

**INFLUENCE OF DPPH (2,2-DIPHENYL-1-PICRYRYLHYDRAZIL) ON D.I DIESEL ENGINE
PERFORMANCE AND EMISSION CHARACTERISTICS
USING RUBBER SEED OIL**

**Submitted in partial fulfillment 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 | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

March 2021



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DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **LOGESHWAR. S (37150107)** and **GURUPRAKASH. R (37150067)** who carried out the project entitled “**INFLUENCE OF DPPH (2,2-DIPHENYL -1- PICRYLHYDRAZIL) ON D.I DIESEL ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS**” under supervision from September 2020 to march 2020

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DECLARATION

We **LOGESHWAR. S (37150107)** and **GURUPRAKASH. R (37150067)** hereby declare that the Project report entitled “**INFLUENCE OF DPPH (2,2-DIPHENYL -1-PICRYLHYDRAZIL) ON D.I DIESEL ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS**” 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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I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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

We would like to express our heartfelt gratitude to **Dr. ARUN KUMAR**, Head of Department. We would like to express our gratitude to all teachers and members for providing us with the requisite resources and information at the appropriate times during our project's progressive reviews.

Last but not least, we want to express our sincere gratitude to our loving parents, family members, and friends, who have all helped me finish my project and earn my degree.

ABSTRACT

Bio diesel is an alternative means of fuel, replacing and reducing the use of petroleum diesel. The main obstacle in the practical usage of biodiesel is that its oxidative stability. Even small percentage of biodiesel blend in diesel develops sticky, polymeric deposits which gets stuck in air filter and causes unpleasant problems. One promising way to approach the problem of oxidation in biodiesel is the use of antioxidants. Antioxidants inhibits the oxidation reaction and the formation of the polymeric deposits. There have been numerous studies carried out with some common antioxidants and still there are hundreds of antioxidants yet to be tested. This study involves in exploring the influence of DPPH (2, 2, - Diphenyl -1- Picrylhydrazyl) on the diesel fuel blend consisting of rubber seed oil and neat diesel. Five samples with rubber seed oil bio diesel blends and neat diesel were made to undergo CO, CO₂, HC, O₂, NO_x, Brake thermal efficiency and specific fuel consumption analysis. Certain samples with biodiesel showed better results than the sample with neat diesel

Keywords: *Antioxidant, emission, performance*

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LIST OF ABBREVIATIONS

ANNs	-	Artificial Neural Networks
BHA	-	Butylated Hydroxyanisole
BSFC	-	Brake Specific Fuel Consumption
BTE	-	Brake Thermal Efficiency
BTME	-	Beef Tallow Methyl Ester
C.I	-	Compression Ignition
DLU	-	Dynamometer Loading Unit
FFA	-	Free Fatty Acids
NOx	-	Nitrous Oxide
PPU	-	Piezo Powering Unit
SFC	-	Specific Fuel Consumption
SO ₂	-	Sulfur Dioxide

CHAPTER 1

INTRODUCTION

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 mono alkyl 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 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 (100C 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.

1.2 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.

1.3 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.

As a result of greenhouse effect, environmental pollution the dependence on petroleum-based fuels are decreasing and the demand for an alternative have been significantly increased. Bio diesel seems like a possible replacement for the petroleum diesel. Many researches have shown decrease in the hydrocarbons, CO and smoke density with biodiesel and their blends of diesel fuel. Rubber seed oil is a type of plant oil derived from rubber tree seeds. Rubber seeds have never been obtained and commercialized in the latex manufacturing process.

