

The Impact of C3, C4 alcohols, and Biodiesel (sesame and palm oil) on DI Diesel engine characteristics

Submitted in partial fulfillment of the requirements for the award of

**Bachelor of Engineering Degree
in
Mechanical Engineering**

By

SEEPANA. DEEPAK (38150105)

SELVAKUMAR (38150104)



**DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119.

MAY - 2022



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SEEPANA. DEEPAK (38150105), SELVAKUMAR (38150104)** who carried out the project entitled **"The Impact of C3, C4 alcohols, and Biodiesel (sesame and palm oil) on DI Diesel engine characteristics."** under my / our supervision from **SEPTEMBER- 2021 to APRIL-2022.**

Internal Guide

Dr.S.GANESAN, M.E, PhD.

Head of the Department

Dr. G. ARUN KUMAR M.E, PhD.

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

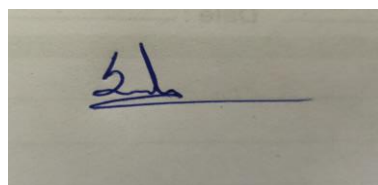
We **SEEPANA DEEPAK** and **SELVAKUMAR** hereby declare that the project report entitled “**The Impact of C3, C4 alcohols, and Biodiesel (sesame and palm oil) on DI Diesel engine characteristics**”, done by me under the guidance of **Prof. Dr. S. GANESAN, M.E., Ph.D.** and **Dr. G. ARUNKUMAR, M.E., Ph.D.** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

DATE:

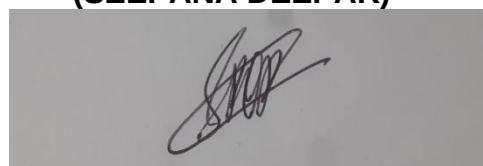
PLACE:

SIGNATURE OF CANDIDATE

(SELVAKUMAR.M)



**SIGNATURE OF CANDIDATE
(SEEPANA DEEPAK)**



ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the Board of management of **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to **Dr. S. PRAKASH, M.E., Ph.D., Dean, School of Mechanical Engineering,** and **Dr. G. ARUNKUMAR, M.E., Ph.D., Head of the Department of Mechanical Engineering** for providing me the necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude towards our project Guide **Dr. S. GANESAN, M.E., Ph.D., Associate Professor, Department of Mechanical Engineering** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my 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

The main objective of the project is to increase the performance of the engine and decrease the emissions from the engine, after testing the performance of biodiesel made by us in the sathyabama's engine lab, a Comparison of emission and performance results is done between diesel and our biodiesel. The biodiesel was made by transesterification process using sesame oil and palm oil, then we made four solutions with different concentrations of diesel, biodiesel, propanol, and butanol. All these four solutions were tested in the engine lab. As far as the emissions, almost all the solutions under most of the loads in the engine were tested to show a significant reduction in emissions such as NO_x, HC, CO₂, and O₂. However, there is a slight Increment in CO emission. from the performance point of view, in certain samples brake thermal efficiency was found higher than that of diesel, in a particular sample, specific fluid consumption was found to be similar to that of diesel. In conclusion our maximum brake thermal efficiency obtained is about 33.45% for S4, which is quite higher than that of baseline diesel 32.59 percent at full load. The SFC values of S1 are almost similar in comparison to diesel fuel at all load conditions. HC emissions of S1 are lower than the diesel fuel and other samples, at 0.875 KW load S1 emission is 5 ppm whereas diesel's is 6 ppm, and max load S1 is 12 and diesel is 16 ppm. CO₂ EMISSIONS of S1 are lower than diesel fuel at every load condition. The best performing sample under no-load conditions is S3, remaining all other loads S1 is the best, at loads 0.875, 1.75, 2.62, and 3.5 KW, S1 values are 0.8, 1, 1.5, and 1.9 ppm respectively. NO_x emission of S3 is lower than the diesel fuel in every load condition except in no-load conditions. At loads 0.875, 1.75, 2.62, and 3.5 KW, S3 values are 117, 207, 354, 412 ppm respectively whereas diesel values are 156, 289, 421, and 526 ppm respectfully.CO at every load in every sample there is a slight increment than diesel emissions. At 0 load S4 the highest emission of 0.015 PPM, at 0.875 KW, it is S3 with 0.025 PPM, at 1.75 KW it is S1 with 0.035 PPM, at 2.62 KW it is S1 again with 0.05 PPM, at 3.5 KW it is S2 with 0.06.O₂ emissions of all solutions are higher than diesel fuel at all load conditions. Highest O₂ recorded was by S2 under no load condition,

which was 19.76 PPM, and least was by Diesel under max load condition which was 11 PPM.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE No.
1	INTRODUCTION	1
	1.1 BIOFUELS	1
	1.2 BIODIESEL	2
	1.3 ADVANTAGES OF BIODIESEL	3
	1.4 DISADVANTAGES OF BIODIESEL.	3
2	LITERATURE REVIEW	4
3	AIM AND SCOPE OF PRESENT INVESTIGATION	11
	3.1 AIM	11
	3.2 SCOPE	11
4	MATERIALS AND METHODS	12
	4.1 BIODIESEL PRODUCTION	12
	4.2 SAMPLE PREPARATION	12
	4.3 EXPERIMENTAL SETUP	12
	4.4 ENGINE TESTING SOFTWARE	16
	4.5 TEST RUN WITH COMPUTERIZED MULTI CYLINDER ENGINE SETUPS.	16
	4.6 ONLINE DATA ACQUISITION	17
	4.7 SMOKEMETER	19
	4.8 GAS ANALYZER	21
5	RESULTS, DISCUSSION, AND PERFORMANCE ANALYSIS	23
	5.1 EMISSIONS	23

CHAPTER NO.	TITLE	PAGE No.
5.2	NOX EMISSIONS.	23
5.3	CO EMISSIONS	25
5.4	O ₂ EMISSIONS	27
5.5	CO ₂ EMISSIONS	28
5.6	HC EMISSIONS	29
5.7	PERFORMANCE ANALYSIS.	31
	5.7.1 Brake Specific Fuel Consumption (BSFC).	31
	5.7.2 Brake Thermal Efficiency (BTHE)	33
6	SUMMARY AND CONCLUSION	34
6.1	SUMMARY	34
6.2	CONCLUSION	34
	REFERENCES	36

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
4.1	Experimental Setup	13
4.2	Engine Testing Lab	14
4.3	B20 Blend	14
4.4	Experimental Setup	16
4.5	Smoke Meter	20
4.6	Linearity Test	20
4.7	Five Gas Analyzer Reading	21
4.8	Five Gas Analyzer	22
5.1	NOX Vs BP	24
5.2	CO Vs BP	26
5.3	O2 Vs BP.	27
5.4	CO2 Vs BP	28
5.5	HC Vs BP	30
5.6	SFC Vs BP	32
5.7	BTHE Vs BP	33

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
4.1	Specifications of the Test Engine	15
5.1	NOx Emissions of S1, S2, S3, S4, Diesel with loads.	24
5.2	CO Emissions of S1, S2, S3, S4, Diesel with Loads.	26
5.3	O2 Emissions of S1, S2, S3, S4, Diesel with loads	27
5.4	CO2 Emissions of S1, S2, S3, S4, Diesel with loads.	28
5.5	HC Emissions of S1, S2, S3, S4, Diesel with loads.	30
5.6	SFC Values of S1, S2, S3, S4, Diesel with loads.	32
5.7	BTHE Values of S1, S2, S3, S3, S4, Diesel with Loads	33

CHAPTER - 1

INTRODUCTION

1.1 BIOFUELS

Bioenergy is energy derived from biofuels. Biofuels square measure fuels made directly or indirectly from organic material – biomass – together with plant materials and animal waste. Overall, bioenergy covers roughly 100 percent of the overall world energy demand. ancient unprocessed biomass like fuelwood, charcoal, and animal dung 2 accounts for much of this and represents the most supply of energy for an outsized range of individuals in developing countries WHO use it chiefly for preparation and heating. More advanced and economical conversion technologies currently permit the extraction of biofuels from materials like wood, crops, and waste matter. Biofuels will be solid, gassy, or liquid, despite the fact that the term is commonly employed in the literature in a very slim sense to refer solely to liquid biofuels for transport. Biofuels could also be derived from agricultural crops, together with standard food plants or from special energy crops. Biofuels may be derived from biology, agricultural or piscary product or municipal wastes, also as from agro-industry, food business, and food service by-products and wastes. A distinction is formed between primary and secondary biofuels. within the case of primary biofuels, like fuelwood, wood chips, and pellets, organic materials square measure employed in AN unprocessed type, primarily for heating, preparation, or electricity production. Secondary biofuels result from the process of biomass and embrace liquid biofuels like fermentation alcohol and biodiesel that may be employed in vehicles and industrial processes. Bioenergy is especially employed in homes (80%), to a lesser extent in business (18%), whereas liquid biofuels for transport still play a restricted role (2%). Even though the assembly of liquid biofuels for transport has big speedily in recent years it presently represents only one of total transport fuel consumption and solely 0.2 to 0.3% of total energy consumption worldwide.

