

Impact of EGR on VCR diesel engine characteristics using ground nut oil and palm oil

Submitted in partial fulfilment of the requirements for the award

Bachelor of Engineering degree in

Mechanical Engineering

By

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DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade "A" by NAAC

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May 2022



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of M.Idris khan (Reg. No. 38150037) and G.Kamesh (Reg. No 38150047) who carried out the project entitled **"Impact of EGR on VCR diesel engine characteristics using ground nut oil and palm oil"** under our supervision from September 2021 to April 2022.

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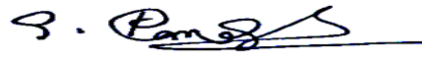
DECLARATION

We M.Idris khan (Reg.No.38150037) and G.Kamesh (Reg. no: 38150047) hereby declare that the Project Report entitled “**Impact of EGR on VCR diesel engine characteristics using ground nut oil and palm oil**” done by us under the guidance of **S. Lakshmisankar M.E.,(Ph.D.)** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

DATE:

1. 

Place: Chennai

2. 

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our sincere thanks to **Dr. S. Prakash, M.E., Ph.D.**, Dean, School of Mechanical Engineering and **Dr. G. Arun Kumar M.E., Ph.D.**, Head of the Department, Dept. of Mechanical Engineering for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **S.Lakshmi Sankar M.E., (Ph.D.)** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We also express our thanks to all Teaching and Non-teaching staff members of the Department of Mechanical Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

Biofuels help in reducing the dependence on crude oil and fostering a cleaner environment. It also generates additional income and employment for rural areas. This will not only help meet India's rural energy needs but also fulfill the rising demands for transportation. The use of carbon fuels will reduce carbon emissions and meet the energy requirements of the 21st century.

Biodiesel is an alternative fuel with growing usage in the transportation sector. In this research work, jojoba oil has been used for a diesel engine. The biodiesel blends were B5, B10, B15, and B20. Compared to other blends, B20 fuels showed better performance and reduced exhaust emissions such as smoke, carbon monoxide, and unburned hydrocarbons. The B20 blended fuels higher NO_x emissions than other fuel blends. This paper provides a comparative baseline to compare biodiesels regarding fuel properties, engine performance, and emission characteristics. biofuel are environment friendly fuels and their utilization would address global concerns about containment of carbon emissions. biofuel are derived from renewable bio- mass resources and, therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO BIO FUEL

Crude oil used to make petroleum products were use to fuel aircraft, four wheeler, and trucks; to heat homes; and make products such as plastics and medicines .Although petroleum products make life easier, finding, producing, and moving crude oil may have negative effects on the environment. Technological advances in exploration, production, and transportation of oil and enforcement of safety and environmental laws and regulations help to avoid and reduce these effects. Petroleum literally means 'rock oil'. It exists in the upper strata of the Earth's crust, and is mainly a complex mixture of hydrocarbons. Today, petroleum has transformed the world we live in. It provides the bulk of our energy and fuel requirements. Now the day's oil counties are demands for the oils price populations increase demands of oils is increased. The petroleum products are affects the environment and increase global warming. The world all countries now to moving for alternative sources that makes are renewable or non- renewable sources. Moe countries are concentrating biofuels the biofuels are taken forwaste fruit ,vegetables wastes and vegetables seeds .biofuels are taken for widely available and cheapest materials are testing for alternative fuels. Now days India curedoils price higher than other countries so we are moving alternative sources. Petroleum products are affects the environments and its emitting the gases of HC,Co,Co₂,Nox the gases are affects environment and increase global warming.

The bio fuels are eco-friendly for all countries fuels are made for Vegetables waste and fruit seeds oils. History records that Rudolph Diesel, the inventor

of the engine that bears his name, used vegetable oils as a fuel in his engines as early as 1900. For many years, the ready availability of inexpensive petroleum middle distillate fuels provided little incentive for experimenting with alternative, renewable fuels for diesel engines. The OPEC oil embargo of the '70's, fuel shortages and rapidly escalating fuel prices caused a resurgence of interest in finding alternative fuels.

However, the success of oil conservation measures and the very real possibility.

Bio fuel for diesel engines (i.e., biodiesel) is a promising alternative fuel for diesel engines that can be used upon the exhaustion of petroleum-derived fuels. Biofuel includes methyl esters and can be derived from raw oil. They are derived from different bio-sources such as vegetable oils, used lubricating oils, or algae. Many types of biofuels can be obtained from raw bio-sources, including Jatropha oil, cottonseed oil, palm oil, used lubricant oils, used vehicle tires, coconut oil, soybean oil, rapeseed oil, microalgae, waste animal fat, Crambe oil, rubber seed oil, castor oil, and waste cooking oil. Waste biomass has also been used to produce bio ethanol or bio methane. Bio fuels must exhibit certain normal physical and chemical properties.

As a matter of fact, the way the bio fuel is produced from the raw materials by transesterification, the mixing temperature and time, and the amount of catalyst or the type of additives that may be added to the produced bio fuel would affect the physical and chemical properties of the bio fuel produced. One important characteristic is the flow behavior with respect to the fuel viscosity at different shear rates (i.e., the relative velocity of the oil film between the moving parts). This characteristic affects the spray behavior when the fuel is injected into the combustion chamber at high pressures and temperatures.

Further, bio fuel is similar to diesel fuel with respect to the dependence of its viscosity on the operating temperature. Several previous studies have aimed to determine the rheological properties of bio fuel derived from vegetable oils. Rheological properties have been studied for different bio fuels produced from waste cooking oil, castor oil, and rubber seed oil. They have been compared to their raw oils and have also been blended with pure diesel fuel and studied at different temperatures and shear rates.

1.2 GROUND NUT OIL

Experiments were performed according to the following procedure: ground nut oil was added to the reactor and fitted with a reflux condenser. When the set temperature was reached the catalyst, diluted in methanol, was introduced in the reactor. Samples were taken at regular intervals and analyzed by gas chromatography. The total reaction time was 60 min. Throughout the experiments, the following variables remained constant: pressure and impeller speed.



Fig 1.1 Ground nut Oil

1.3 PROPERTIES OF GROUND OIL

Table 1.1

Sl no	Property	Crude Peanut Oil	Peanut Oil Methyl ester
1	Density (Kg/M ³)	956	922
2	Specific gravity	1.1	0.96
3	Cloud point (° C)	8	11
4	Pour point (° C)	-3	-6
5	Flash point (° C)	455	180
6	Heating Value (MJ/Kg)	39.1	39.52
7	Cetane Number	24	48
8	Kinematic viscosity (mm ² /sec)	243.25	6.2

1.4 PALM OIL

Palm oil is the most prospective biodiesel feedstock compared to other oilseeds. As discussed earlier, palm oil has higher production yield, low fertilizer, water and pesticide needed for the plantation. Palm oil production takes less sunlight in terms of energy balance to produce a unit of more oil per Hectar.



Fig 1.2 Palm Oil

1.5 PROPERTIES OF PALM OIL

Table 1.2

Characteristics	Palm bio diesel (palm methyl ester)
Types of source	Renewable
Calorific value (MJ/Kg)	41.3
Gross heat of combustion (KJ/Kg)	40.135
Cetane value	65
Flash point (° C)	174.0
Pout point (° C)	16.0
Cloud Point (° C)	16.0
Density at 40 ° C (Kg/L)	0.855
Viscosity at 40 ° C (cST)	4.5
Sulphur content (wt. %)	0.04
Carbon residue (wt. %)	0.02

CHAPTER – 2

2.1 LITERATUR REVIEW

Yesilyurt, Murat aydı , Mustafa. Title as **Experimental investigation on the performance, combustion and exhaust emission characteristics of a compression-ignition engine fueled with cottonseed oil biodiesel/diethyl ether/diesel fuel blends.** The objective of the present study refers to the examination of a diesel engine characteristics for various fractions of diethyl ether (DEE) as an oxygenated fuel additive in cottonseed oil biodiesel-diesel fuel blends. Firstly, several tests performed for diesel and B20 blend. Then. All the fuel samples were run on in a single-cylinder, four-stroke, and direct-injection diesel engine at five different engine loads and fixed engine speed conditions. The experimental results showed that BTE was decreased while increasing in BSFC by addition of DEE in the blend as compared to diesel fuel. Besides, the engine fueled with ternary blends revealed mitigation up to in the HC, smoke, and NOX emissions, on an average, respectively than those of diesel fuel. CO emission exhibited increasing trends with the diesel fuel at higher proportions of DEE despite dropdown remarked for lower concentration at the maximum load. By the way, the CO₂ also dropped under high loads. However, the combustion behaviors vaguely deteriorated when the CI engine run on all ternary blends. could be considered as a promising technique for the utilization of biodiesel/diesel blend efficiently in the CI engines without any major modifications.

