

**EFFECT OF 4 ALLYL 2,6-DIMETHOXYPHENOL ON VCR DIESEL
ENGINE
USING BIODIESEL**

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in Mechanical Engineering
By

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

SATHYABAMA

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

Accredited with grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of A.PUJITH SAI ESWAR (Reg. No. 39150004) and CH.SAI PAVAN KUMAR (Reg. No. 39150021) who carried out the project entitled **"EFFECT OF 4 ALLYL 2,6-DIMETHOXYPHENOL ON VCR DIESEL ENGINE USING BIODIESEL"** under our supervision from December 2022 to APRIL 2023.

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ABSTRACT

The need for biofuel as a fuel for transportation is rising. In this investigation, a diesel engine was run on neem oil. There were four different biodiesel mixes available: B5, Biodiesel blends, B15, and B20. In regards to efficiency and exhaust emissions, such as reduced smoke, carbon dioxide, and unburned hydrocarbons, B20 fuels fared better than other mixes. B20 emits more NO_x than other petrol blends, on average. The quality of pure biodiesel, engine efficiency, and emission characteristics are compared in this article. A sustainable, low-carbon fuel like biodiesel can be used to reduce global carbon emissions. Biodiesel, a by-product of the processing of biomass, is a great replacement for traditional fossil fuels for meeting the increased demand for diesel fuel that results from Biofuels not only help to reduce our reliance on crude oil but also help to make the environment cleaner and more sustainable. Also, it increases the amount of money and job possibilities available to rural populations. As a consequence, both the nation's expanding transportation demands as well as the energy needs of rural India will be satisfied. Using carbon fuels will reduce carbon emissions and meet the century's energy demands for the 21st century.

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CHAPTER 1

INTRODUCTION

Biodiesel is a locally produced, sustainable, and clean-burning substitute for petroleum fuel. The use of biodiesel as a sole source of fuel for vehicles increases energy security, improves the climate and air quality, and provides benefits for safety. Oil exports from the United States began to outpace imports in 2020, but imports of 7.86 thousand gallons per day remained essential for keeping the supply and demand on domestic and international markets in equilibrium. The transit industry accounts for 30% of the country's total energy needs and 70% of its petroleum consumption. By using biodiesel, other alternative fuels, and cutting-edge technology to continue minimising fuel use, the nation's security is enhanced while operating expenses for businesses and consumers are reduced..

The country of the United States makes biodiesel, a fuel that directly replaces or increases the supply of traditional petroleum fuel and is used in diesel engines. There is an energy surplus in soybean biodiesel, which means that for every unit of carbon fuel used during its lifespan, 4.56 units of energy are produced.

Biodiesel increases the fuel's cetane number and enhances lubricity. Diesel engines depend on the lubricity of the fuel to stop moving parts from wearing out too rapidly. The federal restrictions that have reduced the concentration of aromatics and restricted allowed fuel sulphur to only 15 ppm have had the unintended effect of decreasing petroleum diesel's lubricity. The ASTM D975 diesel fuel standard was amended to include a lubricity criterion in order to address this issue. Biodiesel can increase the lubricity of diesel fuel by as much as 1% in the fuel mixture. Check your engine's original equipment manufacturer (OEM) guidelines before using biodiesel to discover the best mix for your car.

1.1 PROJECT OVERVIEW

1.1.1 Neem Oil

Neem oil must first be extracted by cracking open the seeds and separating the shells. The seeds are then squeezed in wooden presses powered by bullocks, hands, or industrial expellers. Sometimes; up to 50% of the overall weight of the seed is produced as oil.

Most commonly, candles cleaners, and other non-edible items utilise this "cold-pressed oil." Typically, it is smelly, acrid, and dark. It includes sulphur compounds, which, in contrast to most vegetable oils, give off a pungent smell reminiscent of garlic.

Hexane is used by a sizable business in India to extract the remaining oil from the seed cake. While not as high quality as cold-pressed oil, such solvent-extracted oil is still used in some cosmetics and consumer goods

Neem seed oil purification currently involves a labour-intensive and expensive procedure.

One technique involves distilling the offensive sulphur compounds out of the oil, which rids it of both rancidity and odour. (because it also removes the free fatty acids). This procedure has a lengthy history of industrial use.

1.1.2 Biodiesel

Biodiesel has a smaller mass energy content than diesel fuel because it contains less carbon and hydrogen. Biodiesel has a smaller volumetric energy content than other diesel because of its higher fuel density. Most biodiesel fuels have much greater viscosities. The blends were prepared using a sartorius digital balance for preparing a small blends of a given liquid.

Conventionally, biodiesel fuel blends can be made by utilising acid or alkali as a catalyst. Transesterification is the process by which methanol reacts with animal or vegetable fat to produce esters and glycerol. Either of the two types of monohydric aliphatic methanol is used to carry out the transesterification reaction. It is possible to conduct the reaction at room temperature.

1.2 LITERATURE SURVEY

Moser B et al. Several fatty acid and alkyl esters were exposed to accelerated oxidation techniques, including pressurized differential scanning calorimetry and EN 14112 (Rancimat method). (PDSC). Both techniques revealed structural patterns that increased oxidative stability, such as fewer double bonds, trans rather than cis unsaturation, unsaturation closer to the ester head group, and the removal of hydroxyl groups. When a bigger ester head group was used with EN 14112, an increase in oxidative stability was also noted. Because of excessive sample evaporation, methyl esters with ten or fewer carbons in the fatty acid backbone were not suitable for measurement at 110 °C (EN 14112).

Demirbas A et al. Vegetable oil fuels were more costly than petroleum-based fuels, vegetable oil fuels have not been widely accepted. Vegetable oil microemulsions and solvent dilution of oils reduce viscosity, but some engine efficiency issues persist. The transesterification procedure is used to reduce the oil's viscosity. More biogasoline than biodiesel fuel is produced during Pyrolysis

. Kyunghyun Ryu et al. The purpose of this research is to look into how antioxidants affect a diesel engine's performance, its ability to burn biodiesel fuel, and its ability to emit exhaust fumes. The study's biodiesel gasoline was made from soybean oil. The findings demonstrate that antioxidant effectiveness is in the following order: TBHQ > PrG > BHA > BHT > -tocopherol. With 100 ppm TBHQ and 300 ppm PrG in biodiesel fuel, the oxidative stability met the 6-hour quality requirement. Antioxidants added to biodiesel gasoline had no effect on the diesel engine's combustion characteristics or exhaust emissions.

J.PavalavanaPandianM et al. studied the The best prime movers for generating electricity for automobiles, trains, and ships are diesel engines. For the purpose of meeting the requirement for diesel fuel protect surroundings from toxic air smoke brought on combustion of diesel fuel, a quick transition to alternative fuels is essential. Recent times have seen biodiesel establish itself as a viable alternative fuel for Compression Ignition (CI) engines due to its many significant benefits, such as biodegradability and renewability. Additionally, it creates engines with comparable performance and significantly reduces toxic emissions.

Hery Sutanto et al.A sustainable plant-based fuel with many benefits, biodiesel can replace fossil diesel fuel. However, due to the high amount of unsaturated fatty acids it contains, storage produces oxidation instability. To solve this issue, a variety of chemicals have been created and put to use, such as antioxidants based on phenolic compounds. One of the top phenolic antioxidants for biofuel is said to be pyrogallol. Sadly, pyrogallol is not very soluble in oil solution. By creating a pyrogallol derivative through a reaction between pyrogallol and methyl linoleate in the presence of the radical 2,2-diphenyl-1-picrylhydrazyl, pyrogallol solubility is enhanced in this study. (DPPH). For the solubility measurement, the spectrophotometric technique was employed.