1.2 BIODIESEL

Biodiesel may be a clean-burning different fuel created from domestic, renewable resources. This biofuel may be a mixture of carboxylic acid alkyl radical esters made of vegetable oils, animal fats, or recycled greases. wherever on the market, biodiesel is utilized in compression -ignition (diesel) engines in its pure kind with very little or no modifications. Diesel engines these days solely remotely correspond to the engine that applied scientists designed. His engine was initio designed to run on coal dirt. Moreover, for the primary few decades, they may run on the subject of something that will burn. while late because the 1970's, automotive diesel engines were very tolerant once it involves the fuel they may use. Today's diesel engines area unit way more economical and cleaner than the first versions, partially as a result of they run on a narrowly outlined fuel. It permits the engine manufactures to tune the equipment for improved potency. Biodiesel and fuel area unit terribly similar in their physical and chemical characteristics. they're similar enough that trendy diesel engines will run on biodiesel. We can mix Biodiesel with fuel at any magnitude relation. We can discover biodiesel blends like B20, that is two hundredth biodiesel and eightieth diesel, at truck stops and gas stations. mixing biodiesel with fuel ends up in a fuel that burns cleaner than diesel alone. everybody has seen those black clouds, or soot, gushing from the exhaust of a diesel truck once it's beneath load. However, after we mix biodiesel with diesel, the soot is reduced, and dirty diesels will become clean diesels. Biodiesel is created through a method within which organically derived oils area unit combined with alcohol (ethanol or methanol) within the presence of a catalyst to make alkyl group or alkyl radical organic compound. The biomass-derived alkyl group or alkyl radical esters is mingling with typical fuel or used as a neat fuel (100% biodiesel). Biodiesel is made of any oil, animal fats, waste vegetable oils, or microalgae oils. There are a unit 3 basic routes to biodiesel production from oils and fats:

- Base catalyzed trans-esterification of the oil.
- Direct acid catalyzed trans-esterification of the oil.
- Conversion of the oil to its fatty acids and so to biodiesel

1.3 ADVANTAGES OF BIODIESEL.

- Produced from Renewable Resources.
- Can be Used in Existing Diesel Engines.
- Less Greenhouse Gas Emissions (e.g., B20 reduces CO₂ by 15%).
- Grown, Produced, and Distributed Locally.
- Cleaner Biofuel Refineries.
- Biodegradable and Non-Toxic.
- Better Fuel Economy.
- Reduced Foreign Oil Dependence.
- Improved Air Quality.
- Biodiesel is Undoubtedly a Safer Alternative to Fossil Fuels.
- Biodiesel Could Possibly End Energy Crisis and Energy Politics.

1.4 DISADVANTAGES OF BIODIESEL.

- Variation in Quality of Biodiesel.
- Not Suitable for Use in Low Temperatures.
- Biodiesel Could Harm the Rubber Houses of Some Engines.
- Biodiesel is Way More Expensive than Petroleum.
- Use of Petroleum Diesel to Produce Biodiesel.
- Monoculture refers to the practice of producing the same crop over and over again rather than producing different crops.
- Increased use of Fertilizers.

CHAPTER - 2

LITERATURE REVIEW

From the experiment of Gossypium arboreum biodiesel conducted by S. Ganesan and team, we have observed that broadly speaking, the Gossypium arboreum oil, combined with diesel oil, provides superior efficiency and a substantial reduction in CO₂ emissions, making it the perfect choice for Gossypium arboreum oil blends GAOB20 and GAOB30.

The experimental investigation of combustion, performance, and emission characteristics of wheat germ oil and its blends have been performed on DI diesel engine by Senthilkumar jayapalan and team, the following conclusions have been drawn. The CO₂ emissions are lower for all the diesel-biodiesel blends and the maximum reduction of CO₂ emission is for sample 6 (70%diesel+30%biofuel+30 ppm TiO₂). The percentage reduction is more than 35% compared to diesel

From the experiment conducted by Hemanandh janarathanam and team on influence of CNG emissions in copper coated catalytic converter in 4 stroke SI engine, The stainless-steel wire mesh coated copper (which is the metal catalyst agent) by using electroplating which provides high conductivity, withstands to higher temperatures (thermal resistance), and is flexible. This coated SS-304 19 wire mesh has reduced the emissions such as CO₂, HC, NO_x, CO from the bike.

In the present work, by Vemuri Sai Srikanth and team the experiments are conducted with suitable biodiesel, piston geometry, and EGR design. With these the investigations are conducted out on a four-stroke single-cylinder water-cooled, computerized test rig of CI diesel engine. The BSFC for RPOME 15% EGR is decreased about 8% compared to the standard engine. This is owing to proper air-fuel mixing in the combustion geometry. The BSFC for RPOME 15% EGR is decreased about 8% compared standard engine. This is owing to proper air-fuel mixing in the combustion geometry.

Our understandings from Ganesan Subbiah and team's research is, Grey relational analysis mainly deals with the objective to "optimize a response which is influenced by several independent variables." Homogeneous combustion catalysts are those additives that are dissolved into diesel fuels homogeneously to play a catalytic role during the combustion process of the engine. The lemon Distilled oil would be one of the safe alternate fuels in the future. Based on the ANOVA results, the parameter of Nanocatalyst CeO_2 composition shows 62 % followed by Biodiesel blend 16%, BP 11%, and Injection Pressure with 9%. CeO_2 composition shows the major contribution of engine performance and the Lemongrass oil blend shows the second most significant affecting parameter.

This study by S. Ganesan and team investigated diesel engine emissions characteristics under various engine process parameters such as Citronella oil, injection pressure, brake power, and ZnO were tested. The main effects plot for both mean of signal to noise ratio the optimized combination is found for various engine performance and emissions. The experimental data shows that at this combination the engine performance is comparable to that of diesel. The emissions are less than that for diesel.

From the research of Rajasekar Rajendran and team, we understood that Catalytic converter design and modification of catalytic materials can be an alternative to overcome the high air pollution problem from the automotive transportation sector especially particular carbon Monoxide and NO_x exhaust emission from the diesel engine. The use of zirconium and alumina coated as a catalyst in the catalytic converter was significantly able to increase the reduction of carbon Monoxide and NO_x exhaust emissions. The increase of catalyst cell amount decreased the concentration of carbon monoxide and NO_x exhaust emission. The optimum design of the catalytic converter was able to reduce exhaust emissions.

The emissions with Hydrotreated Waste cooking oil as fuel recorded by Hemanandh Janarthanam and team showed a reduction in CO, HC, CO_2 , NO_x , Smoke, brake specific fuel consumption and increase in Brake thermal efficiency when compared with Petro diesel as fuel. Thus, the above experiments help us to conclude that, 100% hydrotreated waste cooking oil can be used as fuel

directly without any modification in the engine leading to lesser emissions and better performance of the diesel engine.

This research study by S.P.Venkatesan and team gives the solution to plastic waste management and alternate fuel to diesel. The waste plastic oil is extracted from the plastic waste by the pyrolysis process to which zeolite is used as a catalyst. From the experimental results, the blend having the volume percentage of 50% of diesel, 30% of waste plastic oil and 20% of n-hexanol has shown better performance among the other blends. From the experimental test, the following conclusion is drawn: (1) Among the tested fuel it was observed that the D50WPO30H20 blend shows better performance among all other blends and therefore the brake thermal efficiency of that blend was found to be 1.265% and 14.285% increases when compared with pure diesel and WPO at full load. (2) When compared with pure diesel and WPO, NO_x emission was found to be 4.04% and 8.96% lower when the engine runs with D50WPO30H20 blends. (3) Smoke emission was found to be 30% lower than diesel and 40% lower than WPO when the engine power source with the D50WPO30H20 blend.

It is observed that there is an increment of 55% in the SFC, 9% increase in brake thermal efficiency, 76% decrement in hydrocarbon emission, 10% reduction in emission of Carbon dioxide, and 22% increase in the emission of oxides of nitrogen. Reduction of NO_x emissions with low viscous biofuel using exhaust gas recirculation technique by Rajasekar Rajendran and team, It was concluded that BE-3 with 75% diesel, 22 20% LG, 5% DEE and 500ppm of pyrogallol with 25% EGR was considered to have better performance and emission characteristics when compared with the other two blends.

