device to the drive shaft of the engine. In general brake power increases as the load increases and the proportion of blends increases. At full load condition brake power (in kW) obtained are as follows 2.368, 2.47, 2.48, 2.496, 2.514 for diesel, 5, B10, B15, B20 respectively.

SL NO	LOAD					
		DIESEL	B5	B10	B15	B20
1	0	0	0	0	0	0
2	400	0.556	0.577	0.578	0.581	0.593
3	1000	1.301	1.355	1.356	1.388	1.389
4	1400	1.596	1.867	1.923	1.94	1.958
5	2000	2.368	2.47	2.48	2.496	2.514

TABLE NO..5.2.1 :BRAKE POWER

5.2.2 SPECIFIC FUEL CONSUMPTION

Specific fuel consumption is the ratio that compares the fuel used by the engine to the amount of power the engine produces. Specific fuel consumption allows manufacturers to see which engine use the least fuel while still producing high amount of power. It allows engines of all different sizes to be compared to see which is the most fuel efficient. A lower number equals a higher efficiency because the engine is creating a high level of power while using a low amount of fuel. Diesel engines typically perform better than gasoline engines in term of BSFC. The variation of brake specific fuel consumption with brake power is shown in fig.6.1,,the plot it is reveals that as the load increases the fuel consumption decrease. At full load condition specific fuel consumption obtained are 0.336 kg/kwhr, 0.33 kg/kwhr, 0.32 kg/kwhr, 0.31 kg/kwhr, and 0.30 kg/kwhr, for fuels of diesel, B5, B10, B15, B20 respectively.

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SL NO	LOAD (kW)					
		DIESEL	B5	B10	B15	B20
1	0	0	0	0	0	0
2	400	0.880	0.86	0.85	0.84	0.85
3	1000	0.504	0.47	0.36	0.46	0.35
4	1400	0.439	0.36	0.34	0.33	0.32
5	2000	0.357	0.34	0.33	0.32	0.30

TABLE 5.2.2 : SPECIFIC FUEL CONSUMPTION

5.2.3. BRAKE THERMAL EFFICIENCY (η_{bth})

The variation of brake thermal efficiency with brake power is shown in fig.6.2.,from the plot it is observed that as the load increases the brake thermal efficiency increases. At full load condition the brake thermal efficiency obtained are 24.08%, 24.46%, 25.40%, 26.35%, and 27.65% for fuels of diesel, B5, B10, B15, B20 respectively.

SL NO	LOAD (kW)					
		DIESEL	B5	B10	B15	B20
1	0	0	0	0	0	0
2	400	7.96	9.47	9.68	9.86	9.88
3	1000	16.03	17.49	17.63	18.04	18.63
4	1400	18.45	22.75	24.02	24.22	24.86
5	2000	22.71	24.11	24.63	25.94	27.44

TABLE NO. 5.2.3: BRAKE THERMAL EFFICIENCY

5.2.4. INDICATED THERMAL EFFICIENCY (η_{ith})

The variation of indicated thermal efficiency with brake power is shown in fig.6.3, the plot it is reveals that as the load increases the indicated thermal efficiency increases. At full load condition the indicated Thermal efficiency obtained are 35.90%, 35.27%, 37.21%, 38.45%, and 40.51% for fuels of diesel, B5, B10, B15, B20 respectively.

SL NO	LOAD (kW)					
		DIESEL	B5	B10	B15	B20
1	0	20.83	22.63	23.34	23.47	23.94
2	400	26.59	30.8	31.46	31.95	32.17
3	1000	32.06	34.26	34.94	35.19	36.08
4	1400	33.48	38.51	40.25	40.46	41.45
5	2000	35.18	36.79	38.05	39.51	34.71

TABLE NO.5.2.4 : INDICATED THERMAL EFFICIENCY

5.2.5. MECHANICAL EFFICIENCY(η_{mech}):

The mechanical efficiency of an engine will be highest when the engine is running at the speed at which maximum bhp is developed. The variation of mechanical efficiency with brake power is shown in fig.6.4, the plot it is reveals that as the load increases the mechanical efficiency increases. At full load condition the brake thermal efficiency obtained are 67.06%, 69.35%, 68.25%, 68.52% and 68.25% for fuels of diesel, B5, B10, B15, B20 respectively.

