

PERFORMANCE AND CHARACTERISTIC EMISSION ON DIRECT IGNITION DIESEL ENGINE USING TIO₂ (TITANIUM DIOXIDE)

**Submitted for partial fulfilment of the requirements for the award of
Bachelor of Technology in
Mechanical Engineering**

By

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

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
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BONAFIDE CERTIFICATE

This is to certify that this Project report is the bonafide work of **KHUSHAL. S (37150097)** and **LOKESH. S (37150109)** who carried out the project entitled on **“PERFORMANCE AND CHARACTERISTIC EMISSION ON DIRECT IGNITION DIESEL ENGINE USING TIO₂ (TITANIUM DIOXIDE)”** under our supervision from September 2020 to March 2021.

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DECLARATION

We **KHUSHAL. S (37150097)** and **LOKESH. S (37150109)** hereby declare that the Project report entitled “**PERFORMANCE AND CHARACTERISTIC EMISSION ON DIRECT IGNITION DIESEL ENGINE USING TIO₂ (TITANIUM DIOXIDE)**” done under the guidance of **Dr. GANESAN**, Department of Mechanical Engineering is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology in Mechanical Engineering.

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ABSTRACT

Only a few studies have been conducted using two different biodiesel blends. Blends with diesel and leaves a lot of room for experimentation in this area. Diesel and blended fuel experiments were carried out at each engine load. The effects of engine load and biodiesel on HC, CO, CO₂, and NO_x emissions were investigated in this paper. Biodiesel usage resulted in reduced hydrocarbon emissions (HC) CO, as well as CO₂ and NO_x emissions. In reduced hydrocarbon emissions (HC) CO, as well as CO₂ and NO_x emissions. The emissions of diesel/biodiesel blends were found to be higher in this study. Lower than diesel fuels. Due to their high oil yield, microalgae tend to be a very important option for potential biodiesel production; however, it should be noted that only a few organisms are suitable for biofuel production. Now coming to the emission characteristics we have found that the (BTE) brake thermal efficiency and oxygen content should be high for the emission. Overheating, brake fade and brake pad degradation are just a few. Specific fuel consumption (SFC) is one of the most important metrics employed in aviation. And the emission of HC, CO, NO_x, O₂, and CO₂.

Keywords: *Emission, Nano Catalyst, performance*

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	v
	LIST OF TABLES	viii
	LIST OF FIGURES	ix
	LIST OF ABBREVIATIONS	x
1.	INTRODUCTION	1
1.1	BIODIESEL	1
1.1.1	Advantages of the Use of Biodiesel	1
1.1.2	Disadvantages of the Use of Biodiesel	2
1.2	RAW MATERIALS FOR BIODIESEL PRODUCTION	2
1.3	PHYSICO-CHEMICAL PROPERTIES OF DIESEL FUELS	3
1.4	OKRA SEED OIL	7
1.5	TRANSESTERIFICATION REACTION	8
1.6	ANTIOXIDANT	11
2.	LITERATURE SURVEY	13
3.	MOTO OF THE PROJECT	21
3.1	BENEFITS OF USING BIOFUELS AS A FUELS	22
4.	EXPERIMENTAL SETUP	24
4.1	TEST RUN WITH COMPUTERIZED MULTI CYLINDER ENGINE SETUPS	27
5.	RESULT AND DISCUSSION	34
5.1	BREAK THERMAL EFFICIENCY	35

CHAPTER NO.	TITLE	PAGE NO.
5.2	SPECIFIC FUEL CONSUMPTION	36
5.3	CO ₂ EMISSION ANALYSIS	37
5.4	O ₂ EMISSION ANALYSIS	38
5.5	CO EMISSION ANALYSIS	39
5.6	HC EMISSION ANALYSIS	40
5.7	NO _x EMISSION ANALYSIS	42
5.8	CONCLUSION	43
	REFERENCES	45

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1.1	Properties	12
4.1	Specifications of the Test Engine	25
5.1	Break Thermal Efficiency	35
5.2	Specific Fuel Consumption	36
5.3	CO ₂ Emission Analysis	37
5.4	O ₂ Emission Analysis	38
5.5	Co Emission Analysis	39
5.6	HC Emission Analysis	40
5.7	NO _x Emission Analysis	42

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1.1	Biodiesel Processor	9
4.1	Photographic View of the Experimental set this study	25
4.2	Smoke Meter	31
4.3	Linearity Test	31
4.4	Five Gas Analyzer Reading	33
4.5	Five Gas Analyzer	33
5.1	BTE Vs BP	35
5.2	SFC Vs BP	36
5.3	CO ₂ Vs BP	37
5.4	O ₂ Vs BP	38
5.5	CO Vs BP	40
5.6	HC Vs BP	41
5.7	NO _x Vs BP	42

LIST OF ABBREVIATIONS

BHA	-	Butylated Hydroxyanisole
BHT	-	Butylated Hydroxytoluene
BSFC	-	Brake Specific Fuel Consumption
BTE	-	Brake Thermal Efficiency
BTME	-	Beef Tallow Methyl Ester
C.I	-	Compression Ignition
CFPP	-	Cold Filter Plugging Point
CN	-	Cetane Number
CO	-	Carbon Monoxide
CP	-	Cloud Point
CR	-	Compression Ratio
DC	-	Distillation Curve
EGR	-	Exhaust Gas Recirculation
EGT	-	Exhaust Gas Temperature
FCR	-	Fixed Compression Ratio
FP	-	Flash Point
GC	-	Gas Chromatography
HC	-	Hydrocarbon
IP	-	Injection Pressure
ISU	-	International System of Units
IT	-	Injection Timing
LC	-	Liquid Chromatography
LTFT	-	Low Temperature Flow Test
NDGA	-	Nordihydroguaiaretic Acid
NOx	-	Nitrogen Oxide
PG	-	Propyl Gallate
PP	-	Pour Point
SFC	-	Specific Fuel Consumption
SFC	-	Specific Fuel Consumption
SO ₂	-	Sulfur Dioxide
WDEF	-	Water-Diesel-Emulsified Fuel

CHAPTER 1

INTRODUCTION

1.1 BIODIESEL

Biodiesel is a liquid biofuel made from vegetable oils or animal fats and an alcohol that can be used alone or in combination with diesel engines. Diesel oil is added to the mix. Biodiesel is described as a mixture of long-chain monoalkylic esters from plants. Fatty acids derived from renewable resources that will be used in diesel engines. Blends with diesel fuel are indicated as “Bx”, where “x” is the percentage of biodiesel in the blend. For instance, “B5” indicates a blend with 5% biodiesel and 95% diesel fuel; in consequence, B100 indicates pure biodiesel.

1.1.1 Advantages of the Use of Biodiesel

- Renewable fuel, obtained from vegetable oils or animal fats.
- Low toxicity, in comparison with diesel fuel.
- Degrades more rapidly than diesel fuel, minimizing the environmental consequences of biofuel spills
- Lower emissions of contaminants: carbon monoxide, particulate matter, polycyclic aromatic hydrocarbons, aldehydes.
- Lower health risk, due to reduced emissions of carcinogenic substances.
- No sulfur dioxide (SO₂) emissions.
- Higher flash point (100°C minimum).

- May be blended with diesel fuel at any proportion; both fuels may be mixed during the fuel supply to vehicles.
- Excellent properties as a lubricant.
- It is the only alternative fuel that can be used in a conventional diesel engine, without modifications.
- Used cooking oils and fat residues from meat processing may be used as raw materials.

1.1.2 Disadvantages of the Use of Biodiesel

- Due to the lower calorific value of biodiesel, there is a slight increase in fuel consumption.
- Nitrous oxide (NO_x) emissions are slightly higher than diesel fuel.
- It has a higher freezing point than petrol. This may be uncomfortable in the winter.
- Since it is less reliable than gasoline, long-term storage (more than six months) is not recommended. It is not recommended to use biodiesel for more than a few months.
- When used in pure form, it can degrade plastic and natural rubber gaskets and hoses.

1.2 RAW MATERIALS FOR BIODIESEL PRODUCTION

Vegetable oils, animal fats, and short-chain alcohols are the raw materials used to make biodiesel. Rapeseed (primarily in European Union countries), soybean (Argentina and the United States of America), palm (Asian and Central American countries), and sunflower are the most commonly used oils for biodiesel production worldwide. Other oils, such as peanut, linseed, safflower, used vegetable oils, and animal fats, are also used. The most commonly used alcohol is methanol.

Since cost is a major factor in biodiesel production and distribution (due to the oil prices), non-edible vegetable oils have been studied for several years with promising results.

Aside from the lower cost, another undeniable benefit of non-edible oils for biodiesel production is that no food is wasted in the process.

These and other factors have contributed to the development of biodiesel on a medium and large scale. Castor oil, tung, cotton, and other non-edible oils were used in trials in many countries. Since they are solid, they require preliminary treatment; additionally, highly acidic grease from Cattle, pork, poultry, and fish are all acceptable options. Due to their high oil yield, microalgae tend to be a very important option for potential biodiesel production; however, it should be noted that only a few organisms are suitable for biofuel production.