Taguchi Based Optimization of Diesel Engine Parameters with Blends of Lemon Grass oil with ZnO by S. Ganesan and team shows that, the activation energy of Zinc oxide acts to burn off carbon deposits within the engine cylinder at the wall temperature and prevents the deposition of non-polar compounds on the cylinder wall results reduction in HC emissions. The tests revealed that Zinc oxide nanoparticles can be used as additives in the diesel-biodiesel blend to improve complete combustion of the fuel and reduce the exhaust emissions significantly., it was observed that the multi-response

parameters are optimized using grey relational analysis and converted into a single response. To analyze the experimental data Taguchi 's methodology was used. The main effects plot for both means of average grey grade and signal to noise ratio the optimized combination is found to be A3B1C3. In this particular combination, it is predicted from the experimental data that the engine performance is comparable to that of diesel, moreover, the emissions are less than that for diesel.

From the research of Ganesan Subbiah and team , For better BTHE, we need to operate the engine under the conditions A1B3C1D3. x for low Specific fuel consumption and CO, the engine has to be operated under the condition A3B3C1D1 and A3B2C1D2. x for low HC, an experiment should be conducted with MgO in 45 ppm, BP in 3KW, 200 23 bar of injection pressure, L.B in 10% and for NOx, with MgO in 15 ppm, BP in 4.4 KW, 200 bar of injection pressure and L.B in 10%.

J. Hemanandh and team's experiment results show that engine temperature decreases at higher loads by 2°, NOx and CO decreases and there was a marginal increase in HC and the exhaust temperature. The experiments conducted showed that the refined 26 palm-olein biodiesel, when blended with diesel by varying the pressure, resulted in the desired pattern of emissions.

From the experiment on synthesis of chicken slaughter waste biodiesel in DI diesel engine by Hemanandh Janarthanam and team we can say that the biofuel produced has a low emission rate and a decline in the fuel price. Biochar is produced as a by-product during the experiment that could be used as bio-fertilizer due to the rich nitrogen content to improve the soil quality in comparison with pure diesel, it was found that the blend produces less HC emission than with a yield of 9.68% at 100% load condition.

Experiment on Environmental emission control in CI engine using hydrotreated bio-fuel in India, by Hemanandh Janarthanam and team's results showed that Jatropha oil gave less emission and enhanced performance when compared with refined palm olein oil and Petro diesel. 25 The emissions of CO decreased by

14.26% and 28.57% for HTRPMB100 and HTJATB100 respectively. The HC emissions of HTJATB100 and HTRPMB100 reduced by 57.5% and 52.6 % respectively.

CHAPTER – 3

AIM AND SCOPE OF PRESENT INVESTIGATION

3.1 AIM

The primary aim of this paper is to study the emissions and performance characteristics of a direct injection Diesel engine using C3, C4 alcohols, and Biodiesel (sesame and palm oil). Brake thermal efficiency (BTHE) and Specific fuel consumption (SFC) are also studied.

3.2 SCOPE

The scope of this work is to analyze the performance of the engine at different rated power was evaluated in terms of Specific Fuel Consumption (SFC), Brake Thermal Efficiency (BTHE), and emissions characteristics such as HC, CO, CO₂, and NO_x. The biodiesel is made from sesame oil and palm oil by the transesterification process. The biofuel is tested in the DI Diesel engine. The engine was permitted to run at no load condition, in the beginning, the test blends were added and the emission and performance characteristics for the sample were recorded.

CHAPTER – 4

MATERIALS AND METHODS

4.1 BIODIESEL PRODUCTION

Biodiesel is made by the transesterification process. This Biodiesel is made from sesame oil and palm oil. The Biodiesel was prepared by mixing 60% of palm oil and 40% of sesame oil, making it into a solution, then heating it until it reaches 60c, then adding the catalyst which is NaOH + Methanal (mixed in 1:6 ratio), maintaining it for 90 minutes then two layers will be formed, the top layer is crude biodiesel, and the bottom layer is crude glycerol, then those two layers were separated after that Biodiesel and water were mixed in 1:1 ratio and left that solution idle for 5 to 10 minutes, then another separation happens, the top layer was biodiesel and bottom water, that biodiesel was separated and its PH value will be 7, now biodiesel solution will be heated to 110c then all the moisture will be gone, and the remaining product is the final biodiesel.

4.2 SAMPLE PREPARATION

A total of 4 samples were made with different ratios of biodiesel, diesel, and alcohol

S1 = 75% diesel + 20% biodiesel + 2.5% propanol + 2.5% butanol

S2 = 70% diesel + 20% biodiesel + 5% propanol + 5% butanol

S3 = 65% diesel + 20% biodiesel + 7.5% propanol + 7.5% butanol

S4 = 60% diesel + 20% biodiesel + 10% propanol + 10% butanol

4.3 EXPERIMENTAL SETUP

A single-cylinder, constant speed, Direct Injection engine was used too evaluate the engine performance and emission characteristics of sesame and palm oil biodiesel. The diesel runs under different load conditions at a constant speed of 1500 rpm with the different blend proportions. The diesel engine was directly attached with an eddy current dynamometer for varying the loads from no load (0%) to full load (100%). Based on the engine power, the engine load is varied from a

no-load condition of 0%, 25%, 50%, 75% and full load condition of 100%. The engine loads are varied manually with help of an eddy current dynamometer. The airflow rate was measured with an air drum fitted with a calibrated orifice and the fuel flow was measured using volumetric calibrated burette method. For fuel flow measurement, two fuel tanks were used; one is filled with pure diesel while trans esterified sesame and palm oil biodiesel is filled in another fuel tank. An AVL smoke meter was attached to measure the smoke opacity and exhaust gas temperatures. The test rig was installed with AVL indimicro software to obtain various readings and results during operation. A five-gas analyzer was used to measure the emission characteristics such as HC, CO, CO₂, O₂ and NO_x values from the exhaust gas. The performance and emission tests were conducted at the compression ratio of 17.5 and with rated power.

The performance analysis of the engine at different rated power was evaluated in terms of Specific Fuel Consumption (SFC), Brake Thermal Efficiency (BTHE) and emissions characteristics such as HC, CO, CO₂, and NO_x.



Fig.4.1: Experimental Setup



Fig.4.2: Engine Testing Lab

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

Range of Experiments

- Study of VCR engine performance (Computerized mode)
- Study of emissions with EGR variation
- Study of combustion with different fuel Blends

Utilities Required

Electric supply

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

Computer

IBM compatible with standard configuration

- $P \theta$ -PV plots, performance plots and tabulated results
- Data logging, editing, printing and export, Configurable graphs
- IP, IMEP, FP indication, combustion analysis

Table 4.1: Specifications of the Test Engine

Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel with EGR (Comp.)
Product code	234
Engine	Make Kirloskar, Type 1 cyl., 4 stroke Diesel, water cooled, power 3.5kW at 1500rpm, 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 meter and manometer
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.
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Piezo powering unit	Model AX-409.
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	RTD PT100, Range 0–100o C, 3 Nos; Thermocouple, Range 0-1200 oC, 2 Nos
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC
Software	“EngineSoft” Engine performance analysis software
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Pump	Type Monoblock
Overall dimensions	W 2000 x D 2500 x H 1500 mm

Optional	Computerized Diesel injection pressure measurement with injection variation 0-25 deg BTDC
-----------------	---

4.4 ENGINE TESTING SOFTWARE

EngineSoft is LabVIEW based software package developed by Apex Innovations Pvt. Ltd. for engine performance monitoring system. EngineSoft 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.

4.5 TEST RUN WITH COMPUTERIZED MULTI CYLINDER ENGINE SETUPS.

- Ensure that all the nut bolts of engine, dynamometer, propeller shaft, bass farms are property tightened.
- Ensure that sufficient lubrication oil is present in the engine sump tank

This can be checked marking on the level stick.

- Ensure sufficient fuel in fuel tank. Remove air in fuel line, if any.
- Switch on electric supply and ensure that PPU (Piezo powering unit AX-409), DLU (Dynamometer loading unit AX-155). Load indicator and Voltmeter are switched on. 31
- Start Computer and open "ICEngineSoft" (Double click "ICEngineSoft" icon on the desktop) Select: File| Configure| Product.
- In "Configure the product" window select "Load Default".
- Under "Select File" choose your Setup from drop down menu.