SL NO	LOAD					
	(kW)	DIESEL	B5	B10	B15	B20
1	0	0	0	0	0	0
2	400	29.94	30.74	30.77	30.87	30.63
3	1000	50.01	51.04	51.04	51.27	51.65
4	1400	55.1	58.95	59.67	59.87	59.98
5	2000	64.56	65.54	65.05	65.66	59.12

TABLE NO.5.2.5: MECHANICAL EFFICIENCY

5.2.6. BRAKE MEAN EFFECTIVE PRESSURE (Bmep):

Brake mean effective pressure is the average pressure inside the cylinders of an internal combustion engine based on the calculated brake power. The variation of brake mean effective pressure with brake power is shown in fig.6.5. As brake power increases pressure also gets increases. At full load the Bmep (in kN/m^2) are 342.67, 357.74, 350.05, 359.72 and 271.97 for fuels of diesel B5,B10,B15 and B20.

SL NO	LOAD					
	(Kw)	DIESEL	B5	B10	B15	B20
1	0	0	0	0	0	0
2	400	80.38	83.47	83.58	84.01	83.05
3	1000	188.17	196.11	196.11	197.9	200.95
4	1400	230.88	270.16	278.24	280.64	281.95
5	2000	342.17	357.74	350.05	359.72	271.97

TABLE NO.5.2.6: BRAKE MEAN EFFECTIVE PRESSURE

5.2.7..INDICATED MEAN EFFECTIVE PRESSURE (Imep):

Indicated mean effective pressure is the average pressure inside the cylinders of an internal combustion engine based on the calculated indicated power. It increases as manifold pressure increases. The variation of indicated mean effective pressure with brake power is shown in table. As indicated power increases pressure also gets increases. At full load the Imep (in kN/m^2) are 530.77, 545.25, 538.14, 547.89 and 460.06 for fuels of diesel B5,B10,B15 and B20.The variation is shown in fig.6.6.

SL NO	LOAD					
	(kW)	DIESEL	B5	B10	B15	B20
1	0	188.09	188.09	188.09	188.09	188.09
2	400	268.47	269.67	270.32	272.10	271.14
3	1000	376.268	378.2	385.99	385.99	39.04
4	1400	418.97	417.83	416.33	418.33	460.95
5	2000	530.77	531.14	545.23	547.89	460.06