1.4 RUBBER SEED OIL

Rubber seed oil is a type of plant oil derived from rubber tree seeds. Rubber seeds have never been obtained and commercialized in the latex manufacturing process. According to a recent report, rubber seed oil contains the following fatty acids: 1st [requires citation]

0.2 percent palmitic (C16:0)

8.7% stearic acid (C18:0)

24.6 percent oleic acid (C18:1)

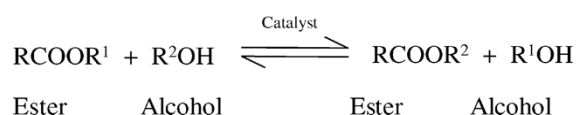
Linoleic acid (C18:2) - 39.6%

Linolenic acid (C18:3) - 16.3%

As a result of greenhouse effect, environmental pollution the dependence on petroleum-based fuels are decreasing and the demand for an alternative have been significantly increased. Bio diesel seems like a possible replacement for the petroleum diesel. Many researches have shown decrease in the hydrocarbons, CO and smoke density with biodiesel and their blends of diesel fuel. Rubber seed oil is a type of plant oil derived from rubber tree seeds. Rubber seeds have never been obtained and commercialized in the latex manufacturing process. In India, the annual rubber seed production potential is about 150 kg per hectare. Rubber seed kernels contain 40–50% of brown color oil. The estimated availability of rubber seeds in India is about 30,000 tons once a year, which may yield rubber seed oil to the tune of about 5000 tons. The Rubber trees yield 3-seeded ellipsoidal capsule, containing seed within each capsule. Capsules are cover the bottom. Kernels are collected by breaking the capsules. These kernels are dried to get rid of the moisture. The kernels are crushed within the crushers and therefore the oil is filtered. As there aren't any many major applications for the rubber seed oil, the seed production is underutilized. The filtered oil is employed as feedstock for the biodiesel production during this study. The vegetable oils produce volatile combustion on heating. Unrefined rubber seed oil contains about 17% of free fatty acid i.e., acid value of 34. The transesterification process considerably decreases the FFA (free fatty acids). The alkaline catalyzed transesterification alone is not suitable for the production of esters from unrefined oils. The oil need to be refined to reduce the acid value. Refining increases the overall production cost of the biodiesel. Acid esterification along with transesterification with alkaline catalyst is the suitable and economical way of producing biodiesel from rubber seed oil. The acid esterification of unrefined rubber seed oil decreases the FFA's present in it.

1.5 TRANS ESTERIFICATION

Transesterification is the process of displacement of alcohol from an ester by another ester. This process is used to reduce the viscosity of triglycerides. Glycerol and alkyl ester are obtained from the transesterification of triglycerides.



The transesterification of the unrefined rubber seed oil involves two esterification process:

- a) Acid esterification
- b) Alkaline esterification

1.5.1 *Acid Esterification*

This process involves in the reduction of the FFA of the crude rubber seed oil using acid catalyst. 200ml of methanol is required for the acid esterification of one litre of rubber seed oil. The rubber seed is heated to about 50°C. The preheated rubber seed oil is mixed methanol and stirred for a few minutes and 0.5% of sulphuric acid is also added with the mixture. At atmospheric temperature the heating and stirring is continued for about 20-30 minutes. The top surface contains the excess alcohol with sulphuric acid which is removed. The lower layer is forwarded to the next process. The Acid esterification reduces the FFA content of the crude rubber seed oil to less than 2%.

1.5.2 *Alkaline Esterification*

After reducing the FFA content the, oil is transesterified to mono esters of fatty acids using acid catalysts. The alcohol to oil ratio, catalyst amount, reaction temperature and duration which affects the process are analyzed. The oil obtained from the acid esterification process is preheated to the temperature of 40-50°C in the flask. 5 gram of NaOH is dissolved in 300ml methanol. Heating and stirring of mixture is continued for about 30 min then the mixture the left alone for the separation of two layers. The lower lawyer contains the impure glycerol and is removed. The upper layer contains the ester. To remove the entrained impurities and glycerol the methyl esters are washed. 10% volume of the hot distilled water is sprayed over the ester and stirred gently. The yellow color layer is removed. This layer is the biodiesel. The alkaline catalyst transesterification process has converted the products of acid esterification to it's mono esters and glycerol.