- Under "Set Parameters" study the parameters under Engine Sensors, Combustion and Performance tabs Click on "OK".
- Changing the Parameters.
- If any parameter is to be changed Click "New/Change". Change the parameter under respective tabs After all changes click "Save & Apply".

Click "OK" to save changes.

- Click "OK" again to reconfigure changes.
- Reconfiguring the graphs.
- Select File| Configure Graph Under "Configure" the Graphs window "Select a Configuration" from the drop-down menu.
- Study the preset configuration of X axis, Y axis. graph ranges, for the selected graphs. Click "CLOSE & SET". Configure the necessary parameters, ranges, as required. Click "SAVE" and then "Close & SET".
- Note three vertical tabs viz. Combustion Performance Report Under Vertical Combustion tab horizontally following tabs are available:

Combustion, Cylinder Pr. PV, Log PV and RPR etc. Similarly, under other vertical tabs we get more horizontal tabs. Start water pump. Adjust the flow rate of "Rotameter (Engine)" to 900-1000 LPH and "Rotameter (Colorimeter)" to 200-250 LPH by manipulating respective globe values provided at the rotameter inlet. Ensure that water is flowing through dynamometer at a pressure of 0.5 to 1 Kg/cm². (For Hydraulic dynamometer at a pressure of 1.5 to 2 Kg/cm²).

- Keep the DLU knob at minimum position. Change the Fuel cock position from "Measuring".
- Tank". Start the engine by starter keys switch and allow it to run at idling condition for 4-5 minutes.

4.6 ONLINE DATA ACQUISITION.

- Click toggle switch Move to "Start/Stop" the device communication. Green

- color indicates ON condition Click toggle switch *Measurement” to Start/Stop data acquisition. Green color indicates ON condition.
- Ensure that Speed, Temperatures and Manometer reading are correctly displayed on the PC. These readings should tally with those displayed on the engine panel.
- Increase the load on the engine by rotating knob on the DLU and confirm the load reading on the indicator and computer are same.
- Gradually increase throttle to full open condition and load the engine simultaneously maintaining engine speed at 2000-2600 RPM.
- Wait for steady state for 3 minutes and ensure that RPM & Load is constant during this period. Change the Fuel cock position from "Tank" to “Measuring”. Click “Log on” on. The fuel metering in ON for next 60 seconds. During first 30 seconds enter engine. Water flow, calorimeter jacket cooling water flow in LPH Click "OK" after recording fuel reading.
- Enter the file name under which the records to be stored. The first reading data is now saved. Change the Fuel cock position from "Measuring " to "Tank".
- Gradually decrease the load to the increase speed in steps of 500 RPM up to 4000 RPM maximum and repeat the data logging for each observation.
- After finishing all the readings simultaneously decrease the load on the engine by DLU. Gradually decrease throttle to full down condition.
- Click toggle switch “Measurement” to Stop data acquisition in PC (Green color indicates ON condition). Click toggle switch “Mode” to Stop the device communication.
- Click: File|Data|Close. Stop the engine by pressing engine stop starter keys. Allow the water to circulate for about 5 minutes for engine cooling and then Stop the pump.

- Click: File|Data|Open. on PC, Select the File under which the readings are stored and click "OK". To view next readings, click "Next Data". The results are displayed on all the three screens.
- Report Printing Click "Report" tab to Performance generating Report Enter File name in "Report File" Select Combustion Report. the Report Requirements viz. Result Data, Observation Data, Graph Only OR Graph and Table. (Note: If "Graph and Table") options Selected.
- Combustion Report, the size of the output file for printing otherwise it becomes too big. However, it can be viewed in Excel) Click: File|Data|Close. after Printing & checking. Click "Exit" and then Shut Down the computer.

4.7 SMOKEMETER

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 Master data 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 second. If the readings are not coming it shows the message in red color
- "Unable to Communicate with Equipment" kindly Check the following:
- Be sure that Smoke meter model name display on screen is same as your Smoke meter if not kindly Master the model in 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 property 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 disconnects the communication with equipment and show the message "Disconnected".
- Report: Click on report button to take the rear 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, a excel file is generated at path "C: \AVLFolder\" The file name of excel file is same as test date and VIN no (Tuesday, January 06, 2009).
- 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.



Fig.4.3: Smoke Meter



Fig.4.4: Linearity Test

4.8 GAS ANALYZER

To take the readings from Gas analyzer to ADCS Software kindly follow the 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 show the message in red color CO, HC power not communicating kindly check the following.
- Be sure that gas analyzer settings in "MAHA Euro" mode.
- Connect to 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 save in database.
- After taking the readings click on "Disconnect button". it disconnects the communication with equipment and show the message Saved Database.
- Click on report button to take a part 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 windows sheet click on "EXPORT TO EXCEL" button. When pressing, export button excel File is generated in a path C:\AVLFolder 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 screen.



Fig.4.5: Five Gas Analyzer Reading



Fig.4.6: Five Gas Analyzer

CHAPTER – 5

RESULTS, DISCUSSION, AND PERFORMANCE ANALYSIS

The engine's performance and emission analysis were carried out when fueled with sesame and palm oil biodiesel for four different volumetric fuel blends with diesel at different loads and compared with diesel fuel operation.

5.1 EMISSIONS

Biodiesel has been shown to possess a bonus over petroleum-based diesel in terms of emissions composition. Combustion of biodiesel emits nominal to no SO₂ emissions, less polyaromatic hydrocarbons, soot, and CO. Combustion potency is outlined because the ratio of the energy free in combustion to the upper heating worth of the fuel. This potency can be optimized through changes of the air body of water to the burner which may conjointly impact final emission composition.

Combustion potency is additionally a operate of the exhaust temperature and therefore the exhaust concentration of CO₂. High concentrations of CO₂ indicate that combustion goes towards completion and most of the fuel is being consumed.

The stack temperature is directly associated with the amount of settled soot and scale on the warmth transfer surfaces. With larger buildup of soot, the conductive heat transfer constant of the surfaces drops and additional helpful heat is lost within the tack. For these reasons, it's vital to tune burners to maximize CO₂ concentrations within the stack whereas minimizing the number of smokes made.

5.2 NOX EMISSIONS

Nitrogen Oxides (NO_x) are a bunch of extremely reactive gases, that include compounds starting from nitrous to acid. These compounds are primarily discharged in truck, car, station and off-road instrumentality exhaust. Nox gases kind when nitrogen and oxygen from the air react at the very high temperatures and pressures inside a combustion cylinder, which might reach up to 4000°F and

300PSI (Johnson, 2015). In the direct injection ICE fuel is sprayed into the cylinder and forms small droplets. Oxygen interacts at the boundary surface between the air and therefore the fuel droplets wherever the localized temperature quantity of oxygen and heat can lead to high levels of Nox formation. These c as a result of than gas throughout combustion, however with the implementation of chemical action converts in gas high-powered vehicles, diesels engines release additional Nox gases to the Setting.

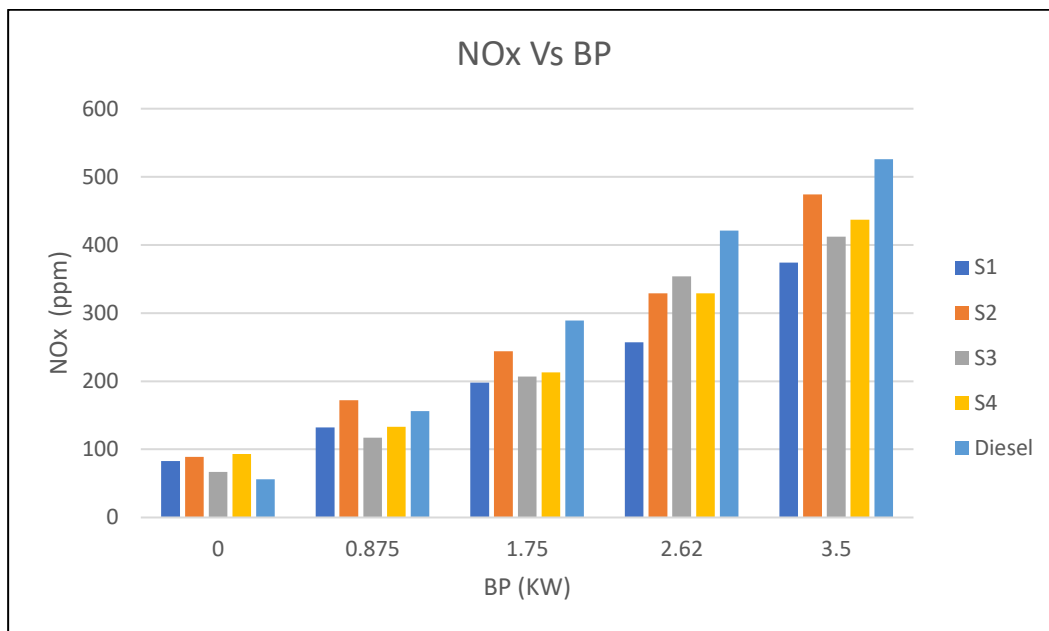


Fig.5.1: NOX Vs BP

The graph shows the comparison of NOX emissions with BP (KW) for S1, S2, S3, S4 diesel. NOx emissions for S1, S2, S3, S4 are significantly lower than diesel emissions.