AatifAvase et al. The use of Biofuels has arisen as a outcome of our need to sustain our present levels of energy consumption and transportation systems. The research focuses on the trans-esterification process for obtaining biodiesel from used cooking oil and its blending with the additive pyrogallol to maintain oxidation stability. Pyrogallol was added to the biodiesel as an additive to boost oxidation stability in order to meet EN 14214 and ASTM 6751 requirements. Three fuel blends—fossil diesel, biodiesel-diesel-additive (B20A), and one cylinder direct ignition engine—were used when comparing emissions and performance at both half and maximum loads. B20 and B20A are discovered to have higher viscosity and cetane numbers than diesel, respectively (30.39% & 13.79% and (5.43% & 2.23%).

David Pimentel et al. switchgrass, and wood biomass all produced less ethanol with regard to energy outputs than their corresponding fossil fuel inputs. The same was

true for the production of biodiesel from soybeans and sunflower, but the energy cost for soybean biodiesel production was only marginally lower than that of ethanol production. The following conclusions were reached when comparing energy outputs to energy inputs: • The fossil energy needed to produce ethanol from switchgrass was 50% higher than the energy yielded. • Using wood biomass to make ethanol resulted in a 57% increase in the amount of fossil energy needed. • The amount of fossil energy needed to make biodiesel from soybeans was 27% higher than the amount of fuel produced.

Marina Corral Bobadilla et al. Research on renewable and sustainable energy sources is being driven by the ever-increasing demand for fuel and the diminishing oil reserves, which are having a serious negative impact on the environment through excessive greenhouse gas emissions, deforestation, and global warming. This necessitates the use of a biodegradable, sustainable alternative fuel like biodiesel. To create the biodiesel, veggie oils underwent direct transesterification. The procedure was controlled by a number of factors. The reaction is accelerated and made more soluble by the alkaline catalyst, which is usually potassium hydroxide (KOH) or sodium hydroxide (NaOH).

CHAPTER – 2

METHODOLOGY

2.1 DESCRIPTION

A clear, light to dark yellow liquid is biodiesel. It contains a low vapour pressure and high boiling point, and it is essentially immiscible with water. The flash point of typical methyl ester bio-diesel is at 150 °C (300 °F), making it relatively inflammable. The density of biodiesel is 0.88 g/cm³, which is lower than the density of water. It is possible to classify uncontaminated biodiesel as non-toxic.

Petrodiesel, the name given to diesel made from petroleum, is a phrase used to describe the viscosity of biodiesel. Nevertheless, It is important to ensure that the biodiesel utilised do not raise sulphur level of combination over 15 ppm In order to increase the lubrication of pure Ultra-Low Sulphur Diesel (ULSD) fuel, it can be added to diesel formulations.

The marking B20, for instance, indicates that the gasoline contains 20% biodiesel. Known as B100, pure biodiesel. The amount of particles, carbon monoxide, and hydrocarbons in the air is decreased, and it is safe and biodegradable. Typically, unmodified diesel engines can run on blends of B20, which is 80 percent petroleum diesel and 20 percent biodiesel.

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2.2 Neem Oil

Neem oil is made by first cracking open the seeds and separating the kernels.

The kernels are subsequently squeezed in wooden presses powered by bullocks, hands, or industrial expellers. Sometimes, up to 50% of the mass of the keel is produced as oil. Most commonly, lamps and other non-edible goods use this "cold-pressed oil."

Typically, it is stinky, bitter, and black. It includes sulphur compounds, which, in contrast to most vegetable oils, give off a strong smell evocative of garlic.

Hexane is used by a sizable business in India to extract the leftover oil from the seed cake. Although the grade of this liquid oil isn't as high as that of cold-pressed oil, it was nonetheless mixed in some consumer goods.

2.2.1 Extraction of neem oil

All seeds must be cracked open, the kernels are separated in order to produce neem oil. The kernels are subsequently squeezed in wooden presses powered by bullocks, hands, or industrial expellers (ghanis). Sometimes, up to 50% of the weight of the kernel is produced as oil.

Most commonly, lamps, soaps, and other non-edible goods use this "cold-pressed oil." Typically, it is stinky, bitter, and black. It includes sulphur compounds, which, in contrast to most vegetable oils, give off a strong smell evocative of garlic.

Hexane is used by a sizable business in India to extract the leftover oil from the seed cake. Although the grade of this solvent-extracted oil is not that of cold-pressed oil, it is nonetheless used in some soaps and consumer goods.

2.2.2 Preparation of neem oil

❖ *Seed pre-conditioning and flaking*

Seed pre-conditioning and flaking are important steps in the process of extracting neem oil from neem seeds. Here are the steps involved:

- **Cleaning:** The neem seeds should be cleaned thoroughly to remove any dirt, debris, or other impurities.
- **Drying:** The cleaned neem seeds should be dried in the sun or in a dryer until they are completely dry.
- **Pre-conditioning:** The dried neem seeds should be pre-conditioned by soaking them in water for 12-24 hours. This helps to soften the seed coat and make it easier to remove.

- Flaking: After pre-conditioning, the neem seeds should be flaked using a mechanical flaker or a rolling mill. This process breaks the seed coat and exposes the kernel inside.
- Extraction: The flaked neem seeds are then ready for oil extraction. The oil can be extracted using a cold-pressing method or a solvent extraction method.

By following these steps, you can ensure that you get high-quality neem oil from your neem seeds.

2.3 BIODIESEL

2.3.1 Definition

The term "biodiesel" refers to a class of products known as mono alkyl esters that are produced from vegetable oil and an alcohol like ethanol. A alternative fuel for diesel vehicles, biodiesel lowers some harmful emissions and is made from renewable organic materials. Widespread interest has been given to biodiesel as a "green" energy source.

2.3.2 Characteristics

Due to its high oxygen concentration, each fuel's characteristics can differ. Biodiesel has a smaller mass energy content than diesel fuel because it contains less carbon and hydrogen. Biodiesel has a volumetric energy content that is approximately 5 to 6% lower due to its greater fuel density. Most biodiesel fuels have viscosities that are noticeably higher than those of conventional gasoline.

Table.2.3 Biodiesel physical characteristics

Specific gravity	0.813
Kinematic viscosity at 40°C	20.5-48.5
Cetane number	47
Higher heating value, Btu/gal	10,900(Kcal/Kg)
Lower heating value, Btu/gal	8,960(Kcal/Kg)
Density, lb/gal at 15.5°C	0.910
Carbon, wt%	76-78
Hydrogen, wt%	12-14
Oxygen, by dif. wt%	8-9
Boiling point, °C	200°C
Flash point, °C	164 °C
Sulfur, wt%	0.1
Cloudpoint-°C	10°C
Pourpoint- °C	4°C

2.3.3 Preparation of Blends

While making blends to this experiment, the specific gravity (g/ l) of the parent fuel is used to ensure that every blend is a 10, 20, 30 volume percent blend of biodiesel fuel. These blends were prepared using a Sartorius digital balance that is accurate. This method of preparing a blend is commonly used when preparing small blends (volume) of a given liquid.