1.6 DPPH (2,2 - DIPHENYL - 1 - PICRYLHYDRAZIL)

DPPH is a organic chemical compound which is a dark colored powder composed of stable free radical molecules. It has several crystalline forms which differs according to the lattice symmetry and melting point. DPPH is a well known radical and acts as a trap for other radicals. The chemical reaction rate reduction upon the adding of DPPH is used as an indicator for the radical nature of the reaction. It has a strong absorption band at about 520 nm. Though the DPPH is used for the antioxidant assay, the radical inhibiting nature of it makes it as a antioxidant in itself for the biodiesel.

CHAPTER 2

LITERATURE SURVEY

Erol İleri The effect of antioxidants on engine performance and exhaust emissions of a diesel engine fueled with B20 (20 vol. percent canola oil methyl ester and 80 vol. percent diesel fuel blend) was studied in an experimental study. Butylated hydroxyanisole (BHA), butyl BHT, tert-butylhydroquinone (TBHQ), and 2-ethylhexyl nitrate (EHN) were all investigated. On a Land Rover TDI 110 turbocharged direct injection diesel engine with water cooling, 4-cycl and 4-cylinder engine. The addition of antioxidants to B20 had no negative impact on the basic properties of the fuel. B20 is a type of vitamin. According to engine performance test results, B20 with antioxidants had lower brake specific fuel consumption (BSFC) than B20 without antioxidants. When TBHQ concentrations were 1000 ppm, BSFC values were significantly reduced (10.19 percent) across the entire engine speed range. In comparison to B20. The EHN antioxidant with B20 had the lowest mean nitrogen oxides (NOx) with a 4.63 percent reduction However, carbon monoxide (CO) emissions have increased as a result of this. B20 is supplemented with each of the antioxidants.

Mustafa Canak The applicability of Artificial Neural Networks (ANNs) for the performance and exhaust-emission values of a diesel engine fueled with biodiesels from various feedstocks and petroleum diesel fuels was investigated. The characteristics of the engine's performance and emissions biodiesels, and two different petroleum diesel fuels (No. 1 and No. 2) grease), as well as their 20% blends with No. 2 diesel fuel, were used as test results. The fuels were plentiful. The engine torque was 257.6 Nm when tested at full load (100%) at 1400-rpm engine speed. The input layer for training the network is the average molecular weight, net heat of combustion, specific gravity, kinematic viscosity, C/Hratio, and cetane number of each fuel, while the output layer is the average molecular weight, net heat

of combustion, specific gravity, kinematic viscosity, C/Hratio, and cetane number of each fuel. Weights in the network have been used to provide formulations for each and every output. The network has yielded R² values of 0.99 and the mean % errors are smaller than 4.2 for the training data, while the R² values are about 0.99 and the mean % errors are smaller than 5.5 for the test data. The performance and exhaust emissions from a diesel engine, using biodiesel blends with No. 2 diesel fuel up to 20%, have been predicted using the ANN model.

Abdul Monyem Biodiesel is a biofuel made from the alkyl monoesters of fatty acids found in vegetable or animal fats. Biodiesel-fueled engines produce less carbon monoxide, unburned hydrocarbons, and particulate emissions than diesel-fueled engines, according to previous research. Biodiesel has the disadvantage of being more prone to oxidation than petroleum-based diesel. The source of energy This oxidation can cause the fuel to become acidic and form insoluble gums and sediments in its advanced stages. That is capable of plugging fuel 5lters. The goal of this research was to see how 8 aximize biodiesel affected engine performance. As well as emissions. The tests were conducted at a single engine speed of 1400 rpm in steady-state conditions. The engine's efficiency the thermal efficiency of the neat biodiesels and their blends was similar to that of No. 2 diesel fuel, but it was higher. Consumption of fuel. Compared to unoxidized biodiesel, 8aximize neat biodiesel produced 15% and 16% less carbon monoxide and hydrocarbons in the exhaust, respectively. The oxides of nitrogen and smoke emissions from 8aximize and unoxidized biodiesel did not differ statistically significantly.