Eko Supriyanto , Jayan Sentanuhady,, Ariyana Dwiputra , Ari Permana , Muhammad Akhsin Muflikhun Title as **The Recent Progress of Natural Source and Manufacturing Process of Biodiesel.** : Biodiesel has caught the attention of many

researchers because it has great potential to be sustainable fossil fuel substitute. Biodiesel has non-toxic and renewable nature and has been proven to emit less amount of environmentally harmful emissions such as hydrocarbons (HC), and carbon monoxide (CO), as well as smoke particles during combustion. Problems related to global warming caused by greenhouse gas (GHG) emissions could also be solved by utilizing biodiesel as a daily energy source. The selection of natural sources of biodiesel should be made with observations from economic, agricultural, and technical perspectives to obtain one feasible biodiesel with superior characteristics. This review paper presents a detailed overview of various natural sources, their physicochemical properties, as well as the performance, emission, and combustion characteristics of biodiesel when used in a diesel engine. The recent progress in studies about natural feedstock's and manufacturing methods used in biodiesel production were evaluated in detail. Finally, the findings of the present work reveal that transesterification is currently the most superior and commonly used biodiesel production method compared to other methods available.

Duran Altiparmak , Ali Keskin, Atilla Koca, Metin Gürü Title as **Alternative fuel properties of tall oil fatty acid methyl ester-diesel fuel blends**. In this experimental work, tall oil methyl ester–diesel fuel blends as alternative fuels for diesel engines were studied. Tall oil methyl ester was produced by reacting tall oil fatty acids with methyl alcohol under optimum conditions. It was observed that the engine torque and power output with tall oil methyl ester–diesel fuel blends increased up to 6.1% and 5.9%, respectively. It was also seen that CO emissions decreased to 38.9% and NO_x emissions increased up to 30% with the new fuel blends. The smoke opacity did not

vary significantly.

A.S.Huzayyin A.H.Bawady M.A.Rady A.Dawood Title as **Experimental evaluation of Diesel engine performance and emission using blends of jojoba oil and Diesel fuel.**

Blending of jojoba oil with gas oil has been shown to be an effective method to reduce engine problems associated with the high viscosity of jojoba oil.

Experimental measurements of different performance parameters of a single cylinder, naturally aspirated, direct injection, Diesel engine have been performed using gas oil and blends of gas oil with jojoba oil. Measurements of engine performance parameters at different load conditions over the engine speed range have generally indicated a negligible loss of engine power, a slight increase in brake specific fuel consumption and a reduction in engine NO_x and soot emission using blends of jojoba oil with gas oil as compared to gas oil. The reduction in engine soot emission has been observed to increase with the increase of jojoba oil percentage in the fuel blend.

Smokers. R Smit. R Title as **Compatibility of pure and blended biofuels with respect to engine performance, durability and emissions.** The report presents the results of a concise literature survey (quick scan) on the compatibility of pure and blended bio fuels with respect to engine performance, durability and emissions. More specifically, information is collected and analyzed to find indications for potential problems (or advantages) with respect to the following questions: Will vehicles using bio fuels, pure or in blends, be able to meet the emission limits. The bio fuels, pure or in blends, be able to meet future fuel specifications? Can possible problems be solved by the use of additives and does this have costs. The bio fuels maintain their advantage on fossil fuels with respect to greenhouse gas emissions in the future?

The survey has been carried out for bio-ethanol, biodiesel, virgin plant oil (VPO), bio-FT diesel (or BTL, biomass-to-liquid), biogas

Obed M. Ali, Rizalman Mamat Title as **Improving Engine Performance And Low Temperature Properties Of Blended Palm Biodiesel Using Additives.** Wide agricultural lands through the world are not fully benefited. Therefore, farming should include the production of nonfood products which are suitable to weather conditions of these lands. This leads to the production of biodiesels as renewable fuel for the domestic energy market, to reduce the dependence on fossil fuels. Biodiesel have gained a large interest of researches during the last few decades, the major reason to find an alternative fuel, is the increasing worry about the greenhouse gas effects and environmental regulations. Many experimental studies are conducted to evaluate the influence of using different additives with Palm Oil Methyl Ester (POME) biodiesel/diesel blends on fuel properties (viscosity, cold properties, anticorrosiveness, cetane number, heat content, volatility) and engine performance.

CHAPTER – 3

AIM AND SCOPE OF WORK

3.1 AIM

The aim of conducting this experimental study is to find the performance for the diesel engine using ground nut and palm oil mixture of diesel.

3.2 SCOPE OF THE WORK

The bio fuel is testing for various blending ratios and performance test of single cylinder diesel engine. The test can be conducting with diesel and ground nut, palm oil blends .the oil blends are making of B10,B20,B25,B30 and B40.The fuels are used to reduce diesel requirement. Vegetables oils are easily available in world that can use for transportation and vehicle. Decreasing of fossil fuels, increasing energy demands, together with the growing of greenhouse gas emissions effects of combustion have lead to the importance of studying biodiesel. Ordinary diesel fuels are available only in certain regions of the world. All countries are moving for easily available oils for biofuel energy. Biodiesel is made by combining alcohol (usually methanol) with vegetable oil, animal fat, or recycled cooking greases. It can be used as an additive to reduce vehicle emissions (typically 20%) or in its pure form as a renewable alternative fuel for diesel engines. As global energy requirements change and grow, it is crucial that all aspects of the bio energy production process are streamlined and improved, from the design of more efficient bio refineries to research into bio hydrogen as an energy carrier. Current energy infrastructures need to be adapted and changed to fulfil the promises of biomass for power generation.