1.3 PHYSICO-CHEMICAL PROPERTIES OF DIESEL FUELS

Since automobiles and their engines are designed to work in a variety of environments, achieving the desired performance and reliability is dependent on both technical factors related to their manufacturing and the nature of the fuels used. As a result, the physico-chemical properties of the fuels must be presented. They have an impact on the performance of the engines. Furthermore, given the large number of fuels produced by combining various combustibles. The study of their physico-chemical properties becomes extremely important.

Viscosity

Viscosity is a measure of resistance to liquid flow caused by internal friction of one component of a fluid flowing over another under the force of gravity, according to the international norm. This is an important property since it influences how fuel behaves. Since ambient temperature has an effect on viscosity, precautions must be taken to prevent the engine's performance from deteriorating, for example, due to the higher viscosity, attempting to start the engine at very low ambient temperatures. The engine may have trouble starting due to a lack of fuel.

Larger droplet volumes, poorer fuel atomization and vaporisation, High viscosity can also lower fuel flow rates, resulting in insufficient fuel delivery. A source of energy Pump distortion may also be caused by a very high viscosity. Finally, High fuel viscosity results in poorer overall combustion, higher emissions, and higher costs. Dilution of oil.

Depending on the measurement method, there are two types of viscosity

Dynamic or absolute (η) viscosity is expressed in ISU (International System of Units) in $[\text{Ns} / \text{m}^2]$. In the CGS system (centimeter, gram, second), dynamic viscosity is expressed in $\text{P} = \text{Poise}$.

Density

The density, or more precisely, the volumetric mass density of a substance is its mass per unit volume. Fuel density is another key property that affects engine performance. Because fuel is metered by volume, not by mass, a greater or lesser mass of fuel is injected depending on its density. Thus, the air-fuel ratio and energy content within the combustion chamber are influenced by fuel density. Density increases when the ambient temperature lowers; therefore, like viscosity, it affects the engine cold starting performance. The measurement unit of density is kg/m^3 .

Cetane Number

Cetane Number (CN) is the main indication of the auto-ignition and combustion quality characteristics of the fuel used in a diesel engine. It affects cold startability, combustion stability and noise. A higher CN generally decreases engine cranking time (the time before the engine reaches by decreasing the ignition delay).

Evaporation characteristics

Evaporation characteristics influence the spray structure and affect the preparation of air–fuel mixture under different engine load conditions. The volatility characteristics are described by using the vapor pressure and distillation curve which are affected by intermolecular interactions. 11 The Distillation Curve (DC)

indicates the amount of fuel that boils off at a given temperature. The curve can be divided into three parts:

- (1) as in the beginning, only the light fractions of the fuel boil, the first region can be called the light end; it affects start ability and is usually characterized by the temperature at which 10% of the fuel has boiled (T10);
- (2) the region around the 50% evaporated point, characterized by the T50;
- (3) the heavy end (i.e., boiling of the heaviest fuel fractions), which is usually characterized by the T90 or T95 and has been the most thoroughly studied with respect to its effect on tailpipe emissions.

Flash Point Closed Cup

The minimum temperature at which the fuel can ignite (flash) when an ignition source is applied under defined conditions is known as the flash point (FP). It is used to classify transportation fuels. Minimum flash point temperatures are needed, as well as storage according to danger level. For the proper handling and protection of the fuel. The flash point is inversely proportional to the temperature.

Cold Flow Characteristics

One of the most fundamental quality criteria for compression ignition engine fuels is the cold flow characteristics, which are primarily dictated by:

1. fuel distillation range, mainly the light-end volatility;
2. hydrocarbon composition: content of paraffins, naphthene, aromatics;
3. use of cold flow additives.

The mechanism of cold flow properties is: During low-temperature engine action, fuel gelling occurs, resulting in crystallisation of the liquid molecules. The molecules of the liquid must produce heat in order for crystallisation to occur. The

strong intermolecular force of interaction provides ample thermodynamic force. This is a good example. When the temperature of a liquid is reduced to a certain point, thermodynamic force is produced. Its thawing stage Fuel crystallisation will result in “fuel starvation” and loss of operability. Solidified material clogs fuel lines, the fuel pump, filters, and injectors, causing problems. Three fuel parameters specify the low-temperature operability of diesel engines: Cloud Point (CP), Cold Filter Plugging Point (CFPP), and Pour Point (PP). When the liquid fuel is cooled, the following parameters can be defined: The lowest temperature at which a given volume of diesel engine fuel passes through a standardised filtration system in a given amount of time is known as the CFPP. The Low Temperature Flow Test (LTFT) was created exclusively for the United States and Canada to predict how. Low-temperature performance is possible with diesel engine fuels. The LTFT stands for “slow cooling test”. PP is the lowest temperature at which the fuel can stop burning, and it is more extreme than CFPP.to go with the breeze.

The cold flow properties of diesel engine fuel must be defined according to the seasonal and climatic conditions in the area where the fuel would be used, The temperature at which a clear liquid product becomes cloudy is defined as follows: CP is the temperature at which a clear liquid product becomes cloudy, i.e. when stable particles (alkane crystals and microcrystals of ice).

Cold Flow Limits

The diesel fuel cold flow performance can be specified by Cloud Point, by CFPP (with maximum delta between CFPP and Cloud Point), or by LTFT.

- a) If Cloud Point (only) or LTFT is used, the maximum allowed temperature should be set no higher than the lowest expected ambient temperature.
- b) If CFPP is used to predict cold flow, the maximum allowed CFPP temperature should be set equal to, or lower than, the lowest expected ambient temperature. In this case, the Cloud Point should be no more than 10°C above the CFPP specified.

Water Content

The fuel should be clear in appearance and free of water, which can plug fuel filters at negative temperatures, leading to engine fuel starvation. Water accelerates oxidation, increases corrosivity and promotes microbial growth. The unit for water content could be [mg/kg].

1.4 OKRA SEED OIL

Materials

The seeds of okra (*H. esculentus*) were procured from the Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan. n-Hexane, methanol, sodium methoxide, sodium hydroxide potassium hydroxide, potassium methoxide and anhydrous sodium sulfate were purchased from Merck (Darmstadt, Germany). Pure fatty acid methyl esters used as standards were procured from Sigma Chemical Co.

Extraction of Oil

Every batch of okra seeds (500 g) was crushed in a coffee grinder. Using the Soxhlet extractor, the extraction was done in n-hexane (0.8 L) on a water bath for 6 hours. It was necessary to distil the solvent. Using a rotary evaporator, cool to 45°C.

Degumming of Oil

The okra seed oil was heated in a beaker over a water bath at 70 degrees Celsius. After that, a measured amount of hot water was applied to the oil to get it up to an 18% final volume. A glass rod was used to thoroughly blend the contents of the beaker. After cooling, the mixture was centrifuged for 15 minutes at 3000 rpm in a refrigerated centrifuge system to isolate the liquid. The recovered oil was stirred for 5 minutes with anhydrous sodium sulphate before being filtered via filter paper in a 50 degree.

Experimental Conditions for Transesterification

Experiments were performed to evaluate the effects of methanol/oil ratio and type and concentration of catalyst on transesterification reaction of crude okra seed oil. The reaction time (120 min), reaction temperature (65 °C) and agitation intensity (600 rpm) was kept constant throughout the experiment. The molar ratio methanol/oil was varied as 3:1, 4:1, 5:1, 6:1, 7:1, 8:1 and 9:1. The catalysts used were sodium hydroxide (1.0%), potassium hydroxide (1.0%), sodium methoxide (1.0%) and potassium methoxide (1.0%). The concentration of NaOCH₃ (the most effective catalyst) found in the present study was varied as 0.00%, 0.50%, 0.75%, 1.00%, 1.25% and 1.50% (w/w of oil).

1.5 TRANSESTERIFICATION REACTION

The transesterification reaction was carried out in a laboratory-scale biodiesel reactor, which consisted of a 1 L round-bottomed flask with a mechanical stirrer, thermostat, sampling outlet, and condensation outlet. A system In a nutshell, the okra seed oil (500 g) was preheated to 65 degrees Celsius. Before starting the reaction on a hot plate for a preliminary examination .catalyst experiments, a known amount of freshly prepared. Catalyst salts such as NaOH, KOH, and others in methanolic solutions. Separately, NaOCH₃ and KOCH₃ were added to the oil and mixed. To ensure that the okra seed oil is completely transformed into .Each experiment was carried out with fatty acid methyl esters (FAMES). 120 minutes.

The contents of the reactor were transferred into a separating funnel as soon as the reaction was completed and allowed to cool and equilibrate for the partitioning of two distinct phases. The upper layer of the two separated phases was made up of methyl. Small amounts of impurities, such as residual alcohol, are present in esters. The lower phase contained glycerol and partial glycerides, while the upper phase contained glycerol in combination with other materials such as unused methanol, catalyst, and so on soaps produced during the reaction, and some methyl esters suspended in the air as well as partial glycerides. The methyl esters in the upper layer were collected and purified further by distilling residual methanol at 80°C (external bath temperature). The remnants of the by repeating the process, the remaining catalyst, methanol, and glycerol were removed. Distilled water was

used for the washings. Any remaining water was then disposed of. Esters are dried with sodium sulphate and then removed filtration using Whatman filter paper.