2.3.4 Properties of Biodiesel

❖ Refractive Index

Specific gravity of the extracted neem oil was discovered to be 0.9111, pH to be 6.5, refractive index to be 1.4668, iodine value to be 70.21g/g, acid value to be 34.33mgKOH/g, and saponification value to be 180.95 mgKOH/g. In the cores of neem seeds, there is 25–45% oil. The outcome revealed that 38.87% of neem seed oil was present in the kernel. The oil's characteristics reveal that it is in a liquid form, has a colour that is brownish yellow, smells like garlic, has a refractive index of 70.90, a pH of 4, and a boiling point of 158 °C.

Density

Neem oil was found to have the following physical characteristics: 2.1% ash, 4.6% moisture, 0.875 g/cm³, 33.5 mm²/s viscosity, 0.88 specific gravity, 206.7 mg KOH saponification value, 122.5 g I₂/100 g iodine value, 1.81 mg KOH/g acid value, and a cetane number of 75.

❖ Cloud and Pour Point

Neem oil's cloud point turns out to be 12°C, which is greater than diesel. Under cold weather conditions, a higher cloud point has a negative impact on engine efficiency and emissions. Neem oil's pour point was discovered to be 7°C. The cloud point and viscosity values, which were 26.8°C and 3.5 mm²/s, respectively, fell within the ASTM standard limit. Physical-chemical characteristics of biodiesel made from neem seeds are listed in Table 1.

Flash Point

Neem oil's flash point differs based on the extraction process and the oil's purity. However, neem oil usually has a flash point between 150°C and 200°C (302°F and 392°F). Neem oil should be handled carefully and kept away from open flames and high temps because it can catch fire if exposed to either.

Cold Flow Properties

Neem oil can solidify at lower temperatures and has a comparatively high melting point. Neem oil's ability to flow in a cold environment depends on its purity as well as the particular handling and storage conditions. Neem oil may harden or become cloudy at room temperature, but warming it will quickly liquefy it. Neem oil's flow characteristics may be impacted by the viscosity of the substance, which rises at lower temps. Neem oil needs to be kept in a cool, dry location away from extreme temps to preserve its quality and flow characteristics. It has many advantageous traits, including the capacity to function as a natural pesticide and fungicide. Neem oil has comparatively high viscosity at room temperature, which results in it being thick and flowing slowly when it comes to its cold flow characteristics. Because of this, it might be challenging to use in some situations, like spraying or blending with other substances.

Neem oil will start to run at a relatively low temperature because it has a relatively low pour point. This means that the oil won't solidify or become too thick to use, which is advantageous in colder climes.

Corrosion

In general, neem oil is thought to be non-corrosive. It is a pure vegetable oil that is made from the neem tree's seeds and does not contain any corrosive or harsh compounds. In reality, because it is non-corrosive and safe for the environment, neem oil is frequently used as a natural substitute for chemical pesticides and fungicides.

Neem oil can, however, have a small corrosive effect on some materials, such as some rubber and plastic varieties, so it's essential to be aware of this. This is so because neem oil includes organic compounds that, over time, can degrade particular materials. However, this impact is typically negligible and is not a significant issue for the majority of applications.

Viscosity

Neem oil's viscosity can change based on conditions like temperature, purity, and processing techniques. Neem oil typically has a comparatively high viscosity, making it thick and slowly flowing. Neem oil is comparable to olive oil in viscosity at room temperature, falling between 50 and 60 centipoise (cP).

Neem oil's viscosity, however, can fluctuate with weather. Neem oil becomes less thick and flows more readily as temperature rises because neem oil has a lower viscosity. Neem oil can have a viscosity of 30 to 40 cP at greater temperatures, which is comparable to the viscosity of vegetable oil.

❖ Cetane Number

Diesel fuel's ability to ignite is gauged by the cetane value. It is a measurement of how quickly gasoline ignites after being injected into a diesel engine's combustion chamber. Neem oil is not a gasoline fuel, so cetane number does not apply to it.

Neem oil is a vegetable oil that is frequently employed in a number of different uses, including horticulture and agriculture as a natural insecticide and fungicide. Although it is not a diesel fuel, it can be used as one in some circumstances. In these situations, the blend of neem oil with other diesel fuels or biofuels would decide the cetane number.

❖ Kinematic Viscosity

Neem oil usually has a kinematic viscosity of 30 to 50 centistokes (cSt) at 40 degrees Celsius. Kinematic viscosity, which is usually expressed in centistokes.

Neem oil's viscosity can change based on conditions like temperature, purity, and processing techniques. Neem oil becomes less viscous and flows more readily as the temperature rises because the kinematic viscosity of neem oil decreases. Neem oil, on the other hand, becomes more viscous and flows more slowly at lower temperatures due to a rise in kinematic viscosity.

Lubricity

It has been discovered that neem oil has excellent lubricity properties, which means it can lessen wear and friction between moving parts. Neem oil contains natural substances like fatty acids and triglycerides that can create a protective film on metal surfaces and lessen friction, which is why this is the case.

Neem oil has been proven to be an efficient lubricant in a number of uses, including in engines, gears, and bearings, according to studies. When used as a lubricant for a sliding contact test, neem oil was discovered in one research to have a greater load-carrying capacity and a lower wear rate than mineral oil. Neem oil has also been discovered to have excellent thermal stability, meaning that it can keep its lubricity qualities even at high temperatures. This qualifies it as a good lubricant for high-temperature applications, like in industrial equipment or engines.

Neem oil has excellent lubricity characteristics overall, making it a suitable substitute for conventional lubricants in some applications. Because of its natural makeup and capacity to lessen friction and wear, it can contribute to extending the lifespan of equipment and lowering upkeep costs.

❖ Oxidative Stability

Since neem oil has excellent oxidative stability, it won't degrade in the presence of oxygen or at high temperatures. This is because neem oil contains natural antioxidants like nimbin, nimbinin, and nimbidin that can aid in reducing the production of free radicals and other reactive species that can result in oxidative harm.

Neem oil has a strong resistance to oxidation, even at high temperatures, according to studies. In one research, accelerated oxidation tests revealed that neem oil had a longer induction period and lower peroxide value than other vegetable oils, such as soybean oil and sunflower oil. Neem oil has also been discovered to have excellent thermal stability, meaning that it can keep its oxidative stability even at high temperatures.

Because of this, it can be used in high-temperature applications like engines and industrial equipment.

2.3.5 Fuel Efficiency

In some situations, neem oil can be used as a biofuel, but the fuel efficiency will differ based on the blend ratio, the type of engine, and the working circumstances.

We can use alternative fuel as neem oil in diesel vehicles, according to studies, but it has less energy than diesel fuel. This can lead to lower fuel efficiency because more neem oil is needed to produce the same quantity of energy as diesel fuel. While diesel fuel has a lower cetane number than neem oil, the latter is simpler to ignite, burns more thoroughly, and produces fewer emissions. To increase its fuel economy, neem oil can also be blended with other biofuels or diesel fuels. Neem oil alone has been discovered to have lower fuel efficiency than a blend of neem oil and biodiesel.

Neem oil can, in general, be used as a biofuel in some situations, but the fuel efficiency will differ based on the blend ratio and operating circumstances. It may not have the same energy density as diesel fuel, but it has other advantages like a better cetane rating and fewer emissions.

2.3.6 Combustion

Vegetable oil known as neem oil is obtained from the neem tree's seeds. Burning neem oil results in combustion, a chemical reaction when the oil and oxygen in the air interact to create heat, light, and different combustion products.

Neem oil combustion is an exothermic reaction, which indicates that heat is released. Burning neem oil as a fuel for cooking or heating is an example of how the heat produced during combustion can be used to create energy.