CHAPTER – 4

METHODOLOGY

4.1 METHODOLOGY IS PRESENTED BELOW

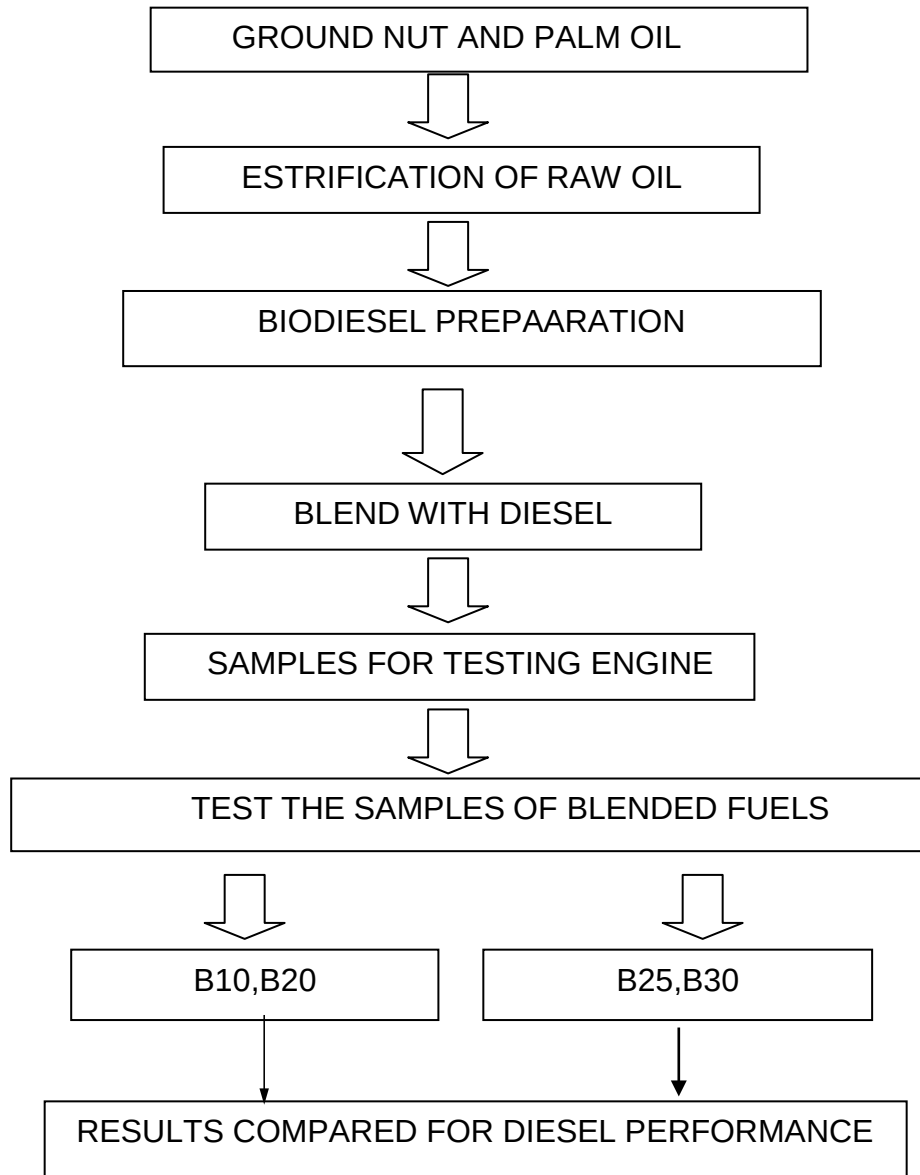


Fig 4.1 Flow chart Methodology

CHAPTER - 5

EXPERIMENTAL SETUP AND EQUIPMENTS

5.1 EXPERIMENTAL SET UP

A single-cylinder has 4-stroke, direct injection Kirloskar TV1 diesel engine with a maximum rated output of 5.20 kW at 1500 rpm was utilized to obtain the set of experimental data required. The engine has a compression ratio of 17.5. The engine has a swept volume of 661.45 (cc), bore diameter of the engine is 87.50 mm and stroke length of 110.00 mm. Injection pressure is 210 bar maintained constantly throughout the process.



Fig 5.1 Engine setup

5.2 VCR ENGINE TEST SETUP-PERFORMANCE TEST RIG

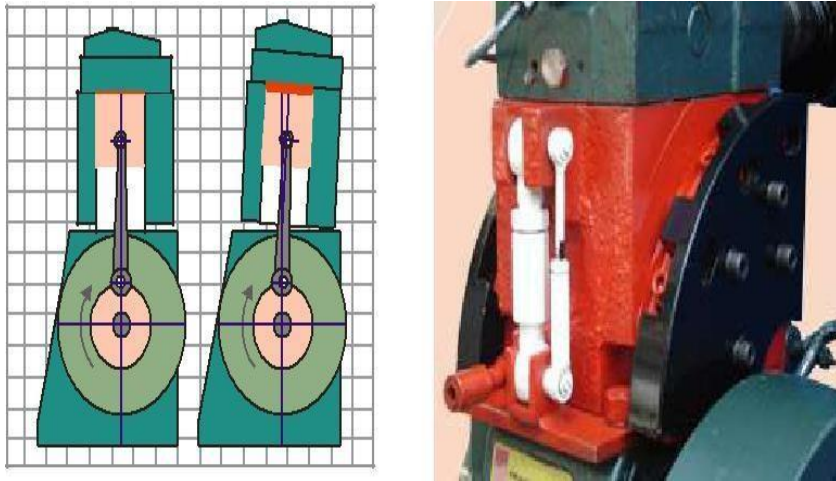
The setup consists of single cylinder, four stroke, VCR (**Variable Compression Ratio**) Electric start Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement.

The setup enables study of VCR engine performance with EGR for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Lab view based Engine Performance Analysis software package “Engine soft” is provided for on line performance evaluation. A computerized Diesel injection pressure measurement is optionally provided

5.3 FEATURES

- CR changing without stopping the engine
- No alteration in Combustion chamber geometry
- Water cooled EGR
- Electric start with battery and charger
- Arrangement for blend test
- PÈ-PV plots, performance plots and tabulated results
- Data logging, editing, printing and export, Configurable graphs

- IP, IMEP, FP indication, combustion analysis



.Figure 5.2

5.4 Range of Experiments

- Study of VCR engine performance (Computerized mode)
- Study of emissions with EGR variation
- Study of combustion with different fuel blends
- Study of pressure volume plot and indicated power

5.5 Utilities Required

Electric supply

230 +/- 10 VAC, 50 Hz, 1 phase

Water supply

Continuous, clean and soft water supply @ 1000 LPH, at 10 m. head. Provide tap with 1" BSP size connection

Computer

IBM compatible with standard configuration

Software

Engine Soft is Lab view based software package developed by Apex Innovations Pvt. Ltd. for engine performance monitoring system. Engine Soft can serve most of the engine testing application needs including monitoring, reporting, data entry, data logging. The software evaluates power, efficiencies, fuel consumption and heat release. It is configurable as per engine set up. Various graphs are obtained at different operating condition. While on line testing of the engine in RUN mode necessary signals are scanned, stored and presented in graph. Stored data file is accessed to view the data graphical and tabular formats. The results and graphs can be printed. The data in excel format can be used for further analysis.

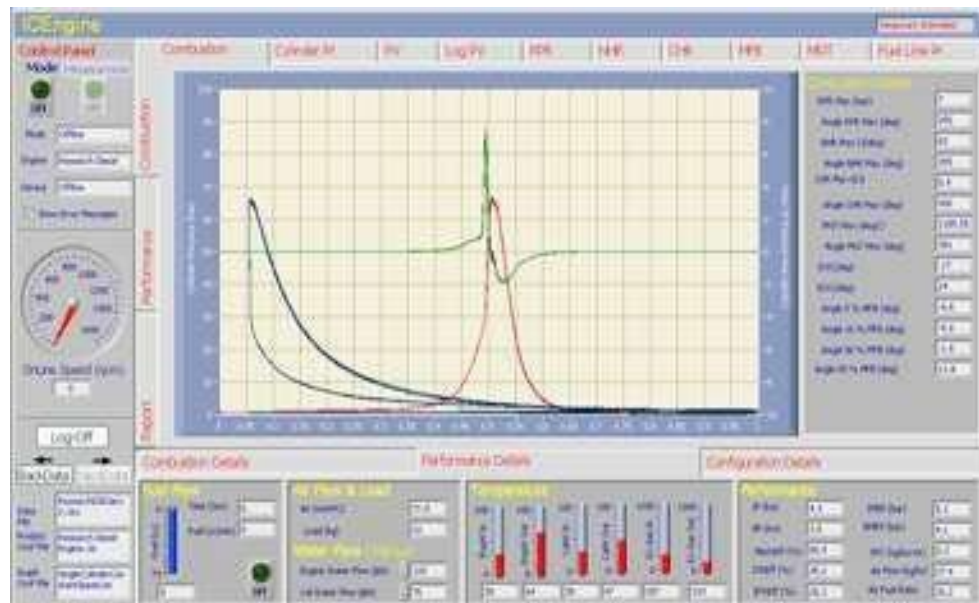


Fig 5.3 Performance analysis

5.6 Specifications of Engine

Table 5.1 Specification of Engine

Product	VCR Engine test setup 1 cylinder, 4stroke, Diesel with EGR (Comp.)
Product code	234
Engine	Make Kirloskar, Type 1 cyl., 4 stroke Diesel, water cooled, power 3.5kW at1500rpm, stroke 110mm, bore 87.5mm.661cc, CR17.5, Modified to VCR engine CR 12 to 18. With electric start arrangement, battery and charger
Dynamometer	Type eddy current, water cooled,
Propeller shaft	With universal joints
Air box	M S fabricated with orifice meterand manometer

Load indicator	Digital, Range 0-50 Kg, Supply230VAC
Load sensor	Load cell, type strain gauge, range0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250mm WC
Software	“Engine Soft” Engine performanceanalysis software
Rotameter	Engine cooling 40-400 LPH;Calorimeter 25-250 LPH
Pump	Type Mono block
Overall dimensions	W 2000 x D 2500 x H 1500 mm

Optional	Computerized Diesel injection pressure measurement with injection variation 0-25 deg BTDC
Fuel tank	Capacity 15 lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
EGR	Water cooled, SS, Range 0-15%
Piezo sensor	Range 5000 PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Piezo powering unit	Model AX-409.
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	RTD PT100, Range 0–100° C, 3 Nos; Thermocouple, Range 0-1200 ° C , 2 Nos