Table 5.1: NOx Emissions of S1, S2, S3, S4, Diesel with loads.

BP (KW)	0	0.875	1.75	2.62	3.5
S1 (ppm)	83	132	198	257	374
S2(ppm)	89	172	244	329	474
S3(ppm)	67	117	207	354	412
S4(ppm)	93	133	213	329	437
Diesel (ppm)	56	156	289	421	526

The graph displays the change in NO_x emissions with BP (KW) for S1, S2, S3, S4, and Diesel. NO_x emissions for S1, S2, S3, and S4 are significantly lower than diesel emissions when the load is applied. S3 out of all samples has recorded a little over diesel-only when 0.875 KW load was applied. When no load was applied diesel actually emitted less NO_x than all the solutions, but as the load was increased diesel emitted a lot of NO_x when compared to other solutions. The least emission of NO_x was produced with diesel when subjected to 0 load which is 56 PPM and the highest also by diesel when subjected to 3.5 KW load. At loads 0.875 and 1.75 KW, S2 emitted 172 and 244 PPM respectfully which were a little higher when compared to other solutions at those Load.

5.3 CO EMISSIONS

Carbon monoxide results from the unfinished combustion wherever the chemical reaction method doesn't occur fully. This concentration is essentially smitten by air/fuel mixture and its highest wherever the excess-air issue (λ) is a smaller amount than one.0 that's classified as wealthy mixture. It is often caused particularly at the time of beginning and instant acceleration of engine wherever the wealthy mixtures are needed. within the wealthy mixtures, because of air deficiency and chemical concentration, all the carbon cannot convert to carbon dioxide and be shaped CO concentration. though CO is made throughout operation in wealthy mixtures, a little portion of CO is additionally emitted below lean conditions due to chemical kinetic effects.

Diesel engines are lean combustion engines that have a systematically high air–fuel quantitative relation ($\lambda > 1$). So, the formation of CO is bottom in diesel engines. None the less, CO is made if the droplets in a very ICE are large or if insufficient turbulence or swirl is made within the combustion chamber.

Carbon monoxide is an inodorous and colorless gas. In humans, CO within the air is inhaled by the lungs and transmitted into the blood. It binds to hemoprotein and inhibits its capability to transfer oxygen. looking on CO concentration within the air, as so resulting in asphyxiation, this could have an effect on the operate of various organs, leading to impaired concentration, slow reflexes, and confusion.

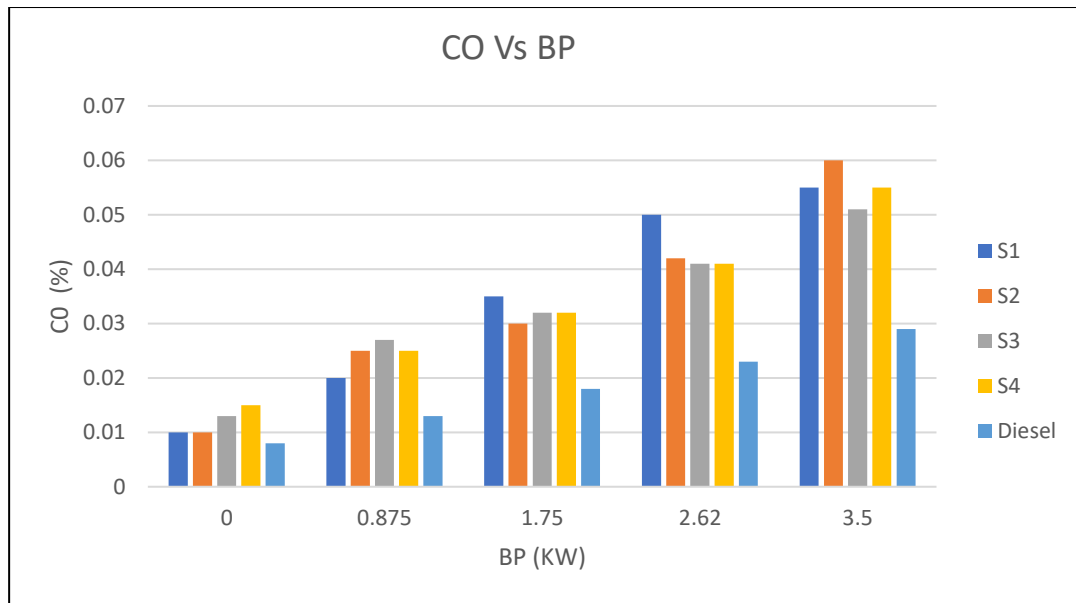


Fig.5.2: CO Vs BP

Table 5.2: CO Emissions of S1, S2, S3, S4, Diesel with Loads.

BP (KW)	0	0.875	1.75	2.62	3.5
S1 (%)	0.01	0.02	0.035	0.05	0.055
S2 (%)	0.01	0.025	0.03	0.042	0.06
S3 (%)	0.013	0.027	0.0320.03	0.041	0.051
S4 (%)	0.015	0.025	0.032	0.041	0.055
Diesel (%)	0.008	0.013	0.018	0.023	0.029

The graph shows the comparison of CO emissions with BP (KW) for S1, S2, S3, and S4 diesel. CO emissions are formed due to air-fuel equivalent ratio, injection pressure, fuel type, and speed. Every sample has slightly higher CO emissions than diesel emissions. At no-load conditions, the highest CO emission is by sample 4, and the least is by diesel which is 0.008 ppm. At 0.875 KW load S3 emitted the highest amount of CO which is 0.027 ppm whereas diesel is only 0.013. when the load of 1.75 KW was applied S1 recorded the highest emission which is 0.035 ppm, while diesel's was only 0.018 ppm. At 2.62 and 3.5 loads S1 recorded the highest emissions 0.05 and 0.055 ppm respectively.

5.4 O₂ EMISSIONS

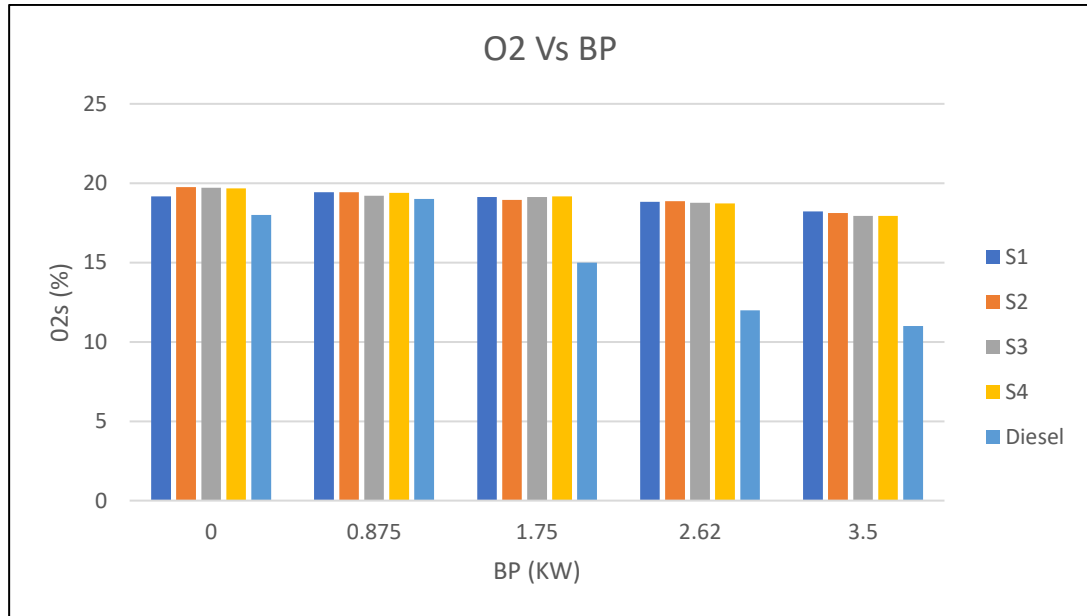


Fig.5.3: O₂ Vs BP

Table 5.3: O₂ Emissions of S1, S2, S3, S4, Diesel with loads

BP (KW)	0	0.875	1.75	2.62	3.5
S1 (%)	19.17	19.43	19.12	18.82	18.23
S2 (%)	19.76	19.44	18.95	18.87	18.12
S3 (%)	19.72	19.21	19.12	18.77	17.94
S4 (%)	19.67	19.39	19.16	18.73	17.94
Diesel (%)	18	19	15	12	11

Figure 5.3 displays the change in O₂ emissions with the BP (KW). The graph displays the change in O₂ emissions with the BP (KW) for S1, S2, S3, S4, and Diesel. O₂ emissions for S1, S2, S3, and S4 have a higher content than diesel in every load condition. There is an increasing pattern of O₂ with the increasing load. Almost all samples have similar O₂ content except diesel. Out of all samples, diesel emitted the least oxygen under all load conditions, at no-load conditions samples 1,2,3, and 4 emitted 19.17, 19.43, 19.72, and 19.67 ppm respectively whereas diesel emitted 18 ppm. At max load conditions, diesel emits only 11 ppm whereas samples 1,2,3, and 4 emitted 18.23, 18.12, 17.94, and 17.94 ppm respectively.