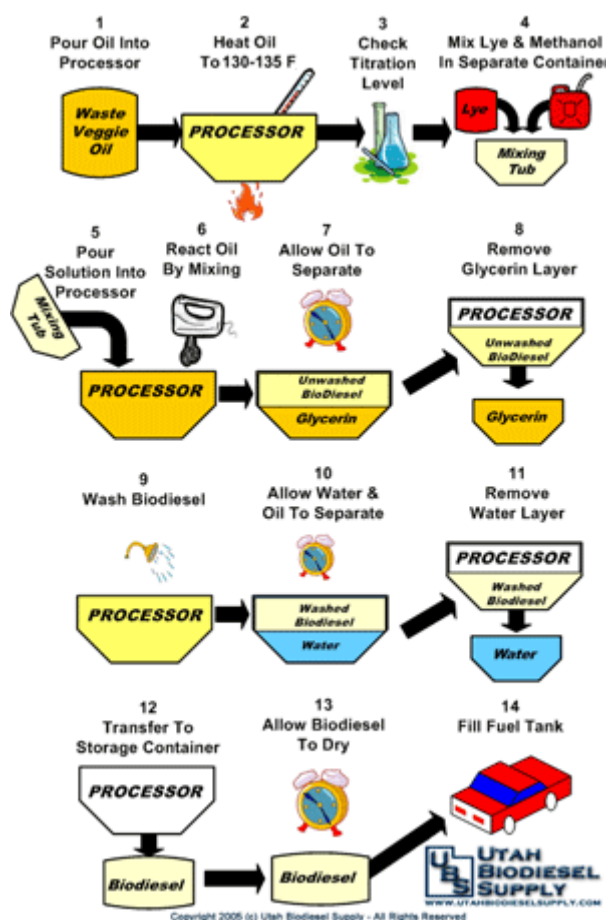


Figure 1.1 Biodiesel Processor

- Step 1:** Obtain some waste vegetable oil filter it, and load it into a Biodiesel Processor.
- Step 2:** Heat the oil up to 130-135° F.
- Step 3:** Measure how acidic the oil is by doing something called a titration. It's simple to do and can be done in under 5 minutes!
- Step 4:** Mix up methanol (racing fuel) and catalyst (either lye or caustic potash) to make something called Methoxide.
- Step 5 & 6:** Pour the methoxide into the processor & mix it for 2-3 hours.

Step 7 & 8: The oil will separate into Biodiesel & Glycerin. Drain off the Glycerin layer.

Step 9, 10 & 11: Wash the Biodiesel with water to remove any remaining contaminants. Allow the water to separate from the Biodiesel. Then drain off dirty water.

Step 12, 13 & 14: Drain off the water, transfer it to a drying tank, and then dry out the fuel. After the fuel is dry, fill up the fuel tank on your diesel engine vehicle and drive away!

TIMING

Biodiesel typically takes a couple of days to a week from start to finish to make a batch. Most people making biodiesel make anywhere between 20 to 100 gallons at a time in a batch process.

Here's a breakdown of typical timing intervals from start to finish:

- **START**
- **Collecting Oil** - 1-2 hours
- **Filtering Oil** - 1-2 hours (depends on amount of oil)
- **Titration Of Oil** - 10-15 minutes
- **Transferring Oil To Processor** - 10-20 minutes
- **Heating Oil** - 1-4 hours (depends on amount of oil, voltage & wattage of element)
- **Making Methoxide** - 5-20 minutes (depends on amount of methanol and catalyst used)
- **Mixing Methoxide Into Oil** - 20-30 minutes
- **Mixing Oil & Methoxide** - 2-3 hours
- **Settling Oil** - 8-10 hours (usually overnight)

- **Draining Glycerin** - 5-10 minutes
- **Transferring Biodiesel To Wash Tank** - 10-20 minutes
- **First Mist Wash** - 2-3 hours
- **Second Mist Wash** - 2-3 hours
- **First Bubble Wash** - 6-8 hours (usually overnight)
- **Second Bubble Wash** - 6-8 hours (usually overnight)
- **Transferring Biodiesel To Drying Containers** - 10-20 minutes (depends on amount)
- **Drying Biodiesel** - 2 hours to 1 week (depends heavily on weather and amount made)
- **Transferring To Storage Containers** - 10-20 minutes (depends on amount)
- **FINISH**

1.6 ANTIOXIDANT

Colorimetric, liquid chromatography (LC), and gas chromatography (GC) are the most popular methods for determining antioxidants. The AOAC's Method 965.28 defines qualitative colour tests for the detection of propyl gallate (PG), nordihydroguaiaretic acid (NDGA), butylated hydroxyanisole (BHA), and butylated hydroxytoluene (BHT). Following solvent and aqueous extractions, PG turns pink in ammonia solution, NDGA turns blue in barium hydroxide, BHA turns red–purple in Ehrlich reagent (diazobenzene sulfonic acid), and BHT turns pink to red in chloroform in the presence of dianisidine (3,3'-dimethoxybenzidine) and sodium nitrite. Here in this project we have add "TITANIUM DIOXIDE" as an Antioxidents.

Titanium dioxide (TiO₂), also known as titanium(IV) oxide or titania (tateni/), is a naturally occurring titanium oxide with the chemical formula TiO₂. It's known as titanium white, Pigment White 6 (PW6), or CI 77891 when used as a pigment. Ilmenite, rutile, and anatase are the most common sources. It can be used

in a variety of ways, including paint, sunscreen, and food colouring. It has the E number E171 when used as a food colouring. In 2014, global production surpassed 9 million tonnes. [number four] (5) [number six] Titanium dioxide is believed to be used in two-thirds of all pigments, with pigments dependent on the oxide accounting for the remaining third.

Application

Paints and varnishes, as well as paper and plastics, are the most popular uses for titanium dioxide, accounting for roughly 80% of global consumption. Other pigment uses, such as printing inks, fibres, rubber, cosmetics, and food, account for another 8% of the total. The rest is used to make technical pure titanium, glass and glass ceramics, electrical ceramics, metal patinas, catalysts, electric conductors, and chemical intermediates, among other things.

Properties

Table 1.1 Properties

Chemical formula	TiO ₂
Molar mass	79.866 g/mol
Appearance	White solid
Odor	Odorless
Density	4.23 g/cm ³ (rutile) 3.78 g/cm ³ (anatase)
Melting point	1,843 °C (3,349 °F; 2,116 K)
Boiling point	2,972 °C (5,382 °F; 3,245 K)
Solubility in water	Insoluble
Band gap	3.05 eV (rutile) ^[1]
Magnetic susceptibility (χ)	+5.9·10 ⁻⁶ cm ³ /mol
Refractive index(n_D)	2.488 (anatase) 2.583 (brookite) 2.609 (rutile)

CHAPTER 2

LITERATURE SURVEY

Lingesan Subramani Nano additives have recently been developed with the aim of reducing diesel engine exhaust emissions. The key distinguishing feature of biodiesel use in diesel engines is higher NO_x formation due to excessive in-O₂, which can be mitigated by using EGR (exhaust gas recirculation). EGR use, on the other hand, poses questions about HC, CO, and smoke pollution. The current research proposal focuses on blending (30% palmbiodiesel/70% diesel) with 25 ppm (milligram) TiO₂ nanoparticles. The cylinder pressure was only slightly lower and the heat release rate was higher than PBN with an improvement in EGR percentage. Finally, it is concluded that combining the effects of nanoparticle blended palm biodiesel with EGR will simultaneously lower all major controlled emissions (HC, CO, and NO_x) and minimise smoke in the engine load, resulting in a sustainable green climate.

D. Yuvarajan The effect of TiO₂ nanofluid on hydrocarbon, carbonmonoxide, nitrogen oxide, and smoke emission from a neat mustard oil methyl ester fueled diesel engine is investigated in this report. Sol-gel was used to make TiO₂ nanoparticles with an average size of 50 nm. The artificially created. The mustard oil methyl ester is used to disperse the particles at different concentrations (100 and 200 ppm). A mechanical homogenizer and an ultrasonicator are used. Experiments were carried out in a four-stroke mode. A single-cylinder diesel engine that runs on diesel, tidy mustard oil methyl ester, and nanofluidmethyl ester is a form of methyl ester. Based on the findings, mustard oil methyl ester appears to be a viable candidate for use as an alternative fuel in existing diesel engines. as compared to neat mustard oil methyl ester, TiO₂ nanofluid associated with mustard oil methyl ester reduced various emissions.

P. Booma Devi The effects of nanoparticles and hydrogen blends on the combustion, efficiency, and emission characteristics of a modified dual fuel engine were investigated in this study. TiO₂, CNT, Al₂O₃, CuO, and CeO₂ nanoparticles are distributed at a fraction of 100 ppm with 20% to improve the stability of the nanoparticles, an ultrasonication procedure is used to agitate them. Combines at 1800 rpm, all blends are checked for various engine loads ranging from 0 percent to 25 percent, 50 percent, 75 percent, and 100 percent the addition of CeO₂ and Al₂O₃ increases the thermal efficiency of the brakes by 4.3 percent and 2.5 percent, respectively., there has been no major improvement in brake-specific fuel consumption.CeO₂ has a record. CNT and TiO₂ nanoparticles minimise BSFC by 23% and 22%, respectively, compared to other blends. The addition of hydrogen and nanoparticles to the exhaust showed a substantial reduction in carbon monoxide, carbon dioxide, and hydrocarbon emissions. CNT is the only material that emits NO_x showed a significant reduction in NO_x as compared to other blends. The findings show that adding nanoparticles improves the results. On neat diesel, hydrogen improves combustion characteristics and engine efficiency. Exhaust gas emissions were lowered.