EMISSION TEST RIG

The following Gas values can be measured

5.6.1 CO

5.6.2 HC

5.6.3 NO_x

5.6.4 CO₂

5.6.5 O₂

GAS ANALYZER: DIGAS 444

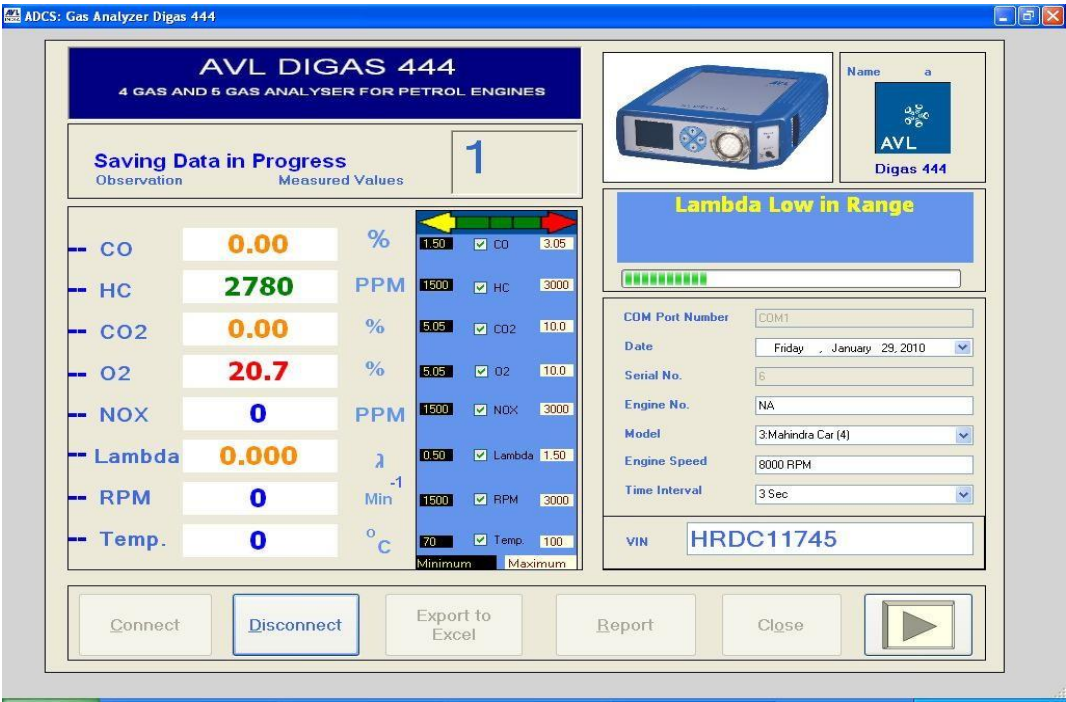


Fig 5.4 Avl Digas 444 Image

SMOKEMETER 437 STD/ SMOKEMETER 437 ° C

Table 5.2 Smoke meter Specifications

Type	AVL 437 Smoke meter Make
Make	AVL India Private Limited
Measuring range	0 to 100 HSU (Hatridge Smoke units)
Smoke Temperature	2500 C (Maximum at entrance)
Ambient temperature	0 to 50°C
Humidity	90% at 50°C (Non conditioning
Power Supply	205 A, 11.5 -36V DC
Principle	Light absorption principle



Fig 5.5 Smoke Meter

5.7 GAS ANALYZER

To take the readings from Gas analyzer to ADCS Software kindly follow these steps.

- Kindly fill the details (Engine No. Model, Engine Type, Engine Speed) in respective text boxes given on the form.
- Click on “Connect button” to connect the PC with equipment and wait for 2-3 minutes. If the readings are not coming it shows the message in red color “CO HC power not communicating.” kindly check the following:
 - Be sure that gas analyzer settings in “MAHA Euro” mode
 - Check the COM port settings with PC and the software.
 - RS232 Cable is working properly and connected with equipment.
 - Readings are coming with equipment and display on panel.
- After 6 seconds readings are automatically saved in database and status bar strip moving according to readings saved in database.
- After taking the readings click on “Disconnect button” to disconnect the communication with equipment and show the message “Data Saved in Database”.
- Report: Click on report button to take the report of the test.
- Print: Click on print button to take the printout of screen as bitmap image.
- Export to MS Excel Sheet: To export data in excel sheet click on “EXPORT TO EXCEL” button. When pressing export button an excel file is generated in a path “C:\AVL\Folder\”. The file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_23).
- Close button: click on close button to exit from current active window or screen.

BLUE POWER FOR A BLUE PLANET (Ver 1.3.0)



Fig 5.6 Emission Analysis

SMOKEMETER 437 STD/ SMOKEMETER 437 C

To take the readings from Smoke meter to ADCS Software kindly follow these steps.

- Kindly fill the details (Engine No. Model, Engine Type, Engine Speed) in respective text boxes given on the form if you didn't check "Vehicle details " check box in Masterdata entry form all the textboxes related to (Engine No. Model, Engine Type, and Engine Speed) become disabled.
- Click on "Connect button "to connect the PC with equipment and wait for 5- 10 seconds. if the readings are not coming it show the message in red color ""Unable toCommunicate with Equipment."" kindly check the following:
 - Be sure that Smoke meter model name display on screen is same as your smokemeter model if not kindly change the model in "Master Data Entry Form"
 - Check the COM port settings with PC and the software in "Master Data Entry "form.
 - RS232 Cable for smoke meter is working properly and connected with equipment.
 - Readings are coming with equipment and display on remote of smoke meter.
- According to "Time interval settings in selection box, readings are automatically saves in database.
- After taking the readings click on "Disconnect button" it disconnect thecommunication and show the message "Disconnected"
- Report: Click on report button to take the report of the test.
- Print: Click on print button to take the printout of screen as bitmap image.
- Export to MS Excel Sheet: To export data in excel sheet click on "EXPORT TOEXCEL" button. When pressing export button a excel file is generated at path "C:\

- AVL Folder\”. The file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_26).
- Close button : click on close button to exit from current active window or screen, it takes time to close, so wait for 10-15 seconds for form window to close.

5.8 SAMPLE PREPARATION



Fig 5.7 Bio Sample

5.8.1 SAMPLES OF GROUND NUT AND PALM OIL

Sample 1:90% Diesel & 10%Biofuel

Sample 2:80% Diesel & 20%Biofuel

Sample 3:75% Diesel & 25%Biofuel

Sample 4:70% Diesel & 30%Biofuel

5.9 EXPERIMENTAL WORK

The biodiesel blends was prepared and samples are ready for testing. The samples of biodiesel are connecting with venturi meter to diesel pump and testing the fuel to engine. The testing was conducting and readings are taken for one by one samples. The emission testing was conducting 437C smoke meter and readings are taken from the meter. The engine was conduct on various load tests and readings are taken.

5.10 EMISSION GASES

5.10.1 EMISSION OF CO GAS

While diesel fuel combustion engines produce lower levels of carbon monoxide than gasoline engines, these emissions can still generate lethal amounts of carbon monoxide given a sufficient amount of time in an enclosed space. Carbon monoxide makes up anywhere from 2% to 12% of diesel exhaust gases. Carbon monoxide results from the incomplete combustion where the oxidation process does not occur completely. This concentration is largely dependent on air/fuel mixture and it is highest where the excess-air factor is less than 1.0 that is classified as rich mixture. It can be caused especially at the time of starting and instantaneous acceleration of engine where the rich mixtures are required. In the rich mixtures, due to air deficiency and reactant concentration, all the carbon cannot convert to CO₂ and be formed CO concentration. Although CO is produced during operation in rich mixtures, a small portion of CO is also emitted under lean conditions because of chemical kinetic effects.

Diesel engines are lean combustion engines which have a consistently high air–fuel ratio. So , the formation of CO is minimal in diesel engines. Nevertheless, CO is produced if the droplets in a diesel engine are too large or if insufficient turbulence or swirl is created in the combustion chamber.

Carbon monoxide is an odorless and colorless gas. In humans, CO in the air is inhaled by the lungs and transmitted into the bloodstream. It binds to hemoglobin and inhibits its capacity to transfer oxygen. Depending on CO concentration in the air, as thus leading to asphyxiation, this can affect the function of different organs, resulting in impaired concentration, slow reflexes, and confusion.

5.10.2 EMISSION OF HC GAS

Hydrocarbon emissions are composed of unburned fuels as a result of insufficient temperature which occurs near the cylinder wall. At this point, the air–fuel mixture temperature is significantly less than the center of the cylinder (Demers and Walters 1999; Correa and Arbilla 2008). Hydrocarbons consist of thousands of species, such as alkanes, alkenes, and aromatics. They are normally stated in terms of equivalent CH₄ content.