5.5 CO₂ EMISSIONS

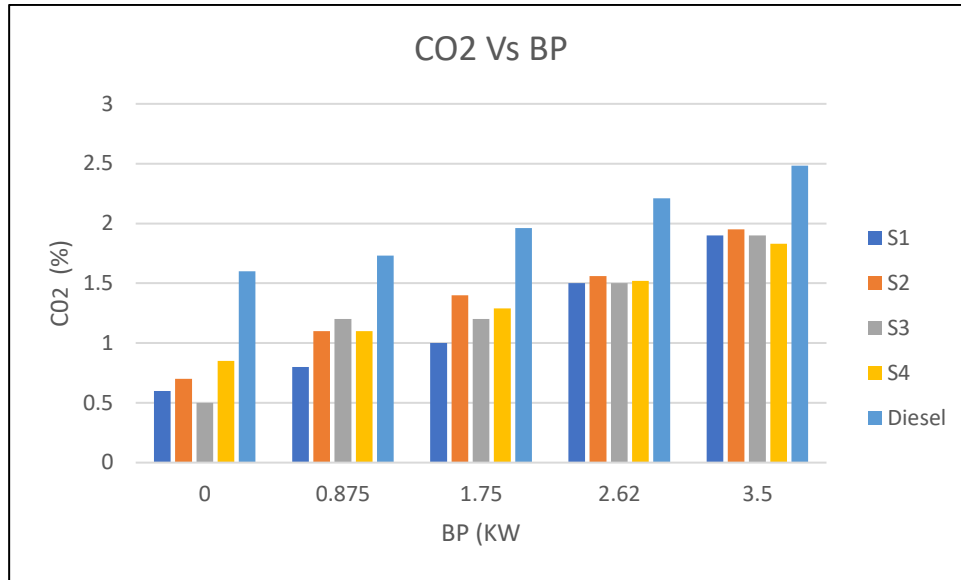


Fig.5.4: CO₂ Vs BP

Table 5.4: CO₂ Emissions of S1, S2, S3, S4, Diesel with loads.

BP (KW)	0	0.875	1.75	2.62	3.5
S1 (%)	0.6	0.8	1	1.5	1.9
S2 (%)	0.7	1.1	1.4	1.56	1.95
S3 (%)	0.5	1.2	1.2	1.5	1.9
S4 (%)	0.85	1.1	1.29	1.52	1.83
Diesel (%)	1.6	1.73	1.96	2.21	2.482

Figure 5.4 depicts the variation of CO₂ emissions versus BP (KW) for different test Fuels. The graph depicts the variation of CO₂ emissions versus BP (KW) for different test fuels. It was recorded that with increasing BP (KW) there is a slight increase in CO₂ emission for all solutions. At higher loads, S2 has a little bit CO₂ emission than other samples but overall all solutions under all conditions, the emission of CO₂ is lower than that of diesel. All samples, S1, S2, S3, and S4 performed better than diesel by emitting less CO₂. When compared under different load conditions, the best performing sample under no-load conditions is S3 which is 0.3 ppm whereas diesel is 1.6 ppm, under 0.875 KW load best performing sample is S1 with 0.8 ppm while diesel is 1.73 ppm, when 1.75 KW load is applied diesel emitted 1.96 ppm CO₂ while best performing sample under this load is S1 emitted only 1 ppm CO₂, when maximum load is applied diesel's CO₂ emission is 2.482 ppm, while S4's emission is 1.83 ppm which is emission under max load (3.5 KW).

5.6 HC EMISSIONS

Hydrocarbon emissions are composed of unburned fuels as a result of short temperature that happens close to the cylinder wall. At now, air-fuel mixture temperature is considerably but the middle of the cylinder. Hydrocarbons encompass thousands of species, like alkanes, alkenes, and aromatics. They're usually declared in terms of equivalent CH₄ content.

Diesel engines usually emit low levels of hydrocarbons. Diesel hydrocarbon emissions occur in the main at lightweight loads. The most important supply of light-load organic compound emissions is lean air–fuel admixture. In lean mixtures, flame speeds could also be too low for combustion to be completed throughout the ability stroke, or combustion might not occur, and these conditions cause high hydrocarbon emissions.

In Diesel engines, the fuel kind, engine adjustment, and style have an effect on the content of hydrocarbons. Besides, HC emissions within the exhaust gas depend upon irregular in operation conditions. High levels of instant modification in engine speed, untidy injection, excessive nozzle cavity volumes, and appliance needle bounce will cause vital quantities of unburned fuel to pass into the exhaust.

Unburned hydrocarbons still react within the exhaust if the temperature is on top of 600 °C and present, thus organic compound emissions from the piping could also be considerably below the hydrocarbons going the cylinder.

Hydrocarbon emissions occur not solely within the vehicle exhaust, however additionally within the engine housing, the equipment, and from region emission of vapors throughout fuel distribution and dispensing. housing hydrocarbon emissions and phase transition losses of hydrocarbon emissions have, severally, 20–35 and 15–25 take some time piping organic compound emissions have 50–60 you look after total hydrocarbon emissions.

Hydrocarbons have harmful effects on atmosphere and human health. With alternative waste matter emissions, they play a big role within the formation of ground-level gas. Vehicles are to blame for regarding fifty you look after the emissions that kind gas. Hydrocarbons are cyanogenic with the potential to tract irritation and cause cancer.

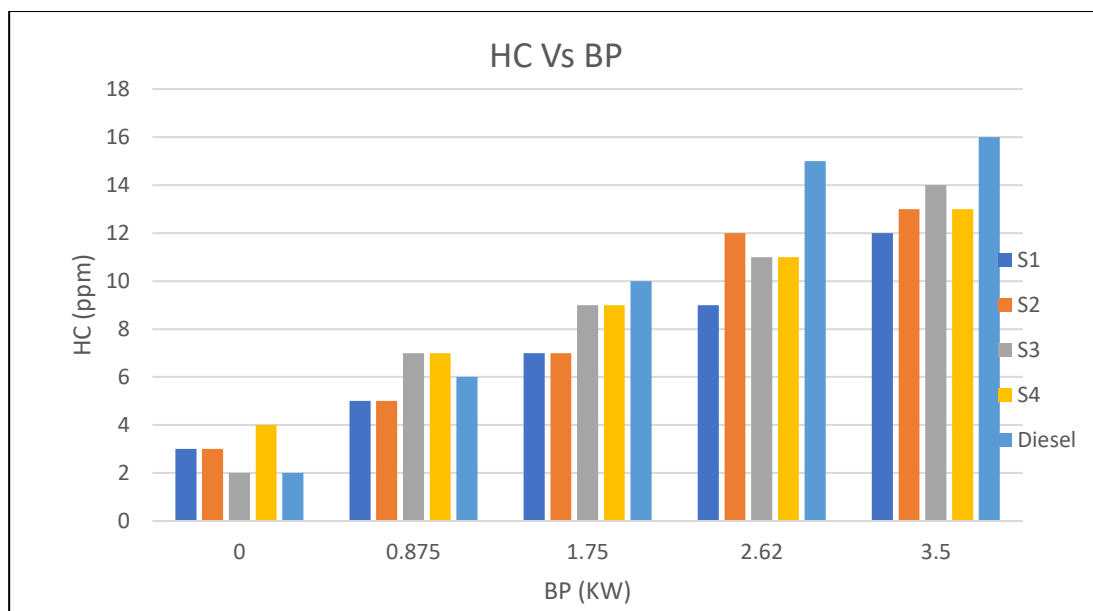


Fig.5.5: HC Vs BP

Table 5.5: HC Emissions of S1, S2, S3, S4, Diesel with loads

BP (KW)	0	0.875	1.75	2.62	3.5
S1 (ppm)	3	5	7	9	12
S2(ppm)	3	5	7	12	13
S3(ppm)	2	7	9	11	14
S4(ppm)	4	7	9	11	13
Diesel(ppm)	2	6	10	15	16