Heinz Peter Berg The current research focuses on the efficiency and emission characteristics of three emulsion fuels with various additives. Diesel, biodiesel, an emulsion fuel with 86 percent biodiesel, 5 percent DEE, 3 percent ethanol, 2 percent water, an emulsion fuel with 86 percent biodiesel, 5 percent EHN, 3 percent Methanol, 50 ppm CNT, 2 percent Water, 2 percent Tween 80 and 2 percent86 percent biodiesel, 5 percent glycerine, 3 percent butanol, 50 ppm TiO₂, 2 percent water ,and an emulsion fuel of 86 percent biodiesel, 5 percent glycerine, 3 percent butanol, 50 ppm TiO₂, 2 percent water a reduction in all emissions.as opposed to biodiesel, with the exception of UHC. Finally, compared to biodiesel, BD.TIO.GLC.B has a small decrease in output, with a 6.6 percent reduction in brake thermal efficiency, but it has the lowest smoke opacity, a 74.3 percent reduction in CO, and a 10.7 percent reduction in NO_x. As a result, it can be concluded that emulsion fuels with the appropriate additives, such as oxygenated fuels, nano metals, stabilisers, cetane improvers, and mixture emulsifiers, will ensure safe and efficient combustion. Alternatives to diesel engines that are green.

Suleyman Simsek The primary goal of this research is to use response surface methodology to evaluate the best engine running parameters for diesel engine efficiency and emissions (RSM). The optimization is used to increase brake thermal efficiency (BTE) while lowering exhaust gas temperature (EGT) and smoke emissions. Diesel engine with four strokes, one cylinder, air cooling, and direct injection. The biodiesel was made from a transesterified mixture of canola, safflower, and waste vegetable oil mixtures. According to the optimization results, the engine's best operating parameters were discovered to be engine load of 1484.85 watts, injection pressure of 215.56 bar, and biodiesel ratio of 25.79 percent. The optimum responses for BTE, EGT, smoke, NO_x, and CO₂ were found to be 20.54 percent, 199.88 °C, 0.26 percent, 558.44 ppm, and 4.52 percent. For BTE, EGT, smoke, NO_x, and CO₂, 99.81 percent, 99.36 percent, 98.84 percent, 98.31 percent, and 99.00 percent, respectively. The outcomes of the RSM were found to be a useful technique for estimating and optimising efficiency in this analysis.

Metin Gumus The impact of compression ratio (CR) and injection parameters such as injection timing (IT) and injection pressure (IP) on the efficiency and emissions of a DI diesel engine using biodiesel blended-diesel fuel (percentages 5, 20, 50, and 100 percent) is investigated in this study. Three separate CRs were used in the tests. IPs (18, 20, and 22 MPa) at 20 N m engine load, ITs (15, 20, and 25 CA BTDC), and ITs (15, 20, and 25 CA BTDC) at 20 N m engine load, 2200 revolutions per minute. With the rise in brake specific fuel consumption (BSFC), brake specific energy consumption (BSEC), and nitrogen oxides (NO_x) emissions, the results showed that brake thermal efficiency (BTE), smoke opacity (OP), carbon monoxide (CO), and hydrocarbon (HC) emissions increased while brake thermal efficiency (BTE), smoke opacity (OP), carbon monoxide (CO), and hydrocarbon (HC) emissions decreased. The biodiesel content of the fuel mixture. The best BSFC, BSEC, and BTE results were found. The CR, IP, and original IT were all increased. An increase in IP, IT, and CR led to a decrease in all tested fuels. CO and HC emissions decrease in the OP, while NO_x emissions rise.

Suat Saridemir In this study, waste vehicle tyre chips were pyrolyzed to obtain their liquid oil types, and then blended into neat diesel fuel at various

percentages (0 percent, 10%, 30%, and 50% by volume) (DF). Four separate engine loads (3, 6, 9, and 12 Nm) were tested on a single-cylinder diesel engine under a variety of conditions. Engine speed is kept constant at 2000 rpm. The engine starts up. On the other hand, the ignition delay of TPL-diesel blends is longer than that of TPL-diesel blends. Furthermore, in these fuels, higher HRR and CP caused an increase in both vibration and noise levels. Aside from that, the carbon and oxygen the hydrogen content of TPL produced is similar to that of neat diesel fuel, but diesel fuel has a higher hydrogen content. As a result, there was no major difference in CO levels among the test fuels. However, as the TPL content of the blends increased, NO_x emissions increased marginally while HC emissions decreased dramatically and steadily. Finally, this paper demonstrates that TPL can be blended into diesel fuel (up to 50%) without causing any adverse effects.

Hossein Pourrahmani Biodiesel has a higher cetane number than diesel, researchers have made concerted efforts to profit from it and achieve better combustion. The main disadvantage of using a biodiesel-diesel mix is the rise in NO_x emissions, which can be mitigated by using water. Heat, Higher HC and CO emissions are generated, which can be mitigated by using metal-based nanoparticles such as oxide of cerium (CeO₂). The results of the sensitivity analysis on the PEDE, however, revealed that the share of output parameters on this newly described PEDE is not the same, necessitating changes. As a result, sensitivity analysis was used to change the exponents of each output parameter. According to the findings, the best output occurs when the sum of the concentration of cerium oxide nanoparticles is 80 parts per million, with biodiesel and water accounting for 6% of the total.

Erdinc Vural Thermal barrier layers were coated on piston and valve surfaces using the plasma spray method in this research. Using the Taguchi optimization process, the effects of coated layers on torque, strength, and brake specific fuel consumption (BSFC) were investigated experimentally and statistically. In this research, the coating materials were Cr₂O₃+25 percent Al₂O₃, Al₂O₃+13 percent TiO₂, and Cr₂O₃+25 percent Al₂O₃. Different speeds were used to measure each coating material. 1400 rpm, 2000 rpm, 2600 rpm, and 3200 rpm were the speeds. The results showed that when Al₂O₃+13 percent TiO₂ was used at a

speed of 2600 rpm, engine torque and BSFC reached their maximum levels. Engine strength, on the other hand, was best when the same coating material was used but at a speed of 3200 rpm. The Taguchi optimization approach was also used to evaluate the coating material and engine speed parameters. The L16 (42) orthogonal array was used to construct the Taguchi analysis. At a speed of 2600 rpm, the coating material Al₂O₃+13 percent TiO₂ produced the highest S/N ratios of engine torque and BSFC. The maximum S/N ratio of engine power was observed when Al₂O₃+13 percent TiO₂ was used at a speed of 500 km/h.3200 revolutions per minute. The coating was found to be effective based on statistical tests. On the engine, the materials (P 0.05) and engine speed (P 0.05) parameters were statistically important. BSFC, torque, and strength.

B Venkatesh Nanoparticles are added to neat biodiesel to boost its transesterification process, efficiency, and emission parameters. The aim of this study is to find out what effect alumina nanoparticles have on the transesterification, emission, and efficiency of coconut biodiesel. There are two fuel tests. That are made through a transesterification process that includes or excludes the addition of alumina nanoparticles. The nitrogen oxide and smoke emissions were decreased by 6%, according to the results of the experiments. By transesterification with the addition of alumina nanoparticles, and 8% for coconut biodiesel when compared to transesterified coconut biodiesel without alumina nanoparticles. When compared to transesterified coconut biodiesel without alumina nanoparticles. Furthermore, the addition of alumina nanoparticles to coconut biodiesel during transesterification significantly decreases unburned hydrocarbon and carbon monoxide emissions. Experiment outcomes how that improves brake thermal efficiency by lowering fuel consumption.

Cenk Kaya The use of WDEF (water-diesel-emulsified fuel) has proven to be one of the most powerful methods for reducing NO_x (nitrogen oxide) without modifying the engine. First, the potential of emulsified fuel on the environment was investigated in this report. The engine parameters' efficiency has been calculated. During the tests; Pure diesel with a water content of 5%, 10%, and 15% has been prepared and tested. When operating at rated power and torque Experiments have shown that there is a small. For maximum torque, there is a 5.22 percent reduction

in brake power. Increases in BSFC (brake-specific fuel consumption) of up to 7.42 percent are also anticipated. Using emulsified petrol, this was achieved. However, because of a major issue with diesel engines, the maximum reduction in NO_x emissions was achieved at 16.84 percent. A minor brake reduction of up to 5.46 percent is needed for maximum strength. It has been observed that power has increased by up to 8.96 percent in the BSFC. As a result of a theoretical analysis, ten percent of the emulsion was emulsified. The effects of Boost are compared to experimental data. The findings agree well with the experimental evidence.

M.S.M. Sani Conventional fuels based on hydrocarbons are rapidly depleting and dangerous to the environment because they release toxic chemicals into the atmosphere. Because of their availability, ease of processing, and widespread testing, higher alcohols and biodiesel are the most promising alternative fuels. Advantages for the climate Alternative fuels such as alcohol and biodiesel are being used in engines. To cut down on emissions and save money on electricity Bioethanol is the most widely used higher alcohol fuel. Butanol, n-butanol, tert-butanol, and iso-butanol are examples of isopropanol, propanol, and ethanol–methanol. Waste cooking oil, Pyrolysis oil, Palmoil, Jatropha oil, Karanja oil, and Linn oil are some of the most widely used biodiesels. The aim of this study is to find out how alternative fuels like alcohol and biodiesel affect engine efficiency and combustion.