C. Muraleedharan vegetable oils can cause problems in compression ignition engines when used for long periods of time. Poor atomization, carbon deposits, ring sticking, fuel pump failure, and other issues are common. Changing the high viscosity to a low viscosity. These issues can be mitigated by incorporating vegetable oil into its blends or esters. The various rubber seed blends important properties of oil and diesel were prepared, including viscosity, calorific value, and flash point. The melting point, fire point, and other properties of the fuel were evaluated and compared to those of diesel. The mixtures were then combined. Engine performance and emission tests were conducted, and the results were compared to those of diesel. Rubber seed oil blends containing 50–80 percent

rubber seed oil gave the best results. Long-term tests with an 9aximized blend and diesel were carried out. It was discovered that engines that run on a blend of fuel have more carbon deposits. Compared to a diesel-fueled engine, there is more space inside the combustion chamber. The use of blends necessitates frequent use. Fuel filter, pump, and combustion chamber cleaning As a result, it is suggested that rubber seed be used. Oil–diesel blend fuel is better for generating electricity in rural areas.

K. Varatharajan One of the major issues with using biodiesel is keeping the fuel at specified levels for a longer period of time. Biodiesel is more susceptible to oxidation than mineral diesel, and it begins to go rancid in a week or less, with complete degradation taking four weeks. Oxidation's end products change the environment. Fuel has physical and chemical properties that cause the formation of insoluble gums that can plug fuel injectors. The use of filters Biodiesel instability is a long-standing problem that has yet to be satisfactorily resolved. As because the use of biodiesel has skyrocketed, the oxidation problem could become significant market barrier. To the expansion of the market. The addition of appropriate antioxidants to biodiesel fuels is a very promising and cost-effective way to improve the stability of biodiesel. In different situations, antioxidants perform better or worse. Biodiesel fuels, and no single inhibitor is suitable for all types of biodiesel fuels. To check the antioxidants for a particular biodiesel, it is necessary to understand the chemistry of antioxidants as well as the key properties of antioxidants. Factors that affect their ability to prevent biodiesel oxidation. The majority of the studies that had been published had been. Despite the fact that the study was limited to a few common antioxidants, hundreds of antioxidants are available for testing.

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 Cr_2O_3 +25 percent Al_2O_3 , Al_2O_3 +13 percent TiO_2 , and Cr_2O_3 +25 percent Al_2O_3 . 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 Al_2O_3 +13 percent TiO_2 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 KayaThe 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 11aximized 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. Biodiesel standards ASTM D6751 and EN 14214 were also decided and debated. 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 12aximized12d 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, 12aximized12d lipase, and SC-CO₂ as an example of new technologies reaction media and extraction solvent.

Kazy Fayeem 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, Botroyococcus 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 alkaline catalyzed 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 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

AIM AND SCOPE

3.1 AIM OF THE PROJECT

The Aim of the project is to publish a journal paper on the influence of antioxidant- DPPH (2,2,- diphenyl -1- picrylhydrazyl) on the various diesel engine parameters with various diesel biodiesel blends.

3.2 SCOPE OF THE PROJECT

The Scope of the project is that to provide various information of rubber seed oil biodiesel with neat diesel which helps in future references for the researches in exploiting rubber seed for a possible alternate to the fossil fuels. It also involves in exploring non traditional antioxidant DPPH which may be useful in future researches.

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** shows the photographic view of the experimental set up used in this study.



Fig 4.1 (a)



Fig 4.1 (b)

Figure 4.1 (a) & (b) Photographic View of the Experimental Set Up

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

4.1 ENGINE TESTING SOFTWARE

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

4.1.1 Test Run with Computerized Multi Cylinder Engine Setups

- Ensure that all the nut bolts of engine, dynamometer, propeller shaft, base frame are properly tightened.
- Ensure that sufficient lubrication oil is present in the engine sump tank. This can be checked by marking on the level stick
- Ensure sufficient fuel in fuel tank. Remove air in fuel line, if any.