Figure 5.5 shows a variation of HC emissions with Load (KW) of different biodiesel blends. The graph shows the variation of HC emissions with Load (KW) of different biodiesel blends. It is shown that with an increasing load there is a decrease in HC emissions for solutions whereas the opposite for diesel. At lower Loads, S4 emitted the highest HC, but as the Load increases HC emission of diesel increases, and S1, S2, S3, and S4 are in a similar range. When compared to diesel S1 performed very well, only under no-load conditions, the HC emission is higher for S1 than diesel, in all other load conditions HC emission is lower for S1. For S2 also similar results as S1 when compared with diesel, we can say in all load conditions it performed better than diesel. In S3 and S4 cases, both performances are almost similar, in comparison to diesel S3s HC emissions is lower in all loads and no-load too, whereas for S4 only in the no-load condition its HC emission is higher than that of diesel, in all other loads its performance is better than diesel.

5.7 PERFORMANCE ANALYSIS

5.7.1 Brake Specific Fuel Consumption (BSFC)

The fuel efficiency of any prime mover that burns fuel and produces rotational, or shaft, power is typically measured with the help of a parameter called Brake Specific Fuel Consumption. It is typically used for comparing the efficiency of internal combustion engines with a shaft output. BSFC may be a live of the fuel potency of any engine that burns fuel and produces movement power output. The BSFC price indicates however with efficiency the engine converts fuel equipped into helpful work. one in every of the most parameters accustomed verify the characteristics of biodiesel on BSFC is hot price. the upper the hot price, the lower the BSFC as a result of a discount within the hot price of a fuel leads to an increase within the fuel consumption for attaining the corresponding power output. though biodiesel has higher hot price however still it's lesser than diesel which ends in higher BSFC than the diesel oil in any respect hundreds. Another parameter that decides the performance characteristics of biodiesel is that the Oxygen content gift within the fuel. this is often as a result of a higher the next oxygen content of biodiesel helps to facilitate better combustion. variable the engine load additionally plays a vital role in learning the performance characteristics of biodiesel. Studies have shown that increasing the engine load from zero to full load shows a decreasing trend within the BSFC and therefore the brake specific energy consumption decreases.

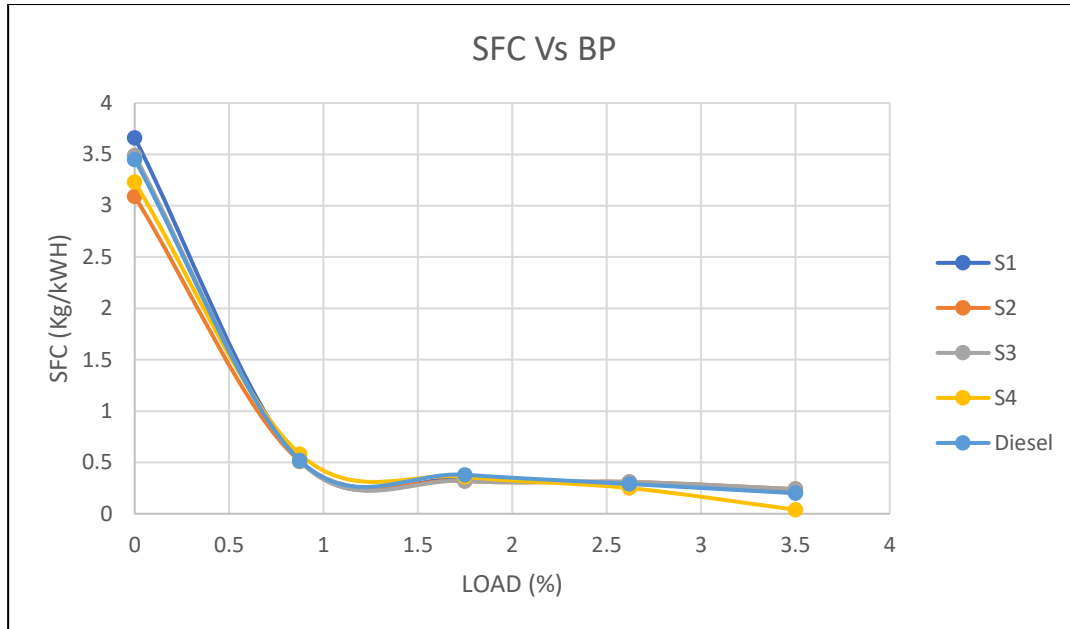


Fig.5.6: SFC Vs BP

Table 5.6: SFC Values of S1, S2, S3, S4, Diesel with loads

BP (KW)	0	0.875	1.75	2.62	3.5
S1 (Kg/kWh)	3.66	0.52	0.34	0.3	0.21
S2(Kg/kWh)	3.09	0.51	0.32	0.31	0.24
S3(Kg/kWh)	3.49	0.51	0.32	0.31	0.24
S4(Kg/kWh)	3.23	0.58	0.36	0.25	0.04
Diesel(Kg/kWh)	3.45	0.52	0.38	0.29	0.2

In this Figure. 5.6 Brake Power (KW) is plotted along X axis and SFC is plotted along Y axis. The variation of SFC for all tested biodiesel blends with varying engine loads is illustrated in the graph. It was found that with increasing BP (KW) there is decreasing in SFC. When no load was applied S1 has the higher SFC of 3.66 kg/kWh. At lower loads of 0.875 kW, S4 has a higher SFC than diesel and other samples, which was 0.58 kg/kWh. At 2.62 KW load diesel's SFC was higher than that

5.7.2 Brake Thermal Efficiency (BTHE)

The variation of BTHE with loads for different fuels shows that BTHE increases with increase in % load due to the reduction in heat losses and increase in power with increasing load. Brake thermal efficiency can be determined as Brake Thermal Efficiency = (Brake Power *100%)/ (Fuel Equivalent of Power).

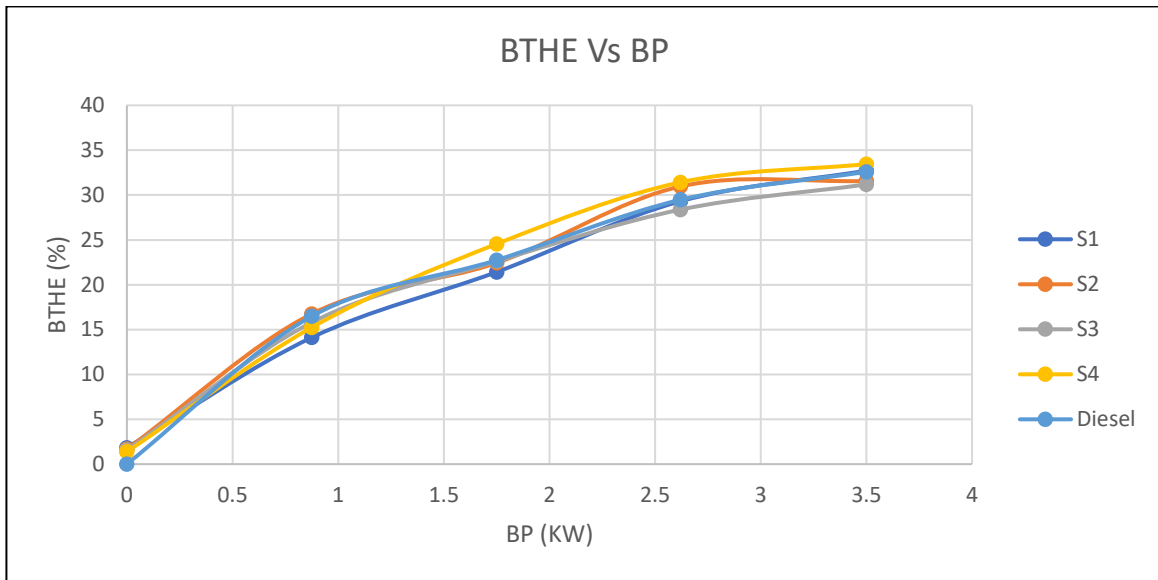


Fig.5.7: BTHE Vs BP

Table 5.7: BTHE Values of S1, S2, S3, S3, S4, Diesel with Loads

BP (KW)	0	0.875	1.75	2.62	3.5
S1(%)	1.84	14.12	21.42	29.31	32.72
S2(%)	1.68	16.75	22.44	30.96	31.57
S3(%)	1.56	15.8	22.61	28.38	31.18
S4(%)	1.38	15.24	24.55	31.42	33.45
Diesel(%)	0	16.49	22.75	29.47	32.59

CHAPTER - 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

An experiment has been done to find the performance and emission of biodiesel and its blend in a single cylinder, constant speed, direct injection engine. The emission trends determined in this experiment showed a difference between varying mixtures of diesel and biodiesel. Differences were also found in the amount of useful heat obtained from the fuels, which could be indicative of the differences in the fuels energy contents.