Shivam Gautam The efficiency and emission characteristics of a biofuelled compression ignition (C.I) engine with an antioxidant are investigated in this study. The beef tallow methyl ester (BTME) was obtained from beef tallow oil using the transesterification process with sodium hydroxide as a catalyst. The aim of this project is to improve efficiency, reduce smoke emissions from BTO operations, and investigate. The ability to use neat BTO directly in the CI engine .This study shows how to invest in the effect of binary BHA and BTO blends on the research engine. The tests were carried out using the following fuel compositions in a single-cylinder four-stroke C.I engine: 20 percent BTME in an 80 percent diesel (B20) mixture, 1000 ppm monophenolic antioxidant (butylated). BHA (butylated hydroxyanisole) combined with B20 (butylated hydroxyanisole + BHA) and 100 percent diesel Based on the findings of the experiments. Since BHA breaks chain

reactions, scavenges initiating radicals, and reduces the amount of nitrogen oxide released, it releases 12.2 percent less nitrogen oxide.

Chatpalliwarl, Deshpande, Modak, and Thakur (2011) Various issues related to biodiesel production are addressed, including sources, opportunities, threats, plant design, and evaluation. The aim of the presented work is to address the important issues surrounding biodiesel development. It provides the basic information needed for the formulation of a Biodiesel plant design. It also provides a potential solution for the mathematical model to test the design problem.

Gulab N. Jham (2009) investigated the use of wild mustard (*Brassica juncea* L.) oil as a biodiesel feedstock. A typical transesterification procedure using methanol and sodium methoxide catalyst yielded biodiesel in 94 percent yield. Mustard oil from the wild. The methyl esters had a cetane number of 61.1, kinematic viscosity of 5.33 mm² s⁻¹ (40 °C), and oxidative stability .for example. Other characteristics include acid value, lubricity, and the amount of free and complete glycerol. The iodine value, Gardner colour, specific gravity, sulphur, and phosphorous content were all measured. In conclusion, wild mustard oil tends to be an acceptable biodiesel feedstock.

Hanifa Taher (2011) Microalgae oil extraction is a major phase in the overall biodiesel production process, Since it is nontoxic, supercritical carbon dioxide (SC-CO₂) has recently been suggested to substitute traditional solvent extraction techniques. Non-toxic, chemically stable, and low-cost It makes use of a solvent that is safe for the environment. As a catalyst, an immobilised enzyme is used in the output reaction. Furthermore, using SC-CO₂ allows for fast product separation. In this paper, traditional biodiesel production with first-generation feedstock is compared to modern biodiesel production using chemical catalysts and solvent extraction. Microalgae, immobilised lipase, and SC-CO₂ as an example of new technologies reaction media and extraction solvent.

Kazy Fayeen Shahriar (2011) Bangladesh is a country that focuses on algae cultivation. *Chlorella* development on a small scale in the lab .In open pond and bioreactor systems, *Botryococcus braunii* was tested. And there was petrol. Transesterification of algae oil is used to make this product. Data was later gathered

from this attempt new stuff. To get a better picture of the real scenario of algae fuel, a cost analysis was prepared. Possibility this research suggests that algae-based fuel has a high potential for use in Bangladesh. For energy output, diesel is being phased out.

Matt Johnston (2011) Investigated the extent and spatial variation of new agricultural output capacity resulting from the closure of yield gaps in 20 ethanol and biodiesel feedstock crops. By closing the 50th percentile, we discover the 20 crops in this study helped close the production gap, bringing global yields back to median levels. Approximately 112.5 billion litres of new ethanol and 8.5 billion litres of new water could be produced production of biodiesel. This research would serve as a valuable new resource for scientists and policymakers alike, allowing them to better understand spatial variation in yield and agricultural intensification potential, as well as use these data to make better use of existing resources. Infrastructure, as well as the allocation of growth and aid capital, must be improved.

Piyanuch Nakpon By alkalicatalyzed transesterification, investigated the development of biodiesel from three mixtures of vegetable oil and used cooking oil. Three types of vegetable oils were examined, including jatropha, roselle, and coconut oils. The impact of the amount of used cooking oil in the oil feedstock (used cooking oil). The effects of different oil/vegetable oil ratios (0.03-0.2 v/v) on methyl ester formation were investigated. maximised Gas chromatography was used to assess the methyl ester content of each reaction state. Chromatography is a technique for separating colours (GC). For all three types of oil feedstock, the optimum used cooking oil/vegetable oil ratio was 0.03 v/v. The methyl ester content of three types of biodiesel was higher than the Thai biodiesel (B100) specification's minimum limit at this ratio. The calculated except for one, the properties of three biodiesel products were within Thai standards' limits. Since biodiesel made from coconut-based cooking oil mixture has a lower viscosity Nonetheless, It was extremely similar to Thai petroleum diesel.

CHAPTER 3

MOTO OF THE PROJECT

The world is facing energy demand crises, rising petroleum prices, and fossil fuel resource depletion. Biodiesel is a fuel made from vegetable oils that has been touted as a promising alternative to gasoline. There have been studies on the use of a blend of diesel and a single biodiesel. Already completed only a few studies have been conducted using two different biodiesel blends. Blends with diesel and leaves a lot of room for experimentation in this area. The current research involves blending two biodiesels made from pongamia pinnata oil and mustard oil with diesel at various mixing ratios. Dual biodiesel's effects on engine and exhaust emissions were studied. At various speeds, a single cylinder, direct injection, air cooled, and high-speed diesel engine was investigated. With a constant engine speed of 3000 rpm, the engine loads. The effects of blends on CO, CO₂, HC, and other gases. Emission tests were used to investigate NO_x and smoke opacity. Blend A's brake thermal efficiency was found to be higher than diesel's. Dual biodiesel blends had higher emissions of smoke, hydrocarbons, and nitrogen oxides than diesel. However, the temperature of the exhaust gas for dual biodiesel engines is higher. The percentage of blended fuels was lower than the percentage of diesel fuel.

Why Petroleum is bad for the environment?

Because it is a fossil fuel, it contributes to polluting emissions, particularly carbon dioxide, one of the most dangerous greenhouse gases. The atmospheric greenhouse layer, which plays a key role in regulating global temperatures, has been altered by human contributions of greenhouse gases.

What are the results of global warming?

Temperature rises, water shortages, increased fire threats, drought, weed and pest invasions, intense storm damage, and salt invasion are just a few of the effects of global warming on ecosystems. Some of Australia's most famous natural landmarks, such as the Great Barrier Reef, are already in danger.

3.1 BENEFITS OF USING BIOFUELS AS A FUELS

- ***Efficient fuel***

Biofuel is made from renewable resources and relatively less-flammable compared to fossil diesel. It has significantly better lubricating properties. It causes less harmful carbon emission compared to standard diesel. Biofuels can be manufactured from a wide range of materials. The overall cost-benefit of using them is much higher.

- ***Cost benefit***

As of now, biofuels cost the same in the market as gasoline does. However, the overall cost-benefit of using them is much higher. They are cleaner fuels, which means they produce fewer emissions on burning. With the increased demand for biofuels, they have the potential of becoming cheaper in the future as well. "Ethanol remains the highest-octane, lowest-cost motor fuel on the planet." With goals such as reducing drop-in biofuel costs, it aims to "enable high-value products from biomass or waste resources" and reduction in the cost of producing biopower. So, the use of biofuels will be less of a drain on the wallet.

- ***Durability of vehicle***

Biofuels are adaptable to current engine designs and perform very well in most conditions. It has higher cetane and better lubricating properties. When biodiesel is used as a combustible fuel, the durability of the engine increases.

There is also no need for engine conversion. This keeps the engine running for longer, requires less maintenance and brings down overall pollution

check costs. Engines designed to work on biofuels produce less emission than other diesel engines.

- ***Renewable***

Most of the fossil fuels will expire and end up in smoke one day. Since most of the sources like manure, corn, switchgrass, soybeans, waste from crops and plants are renewable and are not likely to run out any time soon, it makes the use of biofuels efficient in nature. Also, these crops can be replanted again and again.

- ***Reduce greenhouse gases***

Studies suggest that biofuels reduce greenhouse gases up to 65 percent fossil fuels. When burnt, produce large amounts of greenhouse gases i.e., carbon dioxide in the atmosphere. These greenhouse gases trap sunlight and cause the planet to warm.

Besides, the burning of coal and oil increases the temperature and causes global warming. To reduce the impact of greenhouse gases, people around the world are using biofuels.

CHAPTER 4

EXPERIMENTAL SETUP

A single cylinder, constant speed, Direct Injection engine was used to evaluate the engine performance and emission characteristics of lemongrass 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 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. Air flow 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 transesterified lemongrass biodiesel is filled in another fuel tank. An AVL smoke meter was attached for measuring 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 test was carried out for different blend proportions of lemongrass biofuel blended with the pure diesel fuel. The performance analysis of the engine at different rated power was evaluated in terms Specific Fuel Consumption (SFC), Brake Thermal Efficiency (BTE) and emissions characteristics such as HC, CO, CO₂ and NO_x.