Neem is not advised to be burned for energy generation, though, as it can release airborne toxins like carbon monoxide and particulates.

2.3.7 Emission

The roots of the neem tree, which is indigenous to India and other regions of Southeast Asia, are used to make neem oil. Crushing the seeds and then pressing them to remove the oil is a procedure known as cold-pressing that is used to obtain the oil.

Once the oil has been removed, there are numerous uses for it. The use of neem oil as a natural insecticide is among its most popular applications. Aphids, mites, and whiteflies are just a few of the many insects that the oil is poisonous to. Neem oil, when applied topically to plants, can aid in the management of these pests and guard against plant harm. Another application for neem oil is as a natural pesticide. Powdery mildew and black spot are two fungi that the oil's constituents are useful against. Neem oil, when applied topically to plants, can aid in inhibiting the development of these pathogens and safeguard the plants from harm.

Neem oil is employed in cosmetics and personal care items in addition to being a fungicide and pesticide. Fatty acids and vitamin E found in abundance in the oil can help to feed and moisturise the skin. Additionally, it is thought to possess antibacterial and anti-inflammatory properties that can serve to calm and heal the skin.

CHAPTER – 3

EXPERIMENTAL SETUP

3.1 DIESEL ENGINE

An internal combustion (IC) engine, the diesel engine ignites the fuel after it has been introduced into the combustion chamber at a high temp that a petrol reaches when it is considerably compressed. Unlike spark-ignition engines, like gasoline engines or gas engines, which ignite an air-fuel mixture using a spark plug. A diesel engine has the greatest thermal effectiveness of any imaginable internal or external combustion engine due to its enormous growing proportion and inherent lean burn, which encourages heat dissipation through the excess air. Diesel motors with two and four strokes are both made. In this experiment, a four-stroke diesel engine is being used.

The piston completes four different strokes while the crankshaft revolves in a four-stroke engine, a kind of internal combustion (IC) engine. A piston's whole motion along the cylinder, whether in one direction or the other, is known stroke The four different strokes are referred to as:

- Intake: The intake stroke of a diesel engine begins with the piston moving downward, which creates a vacuum in the cylinder. This vacuum draws in air through the intake valve.
- Compression: Once the air is drawn into the cylinder, the piston moves upward, compressing the air. This compression raises the temperature of the air to a point where it can ignite the fuel.
- Combustion: Fuel is delivered into the cylinder just as the engine's piston reaches the peak of its stroke. Gases quickly expand as a result of the fuel being ignited by the heat produced by the compressed air. By pushing the piston downward, this expansion generates power.

- Exhaust: As the piston moves downward, it pushes the exhaust gases out of the cylinder through the exhaust valve. The cycle then repeats itself, with the piston moving upward to begin the intake stroke again.

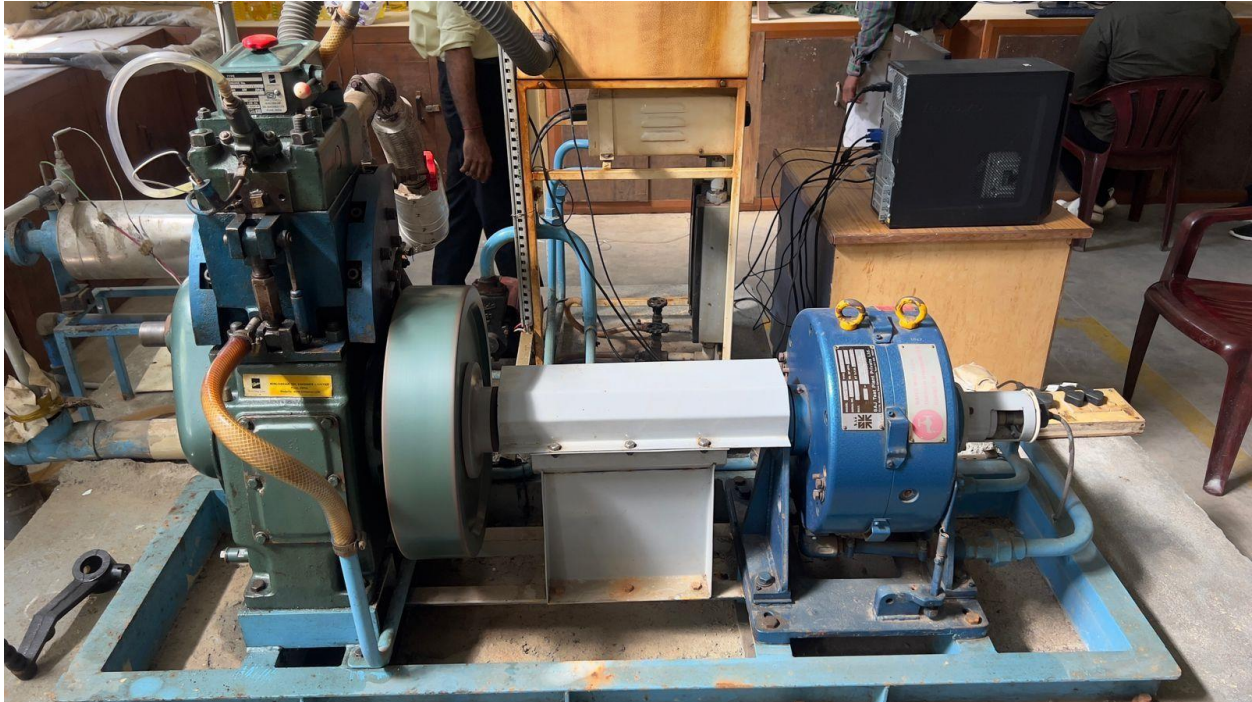


Fig.3.1: Engine setup

Description: An eddy current dynamometer is connected to a single-cylinder, four-stroke diesel engine with an electronic start and a variable compression ratio for loading. The compression ratio can be changed utilising a specially designed tilted cylinder block arrangement without shutting down the engine or changing the geometry of the combustion chamber. The system is equipped with the instruments needed to measure combustion pressure and crank angle. The signals in question are connected to the comput for PPV diagrams via the engine indicator. There is also space for the interface of temperature, fuel flow, airflow, and load monitoring.

Table.3.1: Engine specification

ENGINE	Cylinder-Type1, four stroke, Water cooling system, length of the stroke 110 mm, depth of the bore 87.5mm ,cylinder capacity 661cc.
Power	3.5 Killowatt
Speed	1500 Revolution per minute
Compression ratio range	12:1-18:1
Injection variation	0-25 Deg Before top dead center
Fuel tank	Capacity 15 lit
Methods of cooling	Water
Flywheel diameter	1262mm
Injection pressure	200 bar
Compression Ratio	17.5:1

3.2 EXHAUST GAS ANALYZER

Please follow these instructions to transfer readings from a petrol analyzer to ADCS Software.

- Kindly fill the details (Engine Number Model and Engine Type) in the given form.
- Press Connect button to connect the computer with equipment and then see for 2 to 3 minutes. if
 - the results aren't coming it shows the msg in red colour "CO HC power not communicating." kindly see the following below :
- 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 six seconds results are usually saved in database and status bar strip moving according to result saved in database.
- After taken readings click on "Disconnect button" it disconnects the communication with equipment and shows the message "Data Saved in Database".
- Report: Click on report button to take the report of the test.
- Print: Click on print button to take the printout of screen as bitmap image.
- Export to MS Excel Sheet: To export data in excel sheet click on "EXPORT TO EXCEL" button. When pressing export button an excel file is generated in a path "C:\AVL\Folder\".
 - 8. 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.