- Switch on electric supply and ensure that PPU (Piezo powering unit AX-409), DLU (Dynamometer loading unit AX-155), Load indicator and Voltmeter are switched on.
- Start Computer and open “ICEngineSoft” (Double click “ICEngineSoft” icon on the desktop) Select: File| Configure |Product
- In ”Configure the product” window select “Load Default”.
- Under “Select File” choose your Setup from drop down menu
- Under “Set Parameters” study the parameters under Engine, Sensors, Combustion and Performance tabs. Click on “OK”
- Changing the parameters:
- If any parameter is to be changed Click “New/Change”. Change the parameter under respective tabs. After all changes click “Save & Apply”. Click “OK” to save changes.
- Click “OK” again to reconfigure changes.
- Reconfiguring the graphs
- Select File| Configure| Graph.Under “Configure the Graphs” window “Select a Configuration” from the drop down menu.
- Study the present configuration of X axis, Y axis, graph ranges, for the selected graphs. Click “CLOSE & SET”. Configure the necessary parameters, ranges, as required. Click “SAVE” And then “Close & SET”.
- Note three vertical tabs viz. Combustion, Performance, Report. Under vertical Combustion tab horizontally following tabs are available: Combustion, Cylinder Pr., PV, Log PV and RPR etc. Similarly under other vertical tabs we get more horizontal tabs. Start water pump. Adjust the flow rate of “Rotameter (Engine)” to 900- 1000 LPH and “Rotameter (Calorimeter)” to 200-250 LPH by manipulating respective globe valves provided at the rotameter inlet. Ensure that water is flowing through

dynamometer at a pressure of @ 0.5 to 1 Kg/cm². (For Hydraulic dynamometer at a pressure of @ 1.5 to 2 Kg/cm²)

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

4.1.2 Online Data Acquisition

- Click toggle switch to “Mode” 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 @ 2000-2500 RPM.
- Wait for steady state for @ 3 minutes and ensure that RPM & Load is constant during this period. Change the Fuel cock position from “Tank” to “Measuring”. Click “Log on” on. The fuel metering is ON for next 60 seconds. During first 30 seconds enter engine water flow, calorimeter jacket cooling 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 “Measureme” 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.

4.1.3 Smokemeter

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

- Kindly fill the details (Engine No. Model, Engine Type, Engine Speed) in respective text boxes given on the form if you didn't check “Vehicle detail” check box in Master data entry form all the textboxes related to (Engine No. Model, Engine Type, and Engine Speed) become disabled.
- Click on “Connect button” to connect the PC with equipment and wait for 5- 10 seconds. If the readings are not coming it show the message in red colour “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 ith 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 generated path at \AVLFolder’ “C:”. 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.



Figure 4.2 Smoke Meter



Figure 4.3 Linearity Test

4.1.4 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 “CO HC power and 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 generated path \AVLFolder\ file 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

5.1 O₂ EMISSION RESULT ANALYSIS

Table 5.1 O₂ Emission vs Various Engine Loads

BP(KW)	S1	S2	S3	S4	D
0	18.87	18.92	18.93	18.94	18
0.87	17.55	18.16	17.73	17.67	19
1.76	17.01	17.48	17.07	17.09	15
2.62	16.38	16.73	16.5	16.64	12
3.5	16.42	16.17	16.27	16.46	11