Figure 4.1 Photographic View of the Experimental set this study

Table 4.1 Specifications of the Test Engine

Engine Type	Single Cylinder, 4 Stroke, Water Cooled Engine
	Stroke 110mm, Bore 87.5mm, 661 cc
Power	5.20 KW @ 1500 rpm
Compression ratio	17.5
Injection variation	0-25 deg Btdc
Dynamometer	Eddy current, Water cooled with Loading unit
Fuel tank	15 lt, Dual compartment with fuel metering

Benefits of the VCR engine can be summarized as follows

- 1) Optimum combustion efficiency in the whole load and speed range.
- 2) Low fuel consumption and low exhaust emissions.
- 3) The VCR provides better control over pollutant generation and after-treatment than a conventional fixed compression ratio (FCR) engine also extends the life expectancy of a three way catalytic converter.
- 4) As the geometrical volumetric ratio is under control on VCR engines, the engine always operates below the knock limit, whatever the load.

- 5) The VCR engine provides excellent fuel flexibility, since the compression ratio can be varied and adjusted to suit the properties of the fuel, and therefore the engine will always run at the compression ratio best suited to the fuel being used for bi-fuel (compressed natural gas (CNG)/gasoline) power-trains; the realization of VCR is of specific interest. High fuel flexibility, with optimal combustion efficiency.
- 6) Very smooth idle and full load accelerations are achieved.
- 7) It provides better indicated thermal efficiency than that of FCR engines.
- 8) It allows for a significant idle speed reduction because of reduced misfiring and cyclic irregularities, resulting in low vibration levels.
- 9) Reduction in low-frequency noise because of constant peak pressures.
- 10) Smoother combustion because the rate of heat release is the same (short) both at low and high compression ratios.
- 11) Cold starting emissions can be reduced greatly by early catalyst warm-up in the catalytic converter.
- 12) Improvement in the low end torque of a petrol engine without the risk of detonation.
- 13) Potential technology for future high-boosting super lean burn engines.
- 14) Low CO₂ emissions by down-sizing for the same power output.
- 15) Good idling performance at low ambient temperatures.
- 16) Constant frictional losses owing to almost constant peak pressures.

Engine Testing 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.

4.1 TEST RUN WITH COMPUTERIZED MULTI CYLINDER ENGINE SETUPS

- Ensure that all the bolts of engine, dyanamometer, propeller shaft, base frame are properly tightened.
- Ensure that sufficient lubrication oil is present in the engine sump tank. This can be checked by making 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.
- Start computer and open “IC ENHINE SOFT”(double click “IC ENGINE SOFT” 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 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 the changes click “save and 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 present configuration of x axis, yaxis, graph ranges, for the selected graphs. Click “close and 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.
- Keep the DLU knob at minimum position. Change the Fuel cock position from "Measuring".

Online Data Acquisition

- Click toggles witch “Mode” 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 @2000-2500RPM.
- 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 is 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 on 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 for generating Performance Report, Combustion Report. Enter File name in “Report File” select the Report Requirements viz. Result Data, Observation Data, Graph Only OR Graph and Table. (Note: If “Graph and Table” option is selected under.
- Combustion Report, the size of the output file for printing 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.

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 give non the form if you didn't check "Vehicle details" check box in Master data entry from 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 read colour "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 model is 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 smokemeter is working properly and connected with equipment.
- Readings are coming with equipment and display on remote of smokemeter.
- According to "Time interval settings in selection box, readings are automatically saves in database.
- After taking the readings click on "Disconnect button" it disconnect the communication with equipment 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 TO EXCEL” button. When pressing export button a excel file is generated at path \AVLFolder\ “The file name of excel file is same as Test Data 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.



Figure 4.2 Smoke Meter



Figure 4.3 Linearity Test

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 show the message in red colour “CP 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 save in database and status bar strip moving according to readings save in database.
- After taking the readings click on “Disconnect button” it 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 a excel file is generated path \AVLFolder\ in a “C:”. “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.



Figure 4.4 Five Gas Analyzer Reading



Figure 4.5 Five Gas Analyzer

CHAPTER 5

RESULT AND DISCUSSION

Experiments were carried out on a 4-cylinder direct-injection diesel engine using biodiesel as an alternative fuel and their blends to investigate the engine's emission characteristics under four engine loads at 1800 rev/min. An engine was run on diesel and four different diesel/biodiesel blends as part of a test (B20, B40, B60 and B80). The results were analysed after being made from waste frying oil. Biodiesel usage resulted in reduced hydrocarbon emissions (HC) CO, as well as CO₂ and NO_x emissions. The emissions of diesel/biodiesel blends were found to be higher in this study. Lower than diesel fuels'. Experiments were conducted at 1800 rev/min rated torque at containing 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent. Diesel and blended fuel experiments were carried out at each engine load. The effects of engine load and biodiesel on HC, CO, CO₂, and NO_x emissions were investigated in this paper. . Experiments with diesel and diesel-biodiesel blended fuels were conducted on a diesel engine. The biodiesel used in this study was made from used cooking oil. The tests used blended fuels containing 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent biodiesel by volume. Emissions were studied in relation to engine load and fuel mix.

Experiments with diesel and diesel-biodiesel blended fuels were conducted on a diesel engine. The biodiesel used in this study was made from used cooking oil. The tests used blended fuels containing 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent biodiesel by volume. Emissions were studied in relation to engine load and fuel mix. The utilisation of in general, HC and CO emissions are higher at diesel blended with biodiesel than at diesel; in general, HC and CO emissions are higher at diesel blended with biodiesel than at diesel. Low

engine loads result in lower NOx levels, while high engine loads result in higher NOx levels.

Oxygen enrichment of the fuel improves combustion. However, because of the higher combustion temperature and increased oxygen level in the combustible mixtures, NOx emissions increase.

5.1 BREAK THERMAL EFFICIENCY

Table 5.1 Break Thermal Efficiency

KW	S1	S2	S3	S4	D
0	1.84	1.68	1.56	1.38	2.45
0.87	15.12	15.75	15.98	16.24	16.49
1.75	22.42	24.44	24.61	24.55	22.75
2.6	27.31	28.96	28.38	31.42	31.71
3.5	35.72	29.57	30.18	38.45	32.59

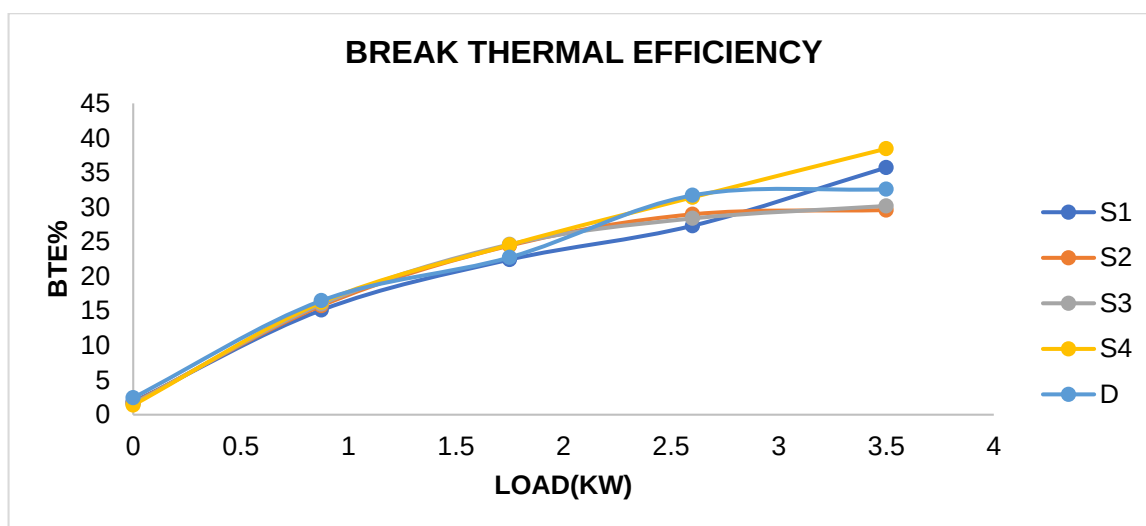


Figure 5.1 BTE Vs BP

The above graph indicates the brake thermal efficiency of a DI diesel engine using dual fuel. The sample 4 which indicates (20OSO20BO-60D). the above

sample 4 shows a high break efficiency performance when compared with other samples. Overheating, brake fade and brake pad degradation are just a few.