Fig.3.2: Exhaust gas analyzer

Table.3.2: Exhaust gas analyzer specification

Manufacturer	SMS Autoline Equipments private limited
Type	Crypton290 five gas analyser
Range	Carbon monoxide -0 to 10 % Carbon dioxide -0 to 20 % Hydrocarbon -0 to 10000 PPM Oxygen-0 to 25 Nitrousoxides-0 to 5000 PPM
Resolution	Carbon monoxide -0.01 % Carbon dioxide -0.10 % Hydrocarbon -1PPM Oxygen -0.01 % Nitrousoxides -1 PPM
principle	Carbon monoxide -NDIR Carbon dioxide -NDIR Hydrocarbon -NDIR Oxygen -Electrochemical Nitrousoxides -Electrochemical

3.3 SMOKE METER

Please follow these instructions to transfer readings from the smokemeter to the ADCS software.

- Please enter the information (Engine Number, Model, Engine Type) in the appropriate field.
- spaces provided on the Master data entry form, all of the textboxes pertaining to (Engine Number, Type, Type Of engine, and Engine Speed) become inactive if the "Vehicle details" check box is not checked.
- Click on "Connect button" to connect the PC with equipment and wait for 5-10 seconds. if
- the readings are not coming it show the message in red color ""Unable to Communicate
- with Equipment."" kindly check the following:
 - Be sure that Smokemeter model name display on screen is same as your smokemeter
- model if not kindly change the model in "Master Data Entry Form"
 - Check the COM port settings with PC and the software in "Master Data Entry" form.
 - RS232 Cable for 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
- 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 “C:\AVLFolder\”. The
- file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_26).
- Close button : click on close button to exit from current active window or screen, it takes time to close, so wait for 10-15 seconds for form window to close.



Fig.3.3: Smokemeter

Table.3.3: Smoke meter specification

Types	AVL437 Smokemeter
Make	Mars Technologies inc
range	0-100 HSU
Temperature of smoke	2500 C(degrees)
Ambient Temperature	0-50°C
Humidity	90% during 50°C
Power	205 Ampers, 11.5-36Volts Direct current
Working Principle	LAP(Light absorption principle)

CHAPTER-4

RESULT AND DISCUSSION

The readings are taken from the single cylinder 2 stroke engine under the running speed of 1500 revolutions per minute and Brake Power 3.5 KW, Injection Pressure 200 Bar

4.1 PURE DIESEL READING

The readings are taken in the pure diesel

Table.4.1: Base reading tabulation

Torqu (Nm)	BP (kW)	FP (kW)	IP (kW)	BMEP (bar)	IMEP (bar)	BTHE (%)	ITHE (%)	Mech Eff. (%)
1.11	0.00	1.23	1.28	0.21	1.50	2.45	24.40	14.14
6.55	0.875	0.88	1.75	1.24	2.29	16.49	30.33	54.37
11.56	1.75	0.78	2.53	2.20	3.12	22.75	32.37	70.29
17.52	2.62	0.61	3.22	3.33	4.06	31.71	38.72	81.90
22.42	3.5	0.43	3.93	4.26	4.78	32.59	35.46	89.10

4.2 BIODIESEL BLEND 10% READING

The readings are taken in the (diesel 90% + neem 10%)

Table.4.2: S10 reading tabulation

Air Flow (kg/h)	Fuel Flow (kg/h)	SFC (kg/kWh)	Vol Eff. (%)	A/F Ratio	HBP (%)	HJW (%)	HGas (%)	HRad (%)
30.24	0.45	2.48	83.96	67.46	3.45	0.00	26.84	69.71
30.05	0.55	0.52	83.99	54.86	16.49	0.00	22.00	61.51
29.62	0.70	0.38	83.16	42.48	22.75	0.00	18.95	58.29
29.00	0.75	0.29	82.65	38.82	31.71	0.00	19.66	48.63
28.54	0.95	0.20	82.50	30.16	31.59	0.00	17.87	50.54

4.3 BIODIESEL BLEND 20% READING

The readings are taken in the (diesel 80% + neem 20%)

Table.4.3: S20 reading tabulation

Torque	time for 5 cc	Total fuel consumption	SFC	BTE D 100	SEC	Indicated thermal Efficiency
0	32.3	0.445820433	A	0	A	42.9919
8	25.7	0.581322957	0.38569729	21.60589	16662.123	54.57666
16	17.01	0.878306878	0.29137038	28.600482	12587.2005	50.42277
24	12.4	1.20483871	0.26646291	31.273896	11511.1979	47.18197

32	8.01	1.865168539	0.30937642	26.935904	13365.0612	37.21201
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4.4 BRAKE THERMAL EFFICIENCY

4.4 BRAKE THERMAL EFFICIENCY

BTE/LOAD(%)	0.875	1.75	2.62	3.5
S1	13.5	19.8	29.5	30.6
S2	14.2	20.8	29.7	31.4
S3	14.9	21.4	29.9	31.9
S4	15.2	21.9	30.1	32.9
Diesel	16.49	22.75	29.47	32.59

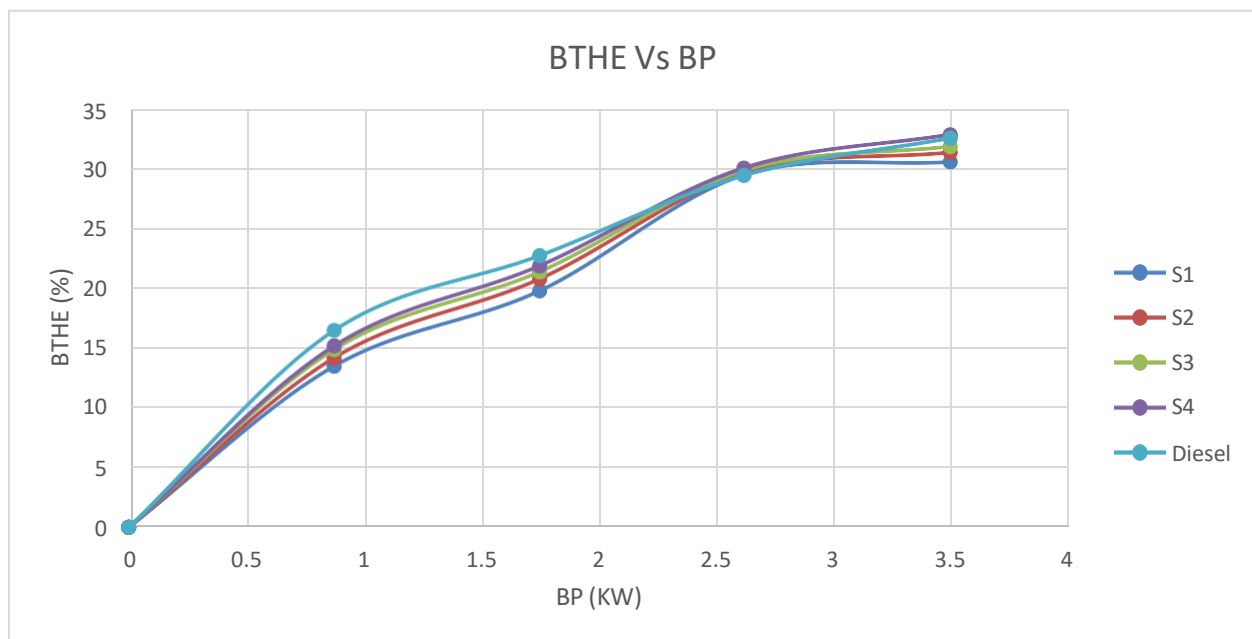


Fig.4.4: Brake power Vs Brake thermal efficiency

Figure 4.4.1 illustrates that all biodiesel blends have characteristics that affect their braking thermal efficiency, both lower and higher. This might be a result of biodiesel's

higher viscosity and lower calorie content compared to diesel. 75D25NO50HA, which contains 25% Neem oil and 75% diesel, achieves the highest brake thermal effectiveness of any biodiesel blend. Engine speeds ranging from 500 to 1500 rpm were used to examine the impact of brake thermal efficiency. A four-cylinder diesel engine is employed as a testing engine in this investigation. They stated that the test engine had a 120 bar pressure.