Diesel engines normally emit low levels of hydrocarbons. Diesel hydrocarbon emissions occur principally at light loads. The major source of light-load hydrocarbon emissions is lean air–fuel mixing. In lean mixtures, flame speeds may be too low for combustion to be completed during the power stroke, or combustion may not occur, and these conditions cause high hydrocarbon emissions. In Diesel engines, the fuel type, engine adjustment, and design affect the content of hydrocarbons. Besides, HC emissions in the exhaust gas depend on irregular operating conditions. High levels of instantaneous change in engine speed, untidy injection, excessive nozzle cavity volumes, and injector needle bounce can cause significant quantities of unburned fuel to pass into the exhaust

Unburned hydrocarbons continue to react in the exhaust if the temperature is above 600 C and oxygen present, so hydrocarbon emissions from the tailpipe may be significantly lower than the hydrocarbons leaving the cylinder. Hydrocarbon emissions occur not only in the vehicle exhaust, but also in the engine crankcase, the fuel system, and from atmospheric venting of vapors during fuel distribution and dispensing .

Crankcase hydrocarbon emissions and evaporative losses of hydrocarbon emissions

have, respectively, 20–35 and 15–25 % while tailpipe hydrocarbon emissions have 50–60 % of total hydrocarbon emissions. Hydrocarbons have harmful effects on environment and human health. With other pollutant emissions, they play a significant role in the formation of ground-level ozone. Vehicles are responsible for about 50 % of the emissions that form ozone. Hydrocarbons are toxic with the potential to respiratory tract irritation and cause cancer.

5.10.3 EMISSION OF NO_x GAS

Diesel engines use highly compressed hot air to ignite the fuel. Air, mainly composed of oxygen and nitrogen, is initially drawn into the combustion chamber. Then, it is compressed, and the fuel is injected directly into this compressed air at about the top of the compression stroke in the combustion chamber. The fuel is burned, and the heat is released. Normally in this process, the nitrogen in the air does not react with oxygen in the combustion chamber and it is emitted identically out of the engine.

However, high temperatures above 1,600 °C in the cylinders cause the nitrogen to react with oxygen and generate NO_x emissions. So, it will not be wrong to say that the major influences of the formation of NO_x are the temperature and concentration of oxygen in the combustion. The amount of produced NO_x is a function of the maximum temperature in the cylinder, oxygen concentrations, and residence time. Most of the emitted NO_x is formed early in the combustion process, when the piston is still near the top of its stroke. This is when the flame temperature is the highest. Increasing the temperature of combustion increases the amount of NO_x by as much as threefold for every 100 °C increase. Nitrogen oxides are referred as nitrogen oxide (NO) and nitrogendioxide (NO₂). NO constitutes 85–95 % of NO_x. It is gradually converted to NO₂ in

atmospheric air. While NO and NO₂ are lumped together as NO_x, there are some distinctive differences between these two pollutants. NO is a colorless and odorless gas, while NO₂ is a reddish brown gas with pungent odor. Road transport is the most important cause of urban NO_x emissions worldwide contributing to 40–70 % of the NO_x. Among various types of vehicles, diesel vehicles are the most important contributors to NO_x emissions. Compared with gasoline engines, they need higher temperatures because they are compression-ignition engines. Diesel engines are responsible for about 85 % of all the NO_x emissions from mobile sources, primarily in the form of NO.

Nitrogen oxides emissions from vehicles are responsible for a large amount of environmental and health hazard. NO_x emissions contribute to acidification, formation of ozone, nutrient enrichment, and smog formation, which have become considerable problems in most major cities worldwide. In the atmosphere, NO_x emissions react chemically with other pollutants to form tropospheric ozone (the primary component of photochemical smog) and other toxic pollutants. NO and NO₂ are considered as toxic; but NO₂ has a level of toxicity five times greater than that of NO and it is also a direct concern of human lung disease. Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection (such as influenza). NO_x emissions are important precursors to acid rain that may affect both terrestrial and aquatic ecosystems. Nitrogen dioxide and airborne nitrate also contribute to pollutant haze, which impairs visibility.

5.10.4 EMISSION OF CO₂ GAS

Among the challenges of the energy transition, reducing CO₂ emissions of the transportation sector is one of the most difficult. Electrification of the vehicles is of course a good solution to replace fossil fuel for mobility. This path is however penalized

by the density of the electricity storage in the batteries. Fossil fuels are a finite resource, hence they should be replaced by bio-based fuel equivalent. This however requires lots of land that may compete with the food production. CO₂ capture is also an alternative, if one can capture with limited energy penalty, and converts captured CO₂ into fuels using renewable electricity.

Fossil fuel use is the primary source of CO₂. CO₂ can also be emitted from direct human-induced impacts on forestry and other land use, such as through deforestation, land clearing for agriculture, and degradation of soils. Likewise, land can also remove CO₂ from the atmosphere through reforestation, improvement of soils, and other activities.

5.10.5 EMISSION OF O₂ GAS

The oxygen concentration is measured with an Oxygen analyzer fitted between air box and inlet manifold of the engine. The test engine is coupled to Magtrol (model-4WB15)-eddy current dynamometer. The main measuring instruments used were; a mass balance with an accuracy of 0.01 g to measure the fuel flow rate, a bomb calorimeter to measure the calorific value of fuel, a thermocouple to measure the temperature of exhaust gas, inlet air, a TDC marker (a magnetic pickup) and an rpm indicator. A Kistler piezo electric transducer measures the combustion chamber pressure (it is a mean value of 50 consecutive cycles) with an increment of 1° crank angle using an AVL data acquisition system (AVL indicom compact). Exhaust gases were measured by HORIBA MEXA 548L five gas analyzer and gases are measured based on non-dispersive infrared principle. The Analyzer measures nitrogen oxides (NO_x) with a resolution of 1 ppm, total unburned hydrocarbon (HC) also at a resolution of 1 ppm, and

carbon monoxide (CO) with a resolution of 0.01%. An AVL smoke meter of model AVL 437C is used to measure the smoke opacity with a range of 0 to 99.99% of smoke opacity with the resolution of 0.01%.

One of the promising results from oxygen enrichment is the significant decrease in smoke density in the exhaust. Agglomeration of soot particle in the diesel exhaust is the major source of smoke in diesel engine. It is formed mainly due to incomplete combustion of fuel hydrocarbons and some is contributed by lubricating oil. Soot formation is strongly dependent on the stoichiometry, temperature, pressure and mixing . Soot in the exhaust gas is dominated by soot formation as well as oxidation. One of the main effects of oxygen enrichment is to increase oxygen–fuel ratio, which in turn improves the oxidation of fuel and suppress the soot formation. Oxygen enrichment also reduces the ignition delay, meaning higher burning rate and shorter combustion duration . which further reduces soot formation. The minimum reduction of smoke opacity in oxygen enrichment is 15% at full load with 27% oxygen enrichment, while the maximum reduction is 60% at no load 27% oxygen enrichment. Consistently there is reduction of smoke opacity levels at all loads and oxygen concentration levels as reported.

CHAPTER - 6

RESULTS AND DISCUSSIONS

6.1 RESULTS

The ground nut and palm oil biodiesel prepared in the five samples and they were one by one poured into a container which is attached to the venturi meter in the front of engine pump. The venturi meter shows the amount of fuel exactly sent to the engine. The exhaust is attached with smoke meter in order to obtain the amount of pollutants released. The results obtained from each of the blend are compared in a graphical format.

6.2 RESULTS ARE EVALUATED WITH GRAPH

- Brake Thermal Efficiency
- Specific Fuel Consumption
- NO_x Emissions
- CO₂ Emissions
- HC Emissions
- CO Emissions
- O₂ Emissions

6.2.1 Brake Thermal Efficiency (BTHE)

Current on-road diesel engines have approximately 42% brake thermal efficiency at full load, with 28% of fuel energy wasted in exhaust gas (including 4% going to pumping loss), 28% of fuel energy dissipating to cooling media as heat rejections to the ambient (including 4% going to mechanical friction and parasitic accessory power), and 2% going to miscellaneous heat losses. There are strong interactions between heat rejections and exhaust gas energy, mainly depending on EGR rate and pumping loss.