5.2 SPECIFIC FUEL CONSUMPTION

Table 5.2 Specific Fuel Consumption

KW	S1	S2	S3	S4	D
0	4.66	5.09	5.49	6.23	2.4
0.87	0.57	0.54	0.54	0.53	0.52
1.75	0.38	0.35	0.35	0.35	0.38
2.6	0.31	0.3	0.3	0.27	0.29
3.5	0.24	0.29	0.28	0.04	0.20

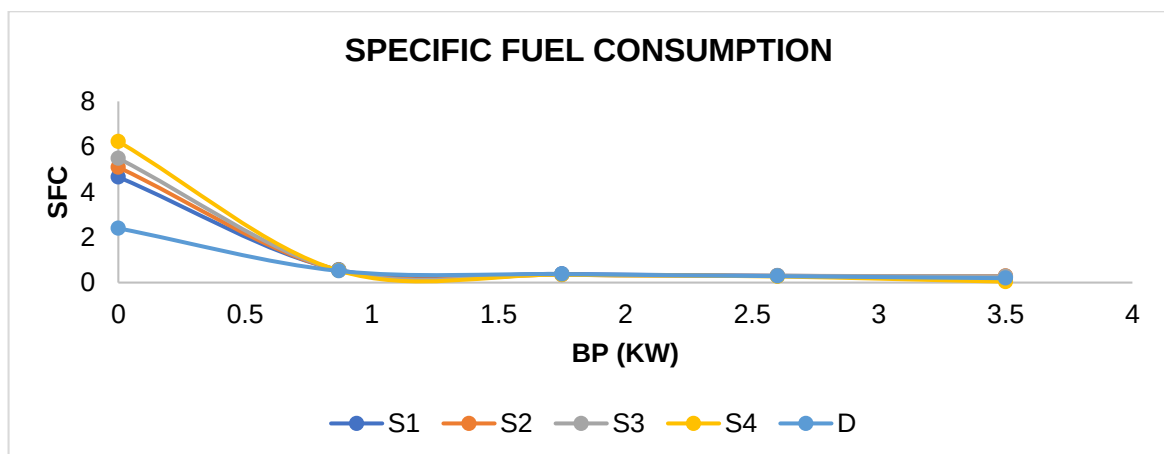


Figure 5.2 SFC Vs BP

The above graph indicates the specific fuel consumption of a di diesel engine using dual fuel. The above graph shows that the fuel consumed during the ignition. The above tells that the sample 2 shows the less fuel consumed when compared with others samples and diesel. Sample2 (10OSO10BO-80D). **Specific fuel consumption (SFC)** is one of the most **important** metrics employed in aviation. It is **important** not only in aircraft design but also in the operation of the

aircraft. First and foremost, **SFC** indicates how efficiently a power plant converts chemical into mechanical energy.

5.3 CO2 EMISSION ANALYSIS

Table 5.3 CO2 Emission Analysis

KW	S1	S2	S3	S4	D
0	1.38	1.44	1.62	1.64	1.6
0.87	1.53	2	2.2	2.38	1.96
1.75	2.04	2.48	3.55	2.97	2.54
2.6	2.5	3.27	3.3	2.98	2.89
3.5	2.84	3.2	3.7	3.97	3.89

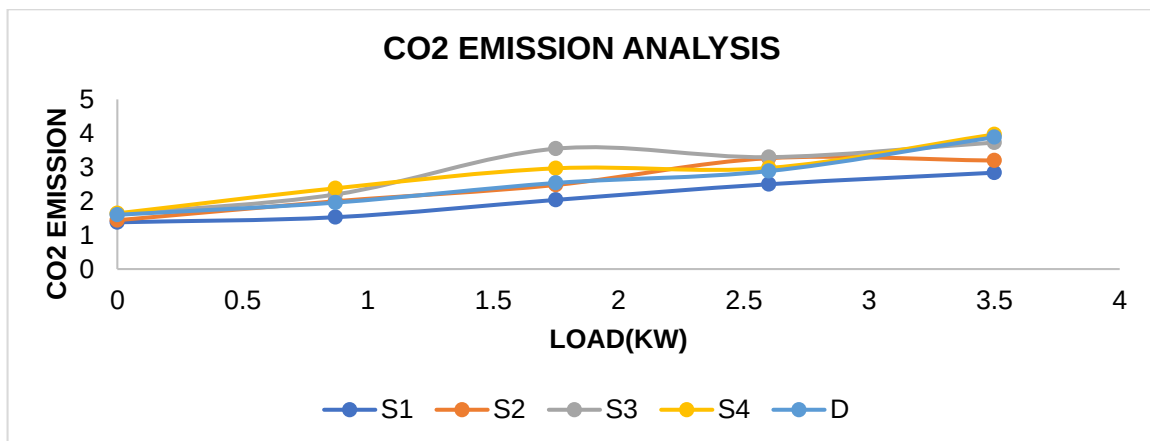


Figure 5.3 CO2 Vs BP

The above Figure represent the emission of carbondioxide gas produced during emission with dual fuel. Reducing carbon emissions would reduce the number of deaths caused by air pollution while also reducing the strain on healthcare systems. A decoupling between the two is required to achieve economic growth while still prioritising carbon emission reductions. The sample1 (S1) represent the least carbon dioxide emission in the proportion (5OSO5BO-90D). The carbon dioxide emission increases with increase in load factor.

The CO₂ emissions of various fuels used in the diesel engine. The CO₂ emission increases with increases in load, as expected. The lower percentage of biodiesel blends emits very low amount of CO₂ in comparison with diesel. B20 emits very low level of CO₂ emissions. Using higher concentration biodiesel blends as the fuel, CO₂ emission is found to increase. But, its emission level is lower than that of the diesel mode. B80 emits more amount of CO₂, as compared to that of biodiesel blends. More amount of CO₂ in exhaust emission is an indication of the complete combustion of fuel. This supports the higher value of exhaust gas temperature.

5.4 O₂ EMISSION ANALYSIS

Table 5.4 O₂ Emission Analysis

KW	S1	S2	S3	S4	D
0	18.32	18.27	17.87	17.86	18
0.87	18.18	17.15	16.8	16.67	19
1.75	17.25	16.6	15.09	15.74	15
2.6	16.59	15.45	15.01	5.83	12
3.5	15.94	15.43	14.55	14.25	11

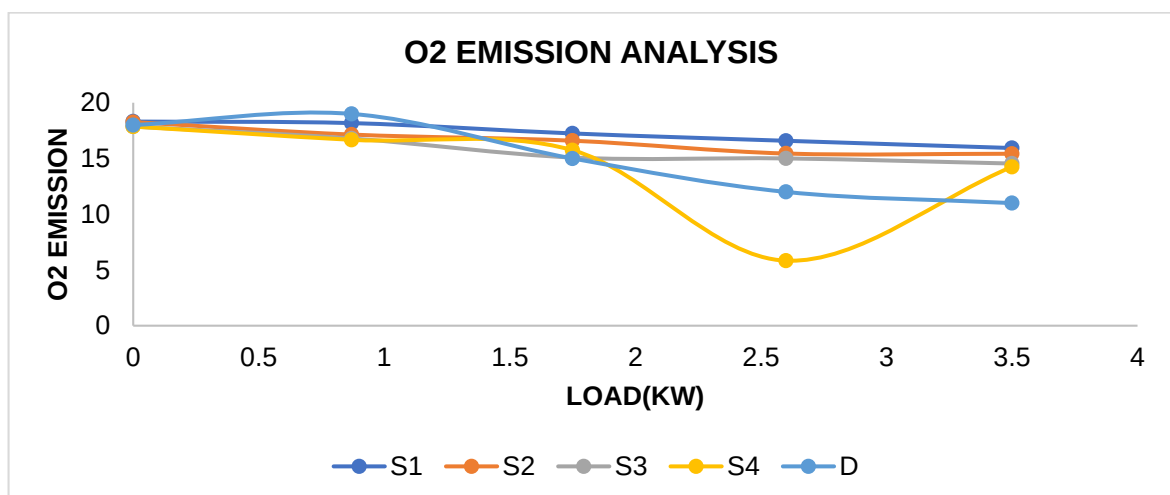


Figure 5.4 O₂ Vs BP

The above graph represent the emission of oxygen gas during the emission with dual fuel. The above sample 2 produces more oxygen and consumes less diesel. We can also choose other samples it also produces more oxygen and consumes more diesel. The reason that the oxygen content should be is, If the engine does not receive enough oxygen during the combustion process, complete conversion of carbon and hydrogen is impossible, resulting in particulates and carbon monoxide, which leads to increased exhaust emissions .the sample consumes(10OSO10BO-80D).decrease in load will increase the oxygen level.

When the engine load is increased, the CO emission for each fuel decreases. The general decreasing trend is aided by higher combustion temperatures at higher engine loads. CO emissions are also reduced when biodiesel is used. It's possible that the oxygen in the fuel promotes complete combustion in the cylinder, lowering CO emissions.