While 90D10NO50HA, a blend of 10% Neem oil and 90% diesel, achieves the lowest braking thermal efficiency of any biodiesel mixture. While combinations 80D20NO50HA and 85D15NO50HA have brake thermal efficiencies of 31.9% and 31.4%, respectively. This might be a result of its increased calorific content and reduced viscosity, which allow it to burn more effectively than other bio-diesel mixes.

4.5 SPECIFIC FUEL CONSUMPTION

The amount of fuel used at 3.5KW had increased due to an increase in engine load. A low calorific value is indicated by an increase in fuel usage. Further research was done at 1500 rpm since the small Specific Fuel Consumption there indicated complete fuel combustion.

4.5 SPECIFIC FUEL CONSUMPTION

SFC/LOAD(%)	0.875	1.75	2.62	3.5
S1	3.24	0.71	0.51	0.31
S2	3.29	0.73	0.49	0.37
S3	3.8	0.78	0.56	0.34
S4	3.9	0.79	0.58	0.39
Diesel	3.45	0.52	0.38	0.29

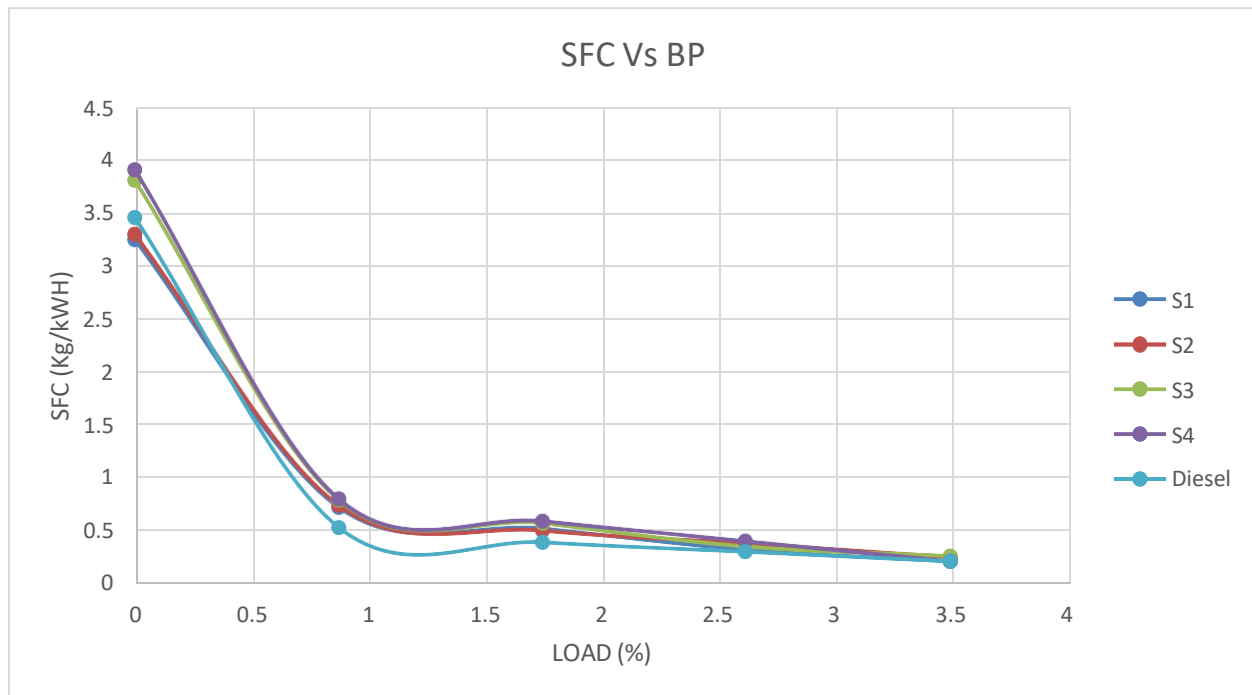


Fig.4.5: Brake power Vs Specific fuel consumption

Figure 4.5.1 makes it clear that every single biodiesel blends have features of lower and greater specific fuel consumption. This might be because biodiesel has a lower energy content and higher viscosity than diesel. The greatest specific fuel consumption of all the biodiesel blends is found in 75D25NO50HA, which contains 25% Neem oil biofuel and 75% diesel. The smallest specific fuel consumption is found in 90D10NO50HA, which includes 10% Neem oil biofuel and 90% diesel, with 0.31 kg/KWH. There are 0.37kg/KWH and 0.34kg/KWH in the blends 80D20NO50HA and 85D15NO50HA, respectively. This might be the case because the mixtures burn more efficiently compared to other biodiesel blends since they have more energy.

4.6 HYDROCARBON EMISSION

Table.4.6: Hydrocarbon emission

BTE/LOAD(%)	0.875	1.75	2.62	3.5
S1	2	4	7	10
S2	3	6	8	13
S3	5	8	10	13
S4	4	6	8	12
Diesel	2	6	10	15