When EGR rate increases, heat rejections become higher and exhaust energy becomes less. Pumping loss is related to EGR rate and air–fuel ratio (or essentially EGR circuit flow restriction, turbine area, and turbocharger efficiency). Such an energy distribution change affects the strategy of waste heat recovery. A roadmap for achieving 50–55% engine thermal efficiency can be planned by allocating improvement targets for each part of the energy distribution or each engine subsystem

TABLE 6.1 Brake Thermal Efficiency (BTHE)

LOAD(KW)	0	0.875	1.75	2.62	3.5
S1(B10)	1.33	14.5	21.4	27.4	30.24
S2(B20)	1.4	14.8	21.8	27.6	30.89
S3(B25)	1.56	14.96	21.95	27.9	31.25
S4(B30)	1.78	15.5	22.1	28.6	31.78
DIESEL	1.6	16.49	22.75	29.47	32.59

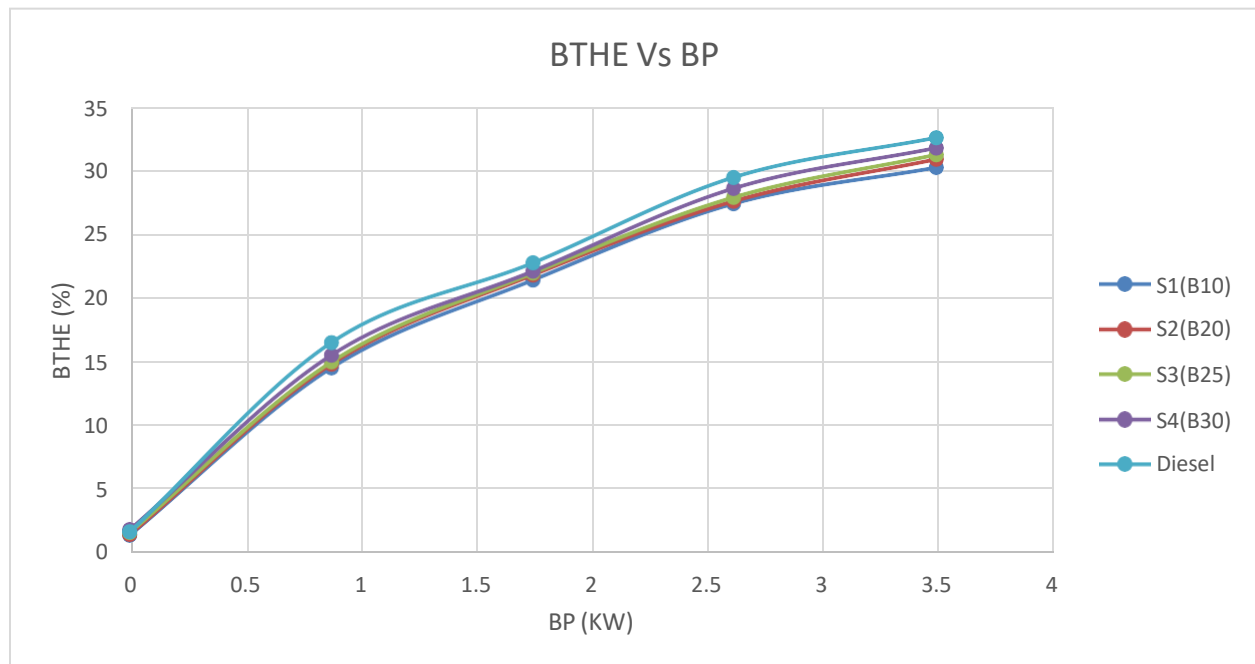


Fig 6.1 BP (KW) v/s Brake Thermal Efficiency (BTHE)

6.2.3 Specific Fuel Consumption (SFC)

Specific fuel consumption (SFC) is a parameter that reflects the efficiency of a combustion engine which burns fuel and produces rotational power (at the shaft or crankshaft). In automotive applications, BSFC is used to evaluate the efficiency of the internal combustion engines (ICE). The keyword “brake” is related to the use of a dynamometer (electrical brake) to measure the engine parameters (fuel mass flow rate, torque, etc.).

An internal combustion engine requires fuel and air to produce energy. The amount of fuel used is usually measured on a dynamometer, as a mass flow rate, in kilograms per second [kg/s]. This parameter cannot be used to evaluate the efficiency of the engine because it is not obvious how much power we can extract from the fuel.

Therefore by dividing the fuel mass flow rate [kg/s] to the engine output power [W], we obtain the brake specific fuel consumption [kg/J]:

Table 6.2 Specific Fuel Consumption (SFC)

LOAD (%)	0%	25%	50%	75%	100%
S1(B10)	5.12	0.79	0.59	0.39	0.19
S2(B20)	5.28	0.75	0.56	0.36	0.18
S3(B25)	5.34	0.72	0.53	0.34	0.16
S4(B30)	5.41	0.69	0.51	0.31	0.12
Diesel	3.45	0.52	0.38	0.29	0.2

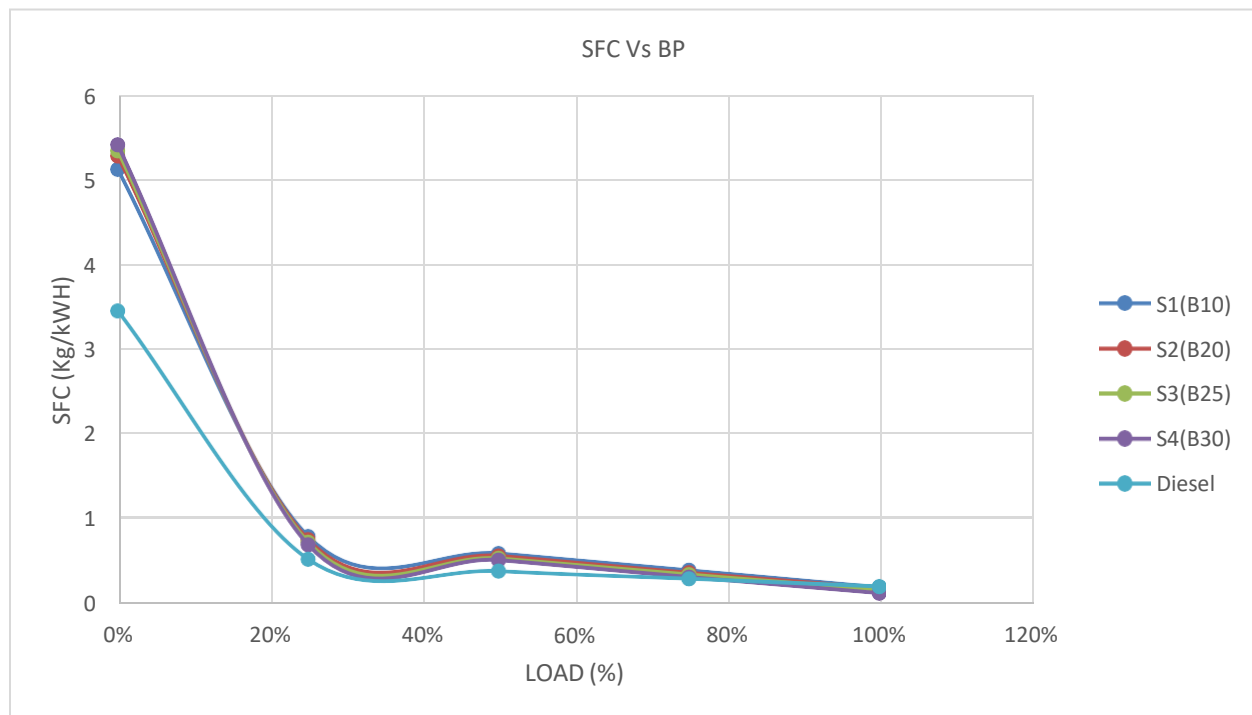


Fig 6.2 Load (%) v/s Specific Fuel Consumption (SFC)

6.2.4 NOx Emissions

The readings are taken from the gas Analyzer for engine exhaust pipe. Its taken for different biodiesel samples and different load , speed. The NO_x is emitting various level for various samples. All the readings has drawn the graph the levels changes are shown in the graph.