TABLE NO.5.2.7: INDICATED MEAN EFFECTIVE PRESSURE

CHAPTER-6

GRAPHICAL ANALYSIS

6.1. BRAKE POWER vs SPECIFIC FUEL CONSUMPTION

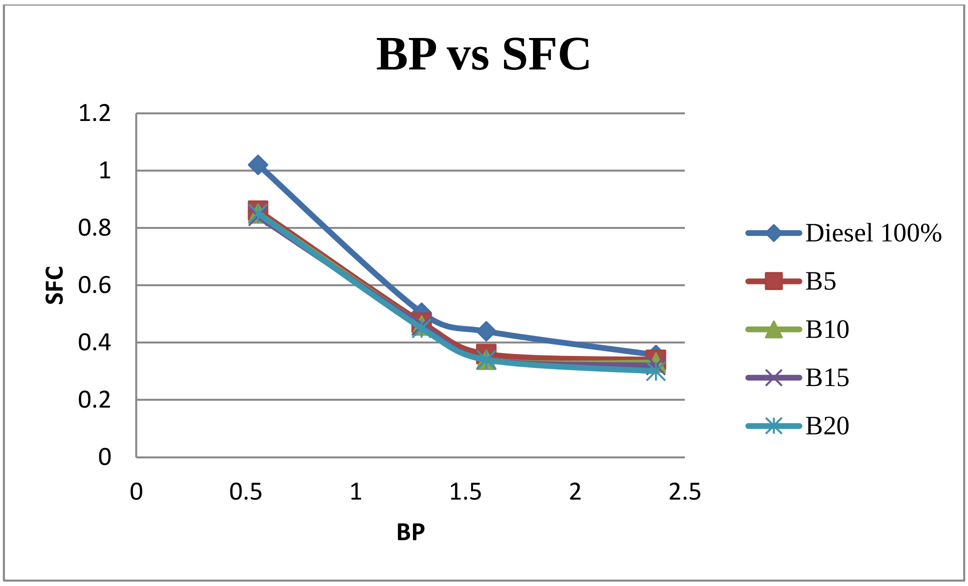

FIG 6.1. BP vs SFC

6.2. BRAKE POWER vs BRAKE THERMAL EFFICIENCY

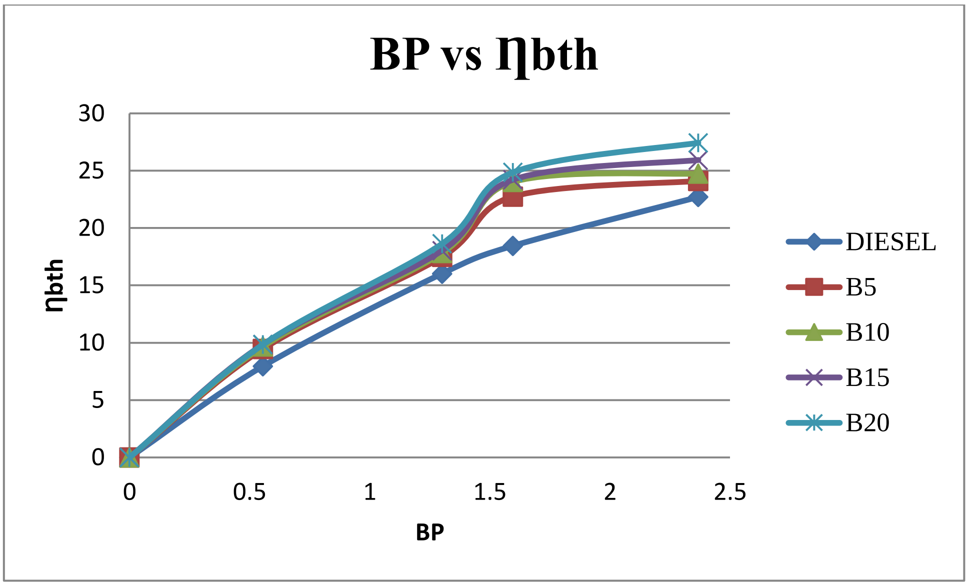

FIG NO.6.2. BP vs η_{bth}

6.3. BRAKE POWER vs INDICATED BRAKE THERMAL EFFICINCY

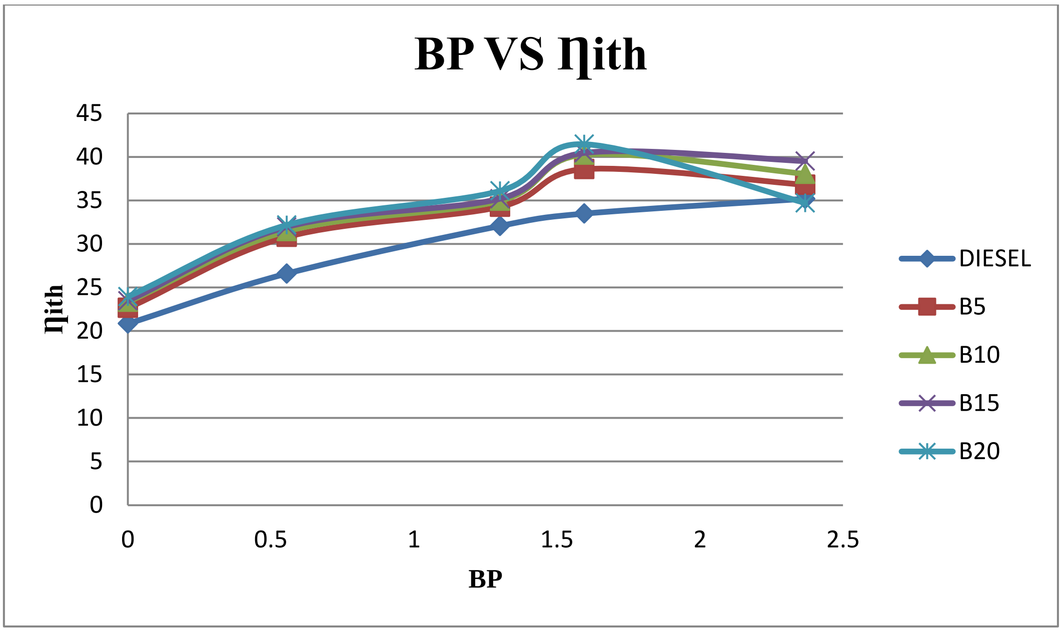

FIG.6.3.BP vs η_{ith}

6.4.BRAKE POWER vs MECHANICAL EFFICIENCY

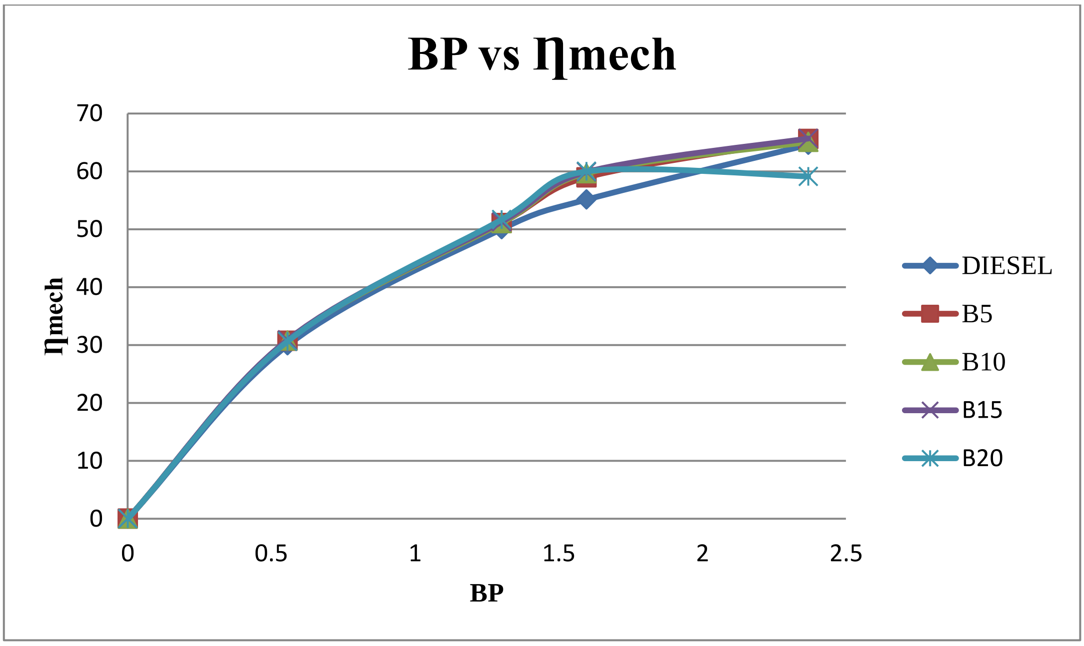

FIG NO. 6.4. BP vs η_{mech}

6.5.BRAKE POWER vs BRAKE MEAN EFFECTIVE PRESSURE

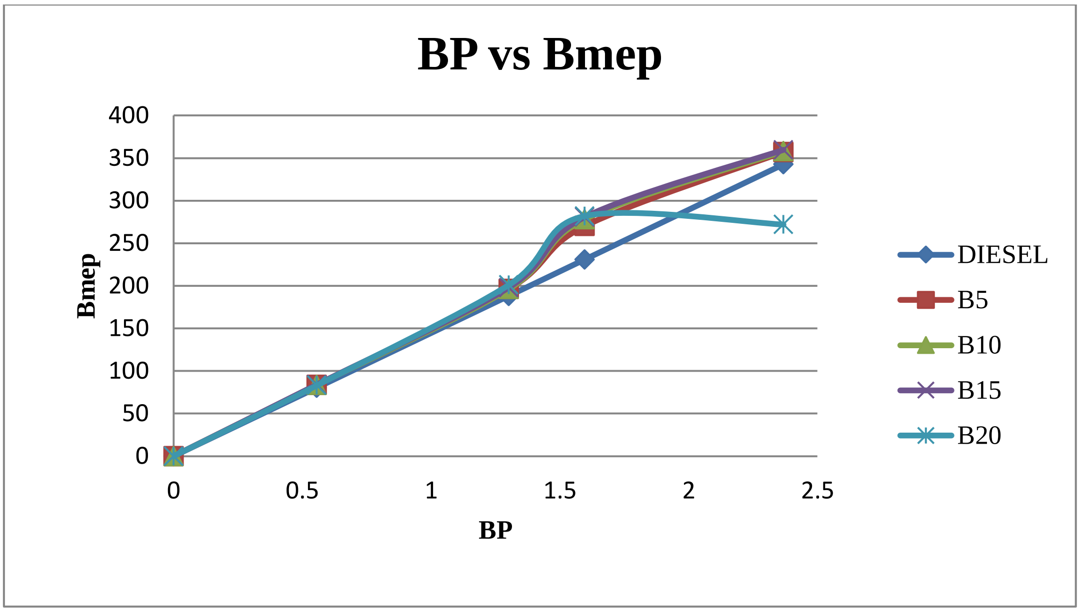

FIG NO.6.5.BP vs B_{mep}

6.6. BRAKE POWER vs INDICATED MEAN EFFECTIVE PRESSURE

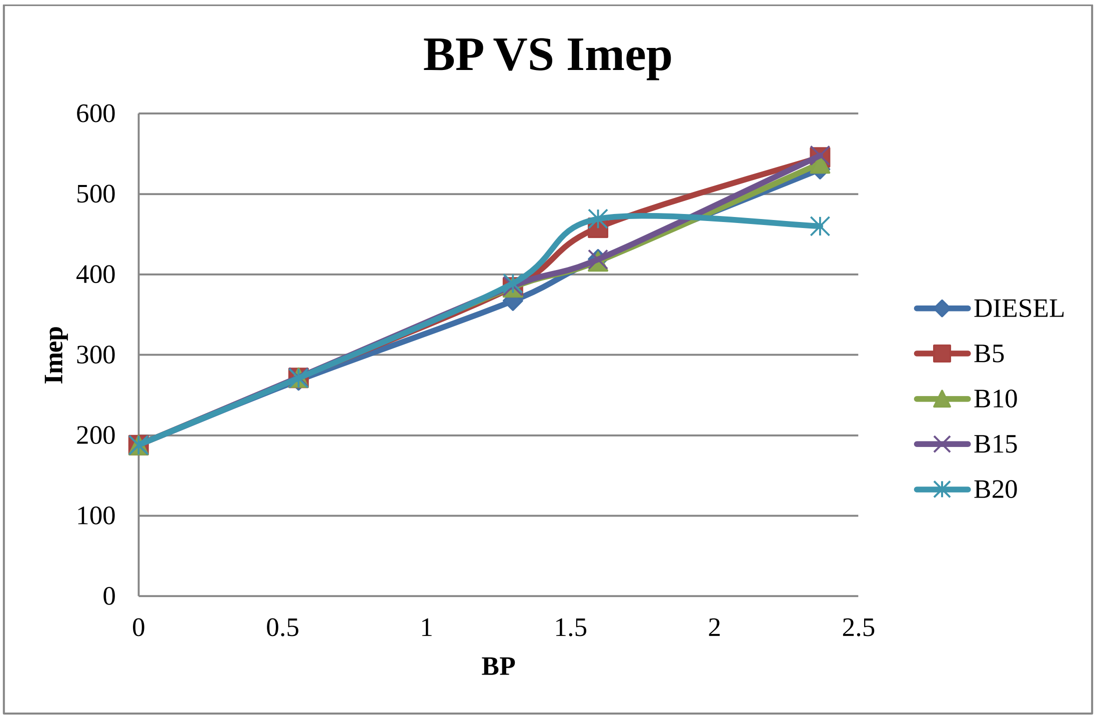

FIG NO.6.6.BP vs I_{mep}

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CHAPTER-7

FUTURE SCOPE

There is a great potential of waste fish oil as a renewable source for production of biodiesel. Research for producing bio fuels from fish oil is in the beginning stages and there is a substantial need for more research to satisfy the other economic issues related to study the other