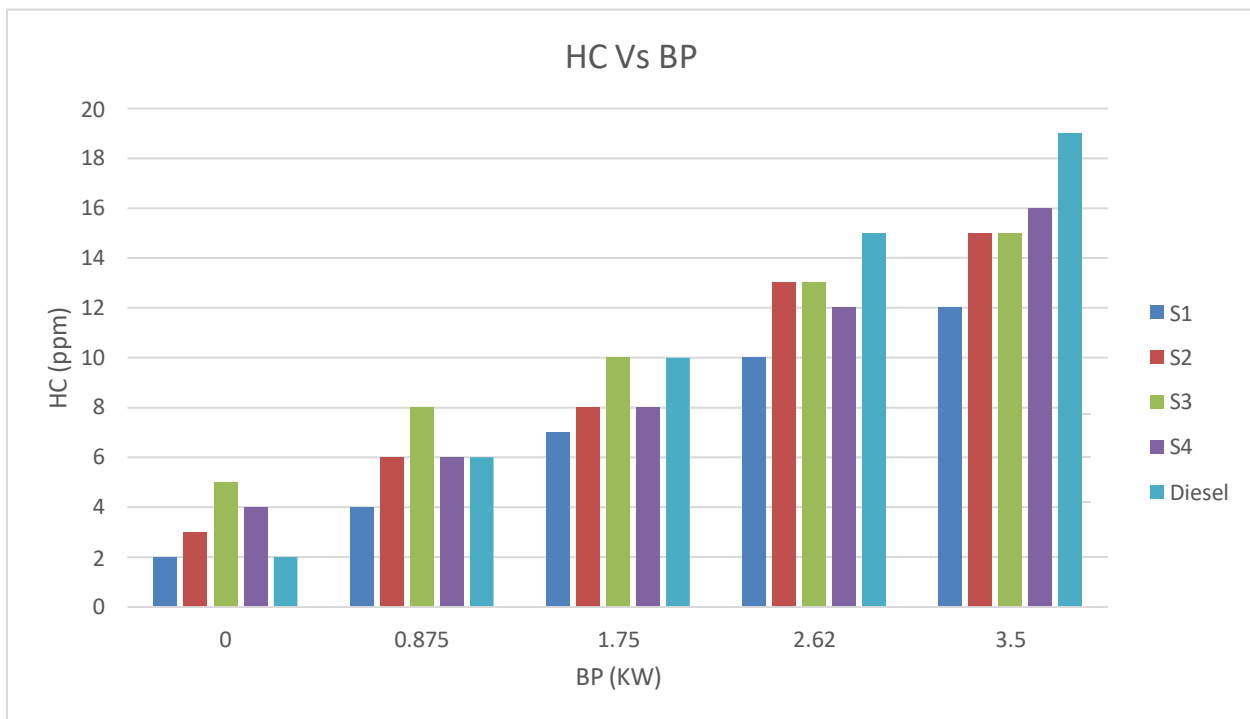


Fig.4.6: Brake power Vs Hydrocarbon emission

HC emissions are significantly influenced by the rate when fuel and air are mixed. If the mixture is excessively lean, the fuel does not automatically ignite, which leads to unburned emissions. If the mixture is too rich, insufficient mixing prevents HC from burning. One of the chemical components of every biodiesel is oxygen. Biodiesel burns better than diesel as a result.

Figure 4.6.1 shows the fact that compared to other blends, 80D20NO50HA has the highest HC emission (13 ppm), whereas 90D10NO50HA has the lowest (10 ppm) HC emission. This is due to the blend's higher volatility, which produces more efficient combustion relative to other blends of biodiesel. The speed at which air and fuel mix have a big impact on HC emission. If the mixture is too lean manufacturing, auto-ignition of the fuel does not occur, leading to unburned emissions. If a mixture is too rich, HC is left unburned due to insufficient mixing.

4.7 CARBON MONOXIDE EMISSION

Table.4.7: CO emission

BTE/LOAD(%)	0.875	1.75	2.62	3.5
Sample1	0.009	0.012	0.015	0.017
Sample2	0.012	0.013	0.015	0.019
Sample3	0.018	0.02	0.025	0.029
Sample4	0.019	0.023	0.029	0.031
Diesel	0.008	0.013	0.018	0.023

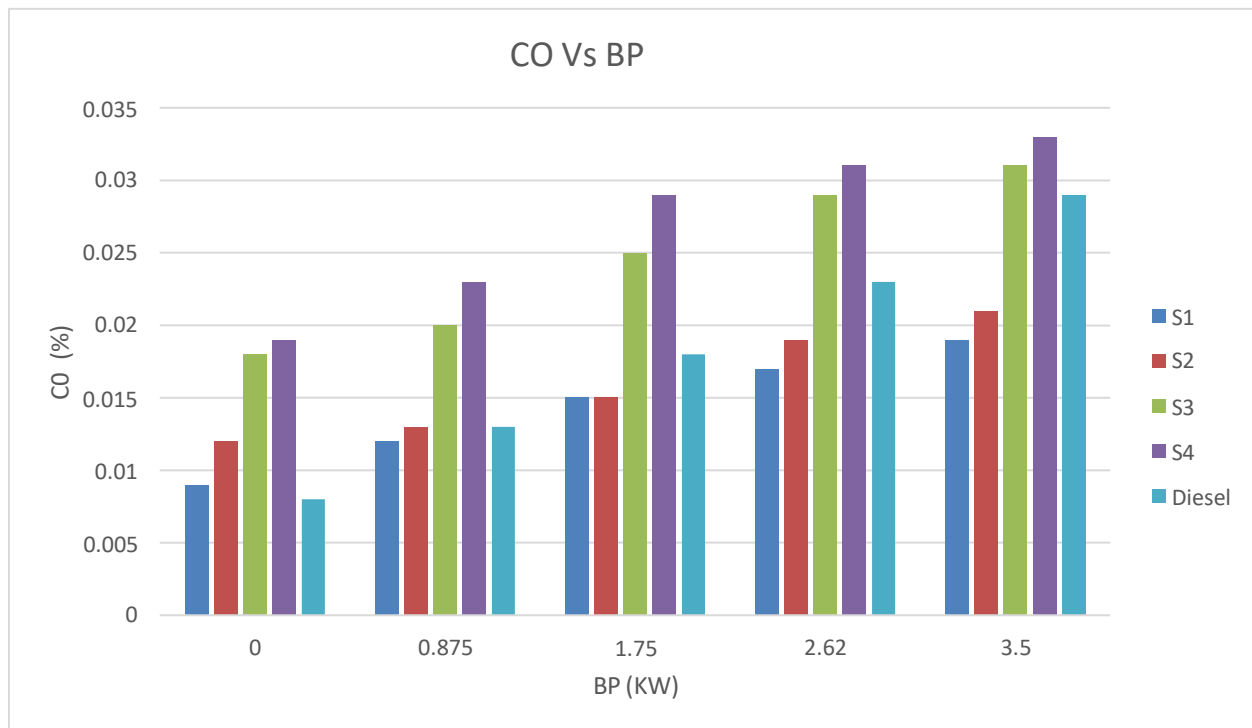


Fig.4.7: Brake power Vs CO emission

Diesel engines typically generate less carbon dioxide than petrol engines due to the lack of air within the environment and the prolonged time needed for CO₂ to be formed during combustion. Figure 4.7.1 demonstrates that biodiesel emits less carbon monoxide (CO) than diesel. The higher oxygen content in 90D10AO50HA, 80D20AO50HA, 75D25BO50HA, and 70D30AO50HA improves oxidation and lowers CO emissions, which is the cause of this.

This is true because of its low viscosity, which improves spray characteristics and encourages greater air-fuel mixing. As opposed to different blends of biodiesel, 90D10NO50HA has the least carbon dioxide emissions of 0.017% and 75D25NO50HA had the greatest CO emission of 0.031%. This is caused by the lower viscosity, which encourages better combustion. The 100D, or pure diesel, emits the largest amount of CO₂ 2.98% at 3.5 KW, according to our observations.

4.8 NOx EMISSION

Table.4.8: NOx emission

BTE/LOAD(%)	0.875	1.75	2.62	3.5
S1	41	101	213	304
S2	81	161	279	398
S3	82	128	270	429
S4	71	140	268	381
Diesel	56	156	289	485