Table 6.3 NOx Emission

Load %	0%	25%	50%	75%	100%
S1(B10)	85	135	215	370	495
S2(B20)	105	170	215	318	452
S3(B25)	92	172	217	321	485
S4(B30)	89	191	348	478	503
DIESEL	81	162	258	308	426

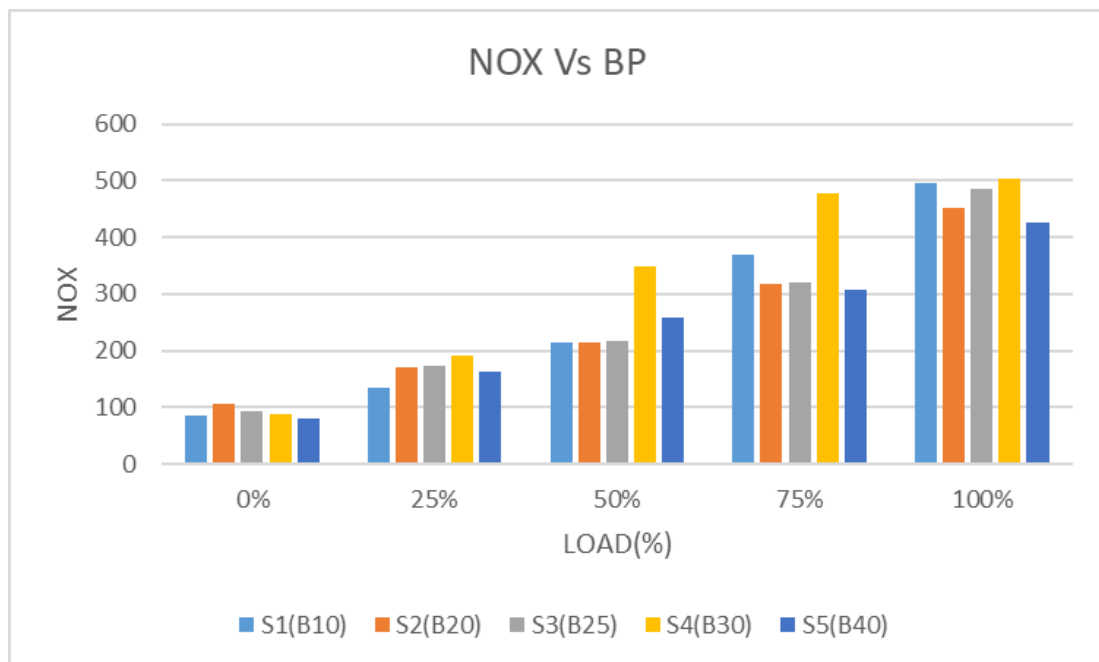


Figure 6.3 Load (%) v/s NOx emission

6.2.5 CO₂ Emissions

The reading are taken from biodiesel samples CO₂ is reduce the load condition on engine. The CO₂ is reducing for the sample and shown the graph.

Table 6.4 CO₂ Emissions

Load KW	0	25	50	75	100
S1(B10)	1.5	1.8	2.1	3.1	3.8
S2(B20)	1.3	2.5	2.8	3.4	3.8
S3(B25)	1.4	1.9	2.9	3.1	3.7
S4(B30)	1.2	1.9	2.5	3.1	3.9
Diesel	1.2	2	2.9	3.5	3.6

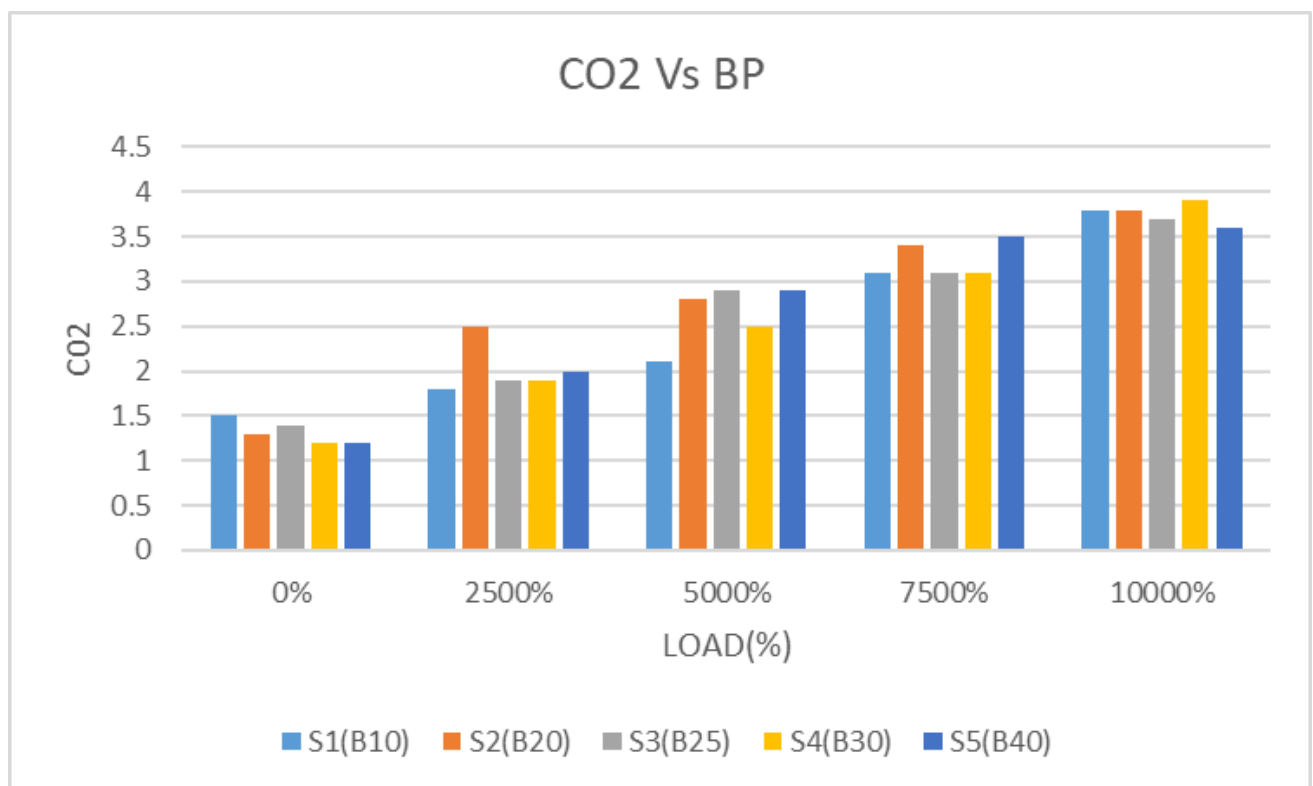


Fig 6.4 Load (%) v/s CO₂ Emission

6.2.6 HC Emissions

The HC values are taken from various sample and load test reports are tabled and graphed. Hc was increased the load applied conditions. The performance has compare to biodiesel is better for the environment. The blended samples are tested the various load.

Table 6.5 HC Emission

Load KW	0	25	50	75	100
S1(B10)	7	11	14	18	21
S2(B20)	5	8	12	16	20
S3(B25)	4	7	9	13	17
S4(B30)	4	9	11	14	17
Diesel	3	5	8	11	15

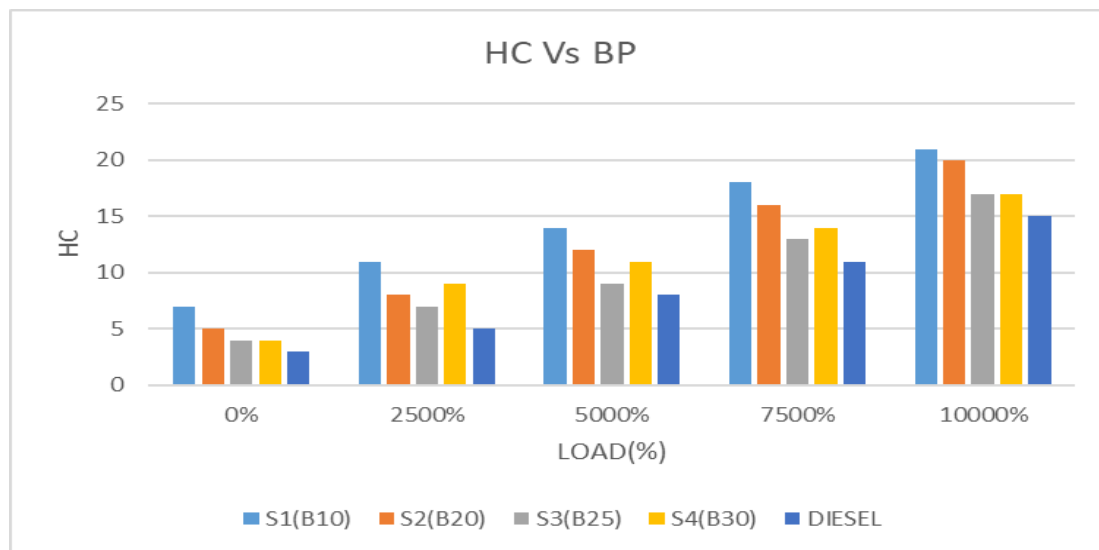


Fig 6.5 Load (%) v/s HC Emission

CO Emissions

CO affects the environment and increases the global warming effects. The biodiesel sample is tested in the engine and the readings are taken for various load conditions and different samples. All are tabled and graphed.