6.2 CONCLUSION

- The maximum brake thermal efficiency obtained is about 33.45% for S4, which is quite higher than that of baseline diesel 32.59 percent at full load.
- The SFC values of S1 are almost similar in comparison to diesel fuel. SFCs of S1 are 3.66 Kg/kWh, 0.52 Kg/kWh, 0.34 Kg/kWh, 0.3 Kg/kWh, and 0.213 Kg/kWh at 0 KW, 0.875 KW, 1.75 KW, 2.62 KW, 3.5 KW.
- HC emissions of S1 are lower than the diesel fuel and other samples, at 0.875 KW load S1 emission is 5 ppm whereas diesel's is 6 ppm, and max load S1 is 12 and diesel is 16 ppm.
- CO₂ EMISSIONS of S1 are lower than diesel fuel at every load condition. The best performing sample under no-load conditions is S3, remaining all other loads S1 is the best, at loads 0.875, 1.75, 2.62, and 3.5 KW, S1 values are 0.8, 1, 1.5, and 1.9 ppm respectively.
- NO_x emission of S3 is lower than the diesel fuel in every load condition except in no-load conditions. At loads 0.875, 1.75, 2.62, and 3.5 KW, S3 values are 117, 207, 354, 412 ppm respectively whereas diesel values are 156, 289, 421, and 526 ppm respectfully.

- CO at every load in every sample there is a slight increment than diesel emissions . At 0 load S4 the highest emission of 0.015 PPM, at 0.875 KW, it is S3 with 0.025 PPM, at 1.75 KW it is S1 with 0.035 PPM, at 2.62 KW it is S1 again with 0.05 PPM, at 3.5 KW it is S2 with 0.06.
- O2 emissions of all solutions are higher than diesel fuel at all load conditions . Highest O2 recorded was by S2 under no load condition, which was 19.76 PPM, and least was by Diesel under max load condition which was 11 PPM.

REFERENCES

1. Exploration of performance and emissions characteristics of Gossypium arboretum biodiesel on diesel engine S. Ganesan a,[†], Obulareddy Yuvatejeswar Reddy b, Kontham Jyothiraditya Reddy b, Phadatare Rahul b
a Department of Mechanical Engineering, Sathyabama Institute of Science and Technology, Chennai, India bDepartment of Mechanical Engineering, Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, Chennai, India article info Article history: Received 20 February 2021 Accepted 24 February 2021.
2. Influence of CNG emissions in copper coated catalytic converter in 4-stroke S.I. engine Cite as: AIP Conference Proceedings 2311, 040015 (2020); <https://doi.org/10.1063/5.0034201> Published Online: 07 December 2020 Hemanandh Janarthanam, Lilly Mercy Jayaraman, Ganesan Subbiah, Devaraj Rangabashiam, Sridhar Raja, B. Rakesh Kumar Reddy, and Swamy Saran.(3)
3. Investigations on the impact of EGR with a modified combustion chamber for CI diesel engine using biodiesel Cite as: AIP Conference Proceedings 2311, 020004 (2020); <https://doi.org/10.1063/5.0034514> Published Online: 07 December 2020 Vemuri Sai Srikanth, S. Ganesan, and K. Vijaya Kumar Reddy.(4)
4. Multi-objective optimization of VCR diesel engine performance and emissions fueled with diesel-lime steam oil blends using grey relational analysis Cite as: AIP Conference Proceedings 2311, 020034 (2020); <https://doi.org/10.1063/5.0034017> Published Online: 07 December 2020 Ganesan Subbiah, R. Sathish Kumar, Devaraj Rangabashiam, Hemanandh Janarathanam, Venkatesan Sorakka Ponnappan, Beemkumar Nagappan, and K. S. Sreenivasan.(5)
5. Influence of nano catalyst on performance of DI diesel engine with blends of Citronella oil using Taguchi approach Cite as: AIP Conference Proceedings

- 2311, 020032 (2020); <https://doi.org/10.1063/5.0034011> Published Online: 07 December 2020 S. Ganesan, J. K. S. Sridhar Raja, N. Beem Kumar, J. Hemanandth, G. Senthilkumar, K. S. Sreenivasan, and R. Rajasekar.(6)
6. Optimum design of catalytic converter to reduce carbon monoxide emissions on diesel engine Cite as: AIP Conference Proceedings 2311, 040011 (2020); <https://doi.org/10.1063/5.0034427> Published Online: 07 December 2020 Rajasekar Rajendran, U. Logesh, N. S. Praveen, and Ganesan Subbiah.(7)
 7. Performance and emission analysis of waste cooking oil as green diesel in 4S diesel engine Cite as: AIP Conference Proceedings 2311, 020022 (2020); <https://doi.org/10.1063/5.0034194> Published Online: 07 December 2020 Hemanandh Janarthanam, Venkatesan Sorakka Ponnappan, Ganesan Subbiah, Purushothaman Mani, D. Suman, and M. Rajesh.(8)
 8. Performance and emission characteristics of diesel engine using waste plastic oil with N-hexanol as an additive Cite as: AIP Conference Proceedings 2311, 020025 (2020); <https://doi.org/10.1063/5.0034393> Published Online: 07 December 2020 S. P. Venkatesan, J. Jeya Jeevahan, J. Hemanandh, S. Ganesan, R. Rajakavieswaran, and V. Saravanan(9)
 9. Performance and emission characteristics of bio fuelled CI engine using palm oil and waste cooking oil Cite as: AIP Conference Proceedings 2311, 020031 (2020); <https://doi.org/10.1063/5.0034010> Published Online: 07 December 2020 S. Ganesan, K. Vijai Anand, S. Sridhar Raja, J. Hemanandh, N. Beem Kumar, K. Shivan Srivastava, and Shone Biju.(10)
 10. Taguchi based optimization of diesel engine parameters with blends of lemon grass oil with ZnO Cite as: AIP Conference Proceedings 2311, 020036 (2020); <https://doi.org/10.1063/5.0034021> Published Online: 07 December 2020 S. Ganesan, S. P. Venkatesan, N. Beem Kumar, M. Purushothaman, J. Hemanandh, J. Senthilkumar, and G.Senthilkumar(11)

11. Effect of nano additives in engine performance and emission characteristics using biodiesel fuel Cite as: AIP Conference Proceedings 2311, 020030 (2020); <https://doi.org/10.1063/5.0034008> Published Online: 07 December 2020 Ganesan Subbiah, Hemanandh Janarthanam, Purushothaman Mani, K. S. Sridhar Raja, R. Periya Sakthivel, S. Sakthivignesh, and K. S. Sreenivasan. (12)
12. Vehicle Emission Analysis by using Refined Sunflower Oil as Alternate Fuel and Varying the Injection Timing in Diesel Engine J. Hemanandha, S. Ganesanb, C. Sathya Sai Puneethc and G. Venkata Sai Naga Manikankata Tejeshd Dept. of Mech. Engg., Sathyabama University, Chennai, India(13)
13. Experimental and synthesis of chicken slaughter waste biodiesel in DI diesel engine Cite as: AIP Conference Proceedings 2311, 020014 (2020); <https://doi.org/10.1063/5.0034144> Published Online: 07 December 2020 Hemanandh Janarthanam, Ganesan Subbiah, K. S. Sridhar Raja, Senthilkumar Gnanamani, Amarjit Roy, and Vineet Chougale.(14)
14. Environmental emission control in CI engine using hydro treated bio-fuel in India Cite as: AIP Conference Proceedings 2311, 020021 (2020); <https://doi.org/10.1063/5.0034184> Published Online: 07 December 2020 Hemanandh Janarthanam, Venkatesan Sorakka Ponnappan, Purushothaman Mani, Ganesan Subbiah, B. Shanjiit, and Tejual Krishna.(15)