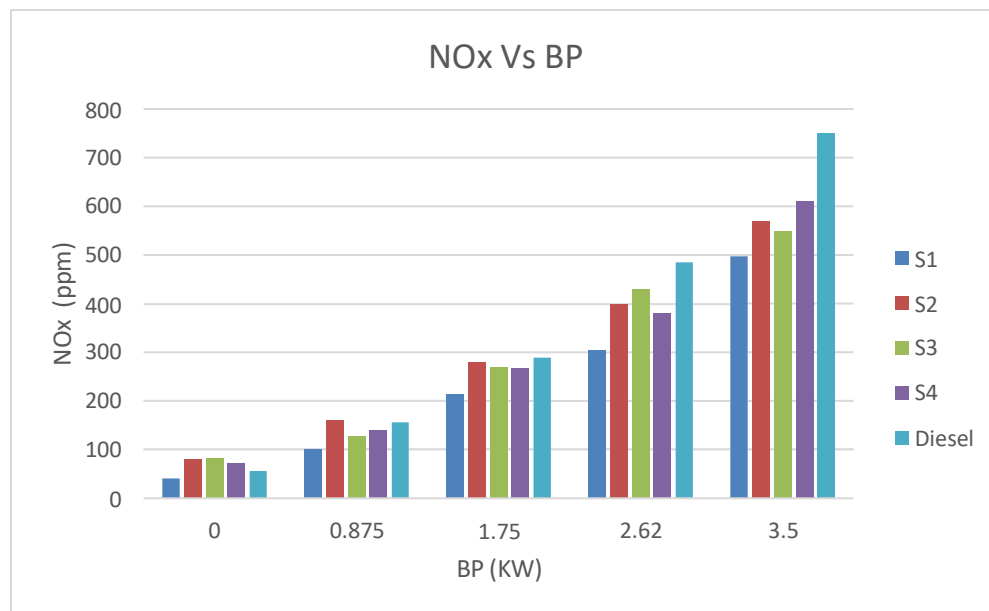


Fig.4.8: Brake power Vs NOx emission

Due to enhanced air availability and higher combustion temperatures, diesel Compared to diesel engines, those powered by biodiesel release more nitrogen oxides (NOx). on normal gasoline. When more alcohol is added, the amounts of nitrogen oxides (NOx) that are emitted from diesel and biodiesel made from Neem oil change as the load does. The main reason for NOx emission is the accumulation of partially used gasoline. Figure 4.8.1 shows that when compared to other blends, 90D10NO50HA has the least NOx emission at 304 ppm and 80D20NO50HA has the highest at 429 ppm due to the blend's lower

viscosity. There are 398 and 381 parts per million in the blends 85D15NO50HA and 75BD25NO50HA, respectively. According to our research, the 100D has the highest Nitrogen output at 650 ppm, with diesel typically containing 500 to 1000 ppm of NOx.

4.9 CO₂ EMISSION

Table.4.9: CO₂ emission

BTE/LOAD(%)	0.875	1.75	2.62	3.5
S1	0.35	0.67	0.89	1.09
S2	0.337	0.69	0.89	1.3
S3	0.7	0.97	1.27	1.6
S4	0.3	0.78	1.27	1.7
Diesel	1.6	1.96	2.54	2.89

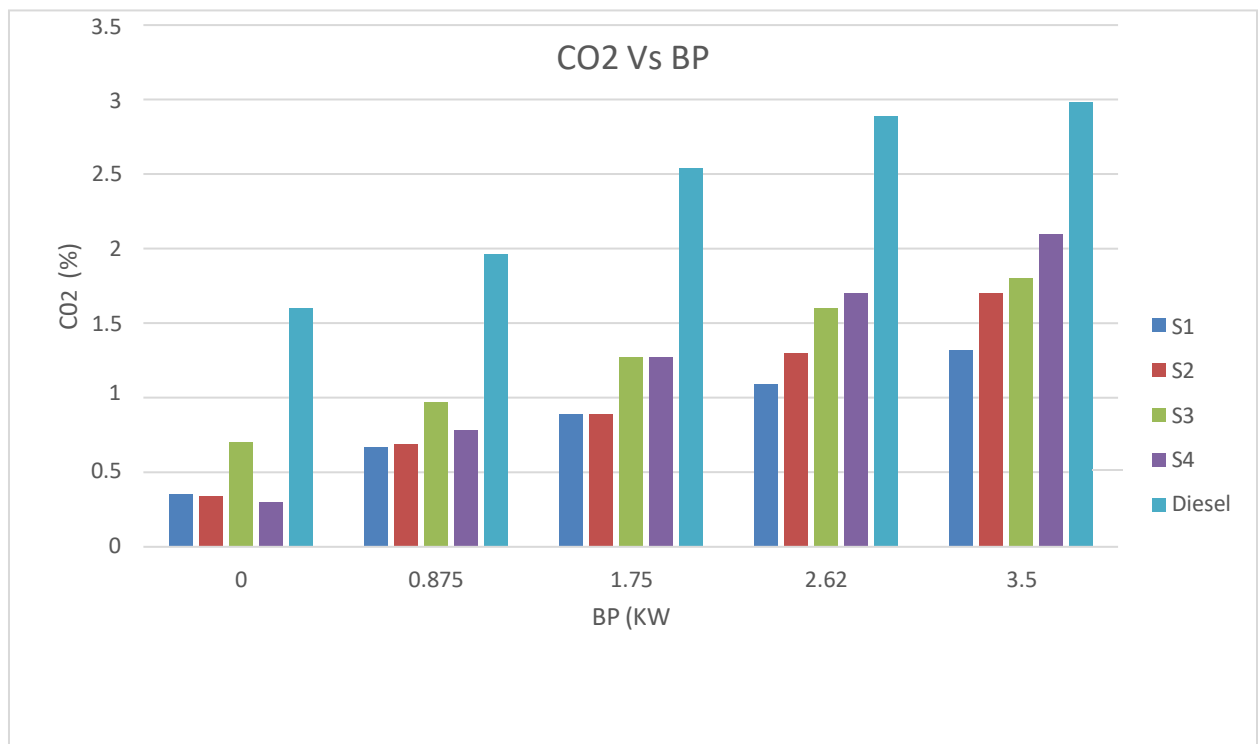


Fig no.4.9: Brake power Vs CO₂ emission

For all biodiesel blends, diesel has the lowest and highest CO₂ characteristic. As was said earlier, biodiesel burns more effectively than diesel because it contains oxygen. 75D25NO50HA emits the greatest CO₂ (1.7%), while 90D10NO50HA produces the least (1.09%), as seen in Figure 4.9.1. In comparison to other biodiesel mixes, the higher combustion temperatures are caused by lower viscosity and enhanced combustion. According to our observations, the 100D, or pure diesel, releases the most CO₂ at 3.5 KW, or 2.98%. Lower viscosity and improved combustion result in greater combustion temperatures when compared to the other biodiesel blends. There are 1.3% and 1.6% in the mixes 85D15NO50HA and 80D20NO50HA, respectively. The 100D emits 2.98% of CO₂ at a load of 3.5 KW.

CHAPTER - 5

CONCLUSION

The threat posed by exhaust emissions and climate change as a result of depleting fossil fuel sources has sparked intense interest worldwide in creating substitute biodiesel fuels for engines. Fatty acid methyl esters are typically created using transesterifying vegetable. Neem oil has been used in this instance as a renewable energy source. The effectiveness and emissions of the biodiesel feedstocks were compiled in this review. Two factors that are crucial are size distribution and degree of unsaturation. μ , s.g, and low temperature performance measures were shown to be closely related for the types of biodiesel that were the subject of this investigation.

The results of the current experiment confirmed that neem oil may be used as a source of biodiesel. Neem seed oil and diesel may help to lessen the effects of transportation on the environment and reliance on imported crude oil. Based on a comparison of Pure Diesel and Biodiesel's performance and emission characteristics, conclusions are formed (PD) The best blend is B25.

- Hence As compared to diesel fuel, a blend of 15% 4-allyl-2,6 dimethoxyphenol and neem oil and 75% diesel at Standard injection pressure and temperature and compression ratio are respectively are 200bar, 27btdc and 17.5:1 offers marginally greater performance and lower emissions.
- At the maximum load of 3.5KW, B20 emits 48.2% fewer hydrocarbons than pure diesel.

With a maximum load of 3.5 KW, B20 has a CO emission rate that is 0.133% much low than pure diesel.

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