economic issues related to bio fuels. There is a considerable potential for the utilization of fish oil in all areas. Producing biodiesel from waste fish oil can reduce the usage of diesel usage in transportation sector and it can reduce pollution to a considerable limit. The fish oil based biodiesel is not only be used in a diesel engines but it can be used for other purposes like boiler fuel in thermal power plants instead of diesel. India is a country of vast horticulture having a wide variety of fishes both salt water fishes well as non salt water fishes. Hence, India has a wide opportunity in using this resource for purpose of making biodiesel. This biodiesel can be made as a byproduct of fish oil hence it become cost effective. Also as the technology develops new cost effective methods can be used for the production of biodiesel.

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CHAPTER-8
CONCLUSION

The biodiesel from waste fish oil is made using the process called transesterification. The produced biodiesel have high viscosity compared to pure diesel. Also the blends have little more dynamic viscosity compared to the pure diesel. The calorific value of biodiesel is less than that of pure diesel but it is within the permissible range. Also the blends prepared from the biodiesel and pure diesel has calorific value within the permissible range. The experimental results obtained from the load test are showing that biodiesel blends can be used in compression ignition engines. The specific fuel consumption of the blends decreases as the biodiesel proportion increases. The brake power of the engine increases as the proportion range increases. Indicated thermal efficiency, brake thermal efficiency, mechanical efficiency increases as the brake power increases and as the proportion of biodiesel increases. Similarly mean effective pressures also increases as the brake power increases. The graphs show the exact variation of the parameters that is found from the load test. From the experimental results it is clear that the biodiesel blends can be used for automobiles since everything is within range and also the pollution is less. From the results the optimum mix of B25 can be used for diesel engines.

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