5.5 CO EMISSION ANALYSIS

Table 5.5 Co Emission Analysis

KW	S1	S2	S3	S4	D
0	0.008	0.004	0.014	0.012	0.008
0.87	0.015	0.008	0.018	0.027	0.013
1.75	0.017	0.016	0.03	0.032	0.018
2.62	0.026	0.024	0.037	0.044	0.023
3.5	0.031	0.035	0.041	0.046	0.029

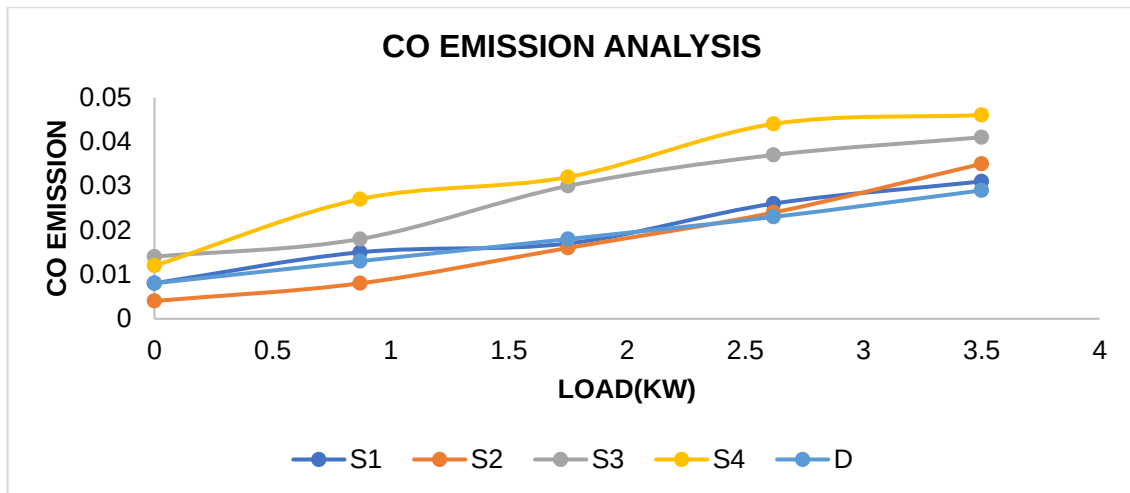


Figure 5.5 CO Vs BP

Carbon monoxide affects the amount of greenhouse gases in the atmosphere, which are linked to climate change and global warming. This means that as land and sea temperatures rise, ecosystems will change, storm activity will increase, and other extreme weather events will occur.

Carbon monoxide (CO) is emitted as a waste product from the exhaust system of vehicles due to the incomplete combustion process that occurs in an engine. Carbon monoxide is produced in the environment by incomplete combustion of any carbon-containing fuel.

So the above sample 2 produces low co emission when compared with other samples. Sample2(10OSO10BO-80D).

5.6 HC EMISSION ANALYSIS

Table 5.6 HC Emission Analysis

KW	S1	S2	S3	S4	D
0	6	5	7	9	2
0.87	9	8	10	11	6
1.75	17	12	15	15	10
2.62	22	15	20	20	15
3.5	23	22	25	25	19

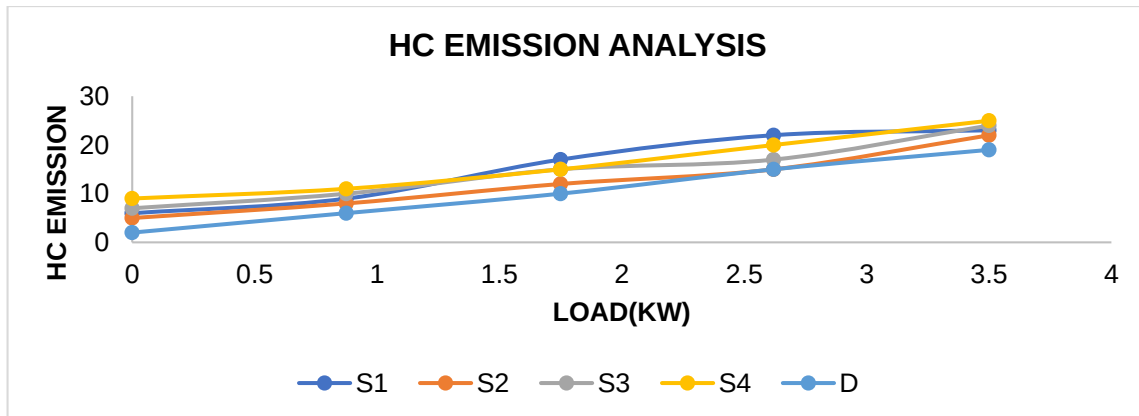


Figure 5.6 HC Vs BP

High HC emissions can result from a lack of spark energy. Incomplete combustion and high hydrocarbons may result if the spark occurs at the wrong time. The above sample represent the emission of HC for dual fuel. The above sample2 produces less HC emission and consumes less diesel. Sample2 (10OSO10BO-80D).

Due to the higher combustion temperature associated with higher engine load, HC emission decreases with increasing engine load for diesel. The HC emission from biodiesel blended fuel is lower than diesel and decreases as the percentage of biodiesel in the fuel increases. Instead of decreasing linearly with engine load, emission has a peak value at 40% engine load. The HC has been reduced. The lower volatility of biodiesel compared to diesel, on the other hand, contributes to a larger difference in HC emissions at low engine loads. For diesel, B20, B40, B60, and B80, the maximum HC concentrations are 35 ppm, 29 ppm, 27 ppm, 26 ppm, and 25 ppm, respectively, indicating that the maximum HC emission decreases with the addition of biodiesel.

5.7 NOX EMISSION ANALYSIS

Table 5.7 NOX Emission Analysis

KW	S1	S2	S3	S4	D
0	42	53	65	76	56
0.87	138	175	159	226	156
1.75	313	341	564	393	289
2.6	327	661	637	615	285
3.5	559	726	748	886	750

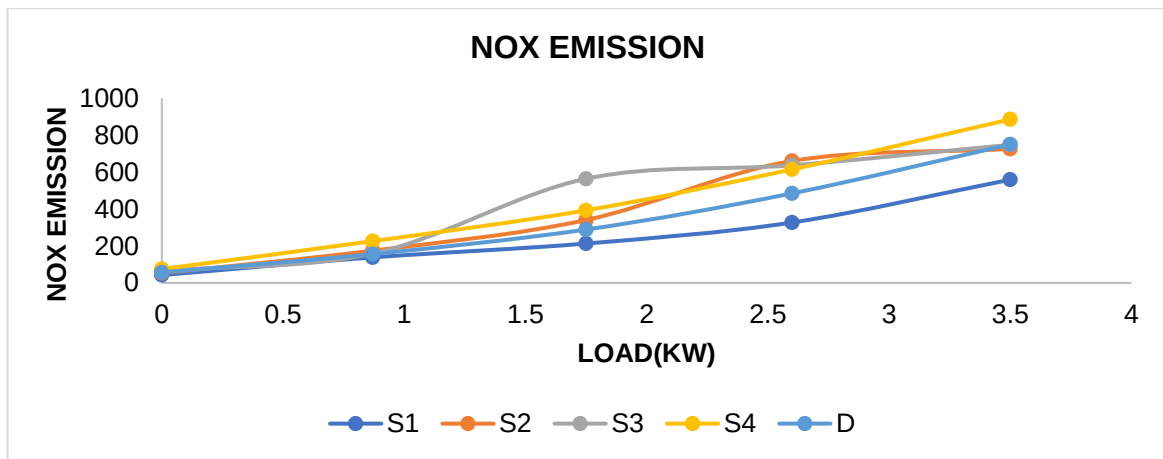


Figure 5.7 NOx Vs BP

The above graph represents the emission of NOx gas produced during emission. The reason why NOx emission is bad for the environment is that humans can suffer serious health consequences from NOx, including respiratory diseases. NOx emissions contribute to acid rain and ground-level ozone formation, which can harm ecosystems, animals, and plants. NOx forms nitric acid (HNO_3) and small particles when it reacts with ammonium (NH_4^+), water vapour, and other compounds. The above sample 1 produces low NOx emission when compared with other samples. But consumes more diesel. Sample 1 (5OSO5BO-90D).

The variation of NO_x emission with engine load. The NO_x concentration increases with increase of engine load for all the fuels. Compared with diesel, NO_x emission of the biodiesel blended fuel increases slightly at all tested engine loads and the increase is more obvious at higher engine loads. From diesel to B80, the NO_x emission increases. The peak concentrations at the 80% engine load are 670 ppm, 640 ppm, 640 ppm, 620 ppm and 600 ppm respectively, for diesel, B20, B40, B60, B80.

5.8 CONCLUSION

Therefore we are going to conclude that the emission performance and all the other characteristics which played a vital role for the biodiesel production and performance and analysis of the give dual fuel (okra seed oil call its as OSO)and (bergomot oil call it as BO).and the antioxidant which played a vital role(titanium dioxide). Biofuel is a natural resources produced from dead and decayed organic plants. Nut now days these resources is depleting day by day so we introduce biodiesel production from waste cooking oil etc... by transestrification process we have produced a biodiesel production which low viscosity and others properties as mentioned above. Now coming to the emission characteristics we have found that the (BTE) break thermal efficiency and oxygen content should be high for the emission. Overheating, brake fade and brake pad degradation are just a few. Specific fuel consumption (SFC) is one of the most important metrics employed in aviation. And the emission of HC, CO, NO_x, O₂, and CO₂.

From diesel to B80, the NO_x emission increases. The peak concentrations at the 80% engine load are 670 ppm, 640 ppm, 640 ppm, 620 ppm and 600 ppm respectively, for diesel, B20, B40, B60, B80.

For diesel, B20, B40, B60, and B80, the maximum HC concentrations are 35 ppm, 29 ppm, 27 ppm, 26 ppm, and 25 ppm, respectively, indicating that the maximum HC emission decreases with the addition of biodiesel.

More amount of CO₂ in exhaust emission is an indication of the complete combustion of fuel. This supports the higher value of exhaust gas temperature.

Finally I am going to conclude that the, above values obtain from (OSO&BO) will change according to the molar ratio taken. And for other oils the emission and performance changes due to the physical and chemical properties. Till now there is a problem in nox emission after few years there will be problem in co2 emission. I will suggest to use ecofriendly biodiesel which results in low nox and co2 emission.

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