II

Table 6.6 CO Emission

Load KW	0	25	50	75	100
S1(B10)	0.01	0.03	0.05	0.07	0.075
S2(B20)	0.015	0.03	0.04	0.045	0.05
S3(B25)	0.01	0.02	0.03	0.05	0.07
S4(B30)	0.02	0.04	0.05	0.05	0.07
S5(B40)	0.01	0.03	0.035	0.04	0.05

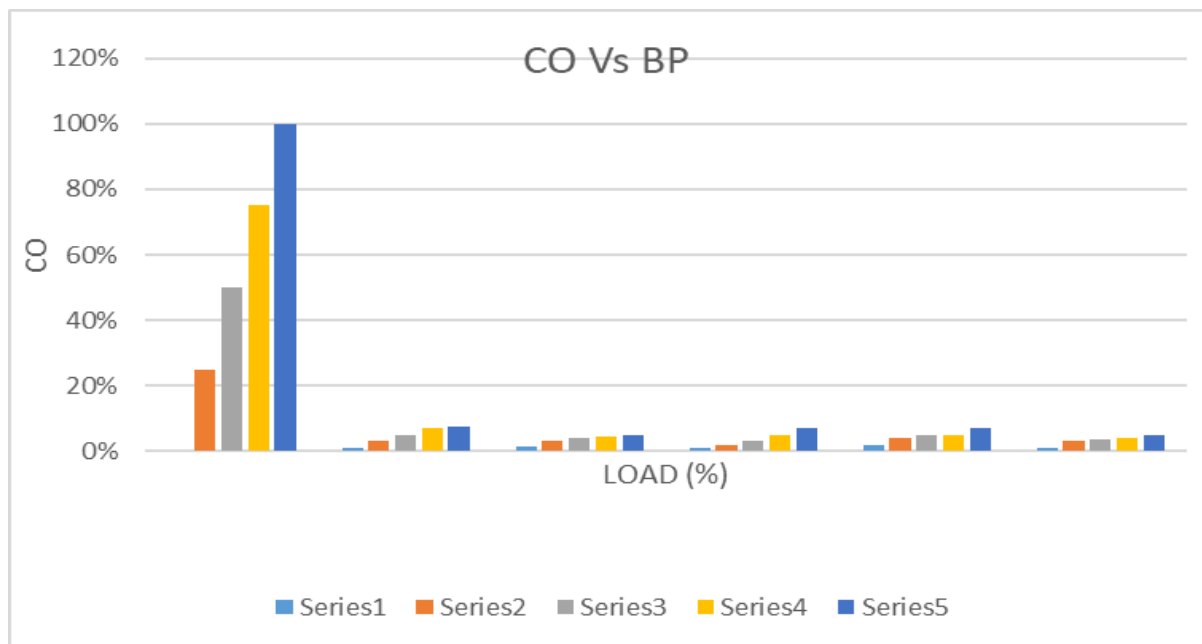


FIG 6.6 Load % V/s CO Emission

6.2.7 O₂ Emissions

The prepared biodiesel sample was tested the diesel engine and O₂ values are taken from the exhaust pipe line using gas analyzer it reduced for the various samples. The O₂ is increased fuel is not fully burned the engine. The engine efficiency is reduce O₂ values reduces performance of the engine is increase.

Table 6.7 O₂ Emission

Load KW	0	25	50	75	100
S1(B10)	19.8	18.7	17.5	16.4	15.5
S2(B20)	19.5	17.8	17.1	16.8	15.9
S3(B25)	19.7	18.4	17.8	16.8	15.7
S4(B30)	19.25	18.52	17.9	16.3	15.8
DIESEL	19.9	18.5	16.72	15.8	15.84

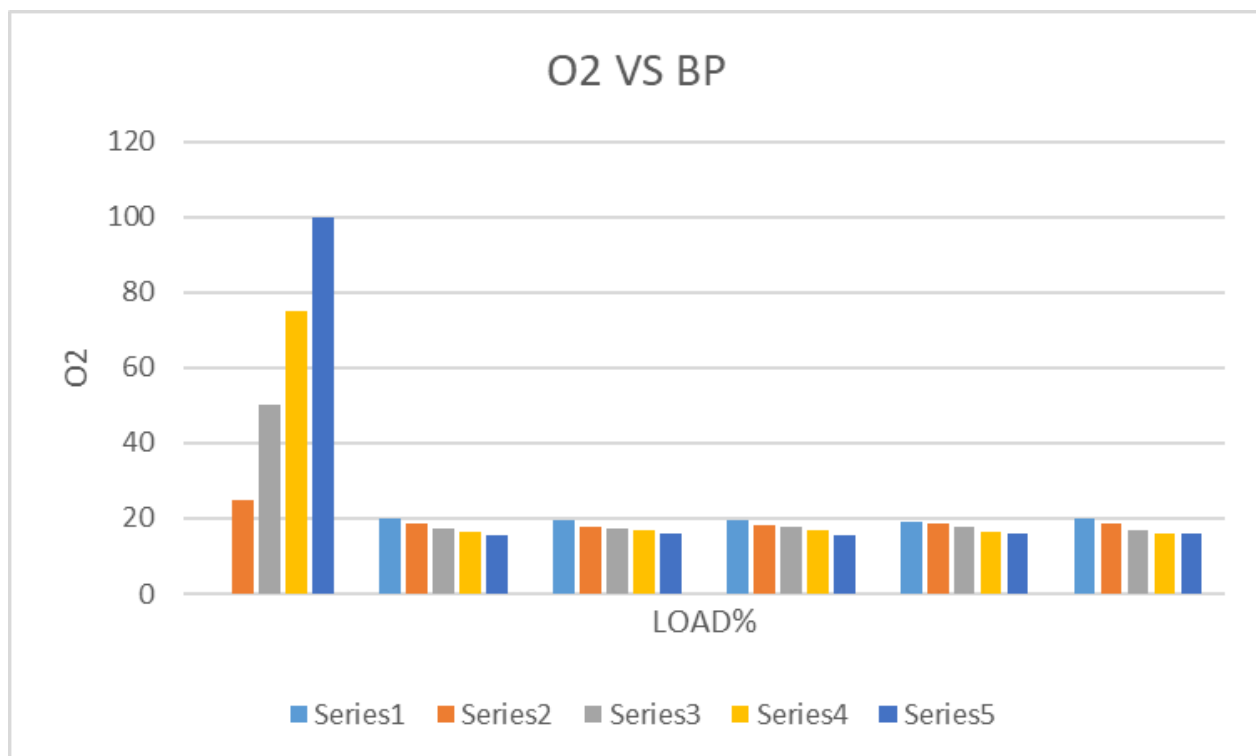


Fig 6.7 Load % Vs O₂ Emission

CHAPTER - 7

CONCLUSIONS

The Experimental analysis is study for alternative fuels feasibility. The source is using to develop the jojoba and grape seed oil for future bio fuel. The biodiesel is analyzed the performance and characteristics of NO_x, CO, HC, CO₂, O₂, BTH and SFC. Test has been conducted and the values are Tabled and chart has been drawn the values are come positive for the test results.

The results indicated the biodiesel is increased the brake thermal efficiency. Biodiesel sample are reduced the harmful gas effects in exhaust. Ground nut and palm oil blends is equally blended. The blend sample S1 (ground 5% + palm oil 5% + diesel 90%). All samples are made for the blends for B20, B25, B30 and B40 .The bi diesel is near to come the diesel values for the testing. It used for the alternative fuel for the transportation purpose.

Test results are come for NO_x, CO, CO₂, HC has increased the O₂ has been decreased. All other parameter has shown the significant improvement for the diesel.

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