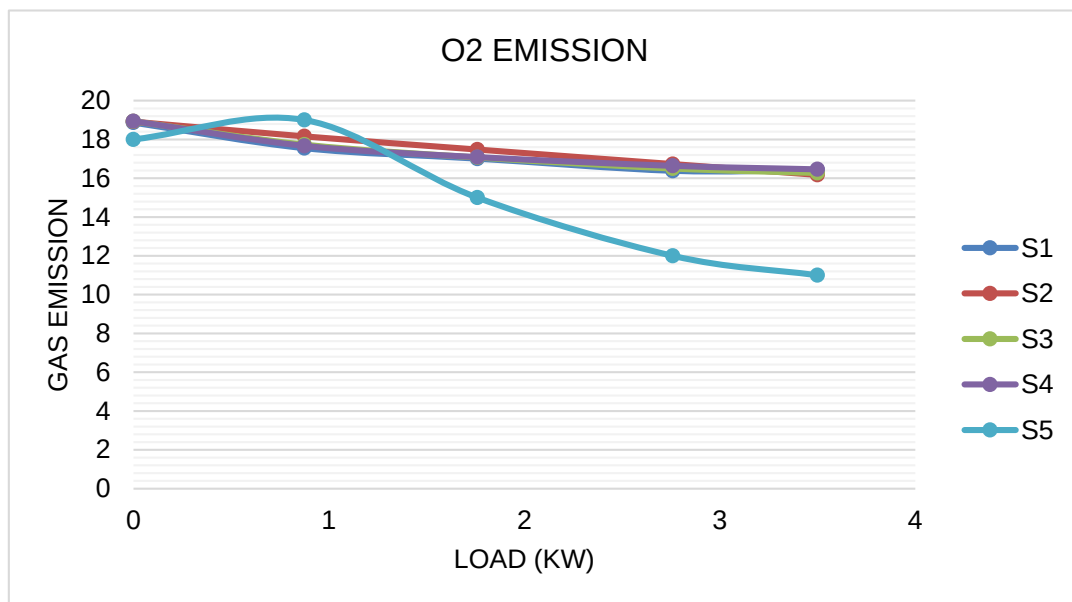


Figure 5.1 O₂ (ppm) vs BP(kw)

The above graph represents the emission of oxygen gas during the combustion of sample fuel and neat diesel. The above sample 1 emits more oxygen for the first three power inputs. The sample 2 also emits a similar level of oxygen content. The oxygen emission from the diesel decreases as the power increases. 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. From the graph the O₂ emissions from all the samples and can be inferred. Although the Sample 5(neat diesel) has the highest amount of O₂ emission at about 2 BP (kw) engine with increasing load the Sample 5(neat diesel) emits less O₂ in relative to other samples. The Sample 2 (20BD+80D) has initial emission level of 18.94 ppm at 1 BP (kw) engine load which almost equal to the Sample 5 at 2 BP (kw). The sample 2(20BD+80D) also high emissions at 3 BP (kw) engine load. Sample 4(40BD+60D) was also close behind Sample 2(20BD+80D) and got a slight edge at 5 BP (kw). Regardless of the percentage of biodiesel in the blend, the samples with biodiesel significantly emits high O₂ in relative to the diesel.

5.2 CO₂ EMISSION RESULT ANALYSIS

Table 5.2 Co₂ Emission vs Various Engine Loads

BP(KW)	S1	S2	S3	S4	D
0	0.029	0.016	0.022	0.039	0.008
0.875	0.032	0.029	0.039	0.046	0.013
1.75	0.048	0.034	0.041	0.054	0.018
2.62	0.064	0.042	0.058	0.061	0.023
3.5	0.074	0.05	0.065	0.078	0.029

The graph indicates the emission of carbon di oxide gas during the combustion of samples and neat diesel. Reducing the carbon emissions is one of the main goal to achieve on a global level to reduce the impact of greenhouse effect and problems arising from it. The carbon emissions cannot be reduced all of a sudden but steps taken towards its reduction may help future breakthroughs. The high CO₂ emission from neat diesel is obviously clear, whereas it's biodiesel mixed counterparts are emitting less CO₂. Sample 3 has the least CO₂ emission. From fig 3.2 CO₂ vs BP the CO₂ emissions from all the samples and can be inferred. The Sample 5 (neat diesel) has the highest CO₂ emission of 3.89 ppm at 3.5 BP (kw) engine load whereas its other counterparts having biodiesel blend has the CO₂ emission at a considerably low rate. The Sample 1 (10BD+90D) has the highest CO₂ emission of 1.86 ppm at 0.875 BP (kw) which is near to the low CO₂ emission of sample 5 (neat diesel) valued at 1.6 ppm. The Sample 2 has the lowest CO₂ emission level till 3.5 BP (kw) engine load whereas at 3.5 BP (kw) the sample 4(40BD+60D) has CO₂ emission of 2.42 ppm which lowest at that engine load.

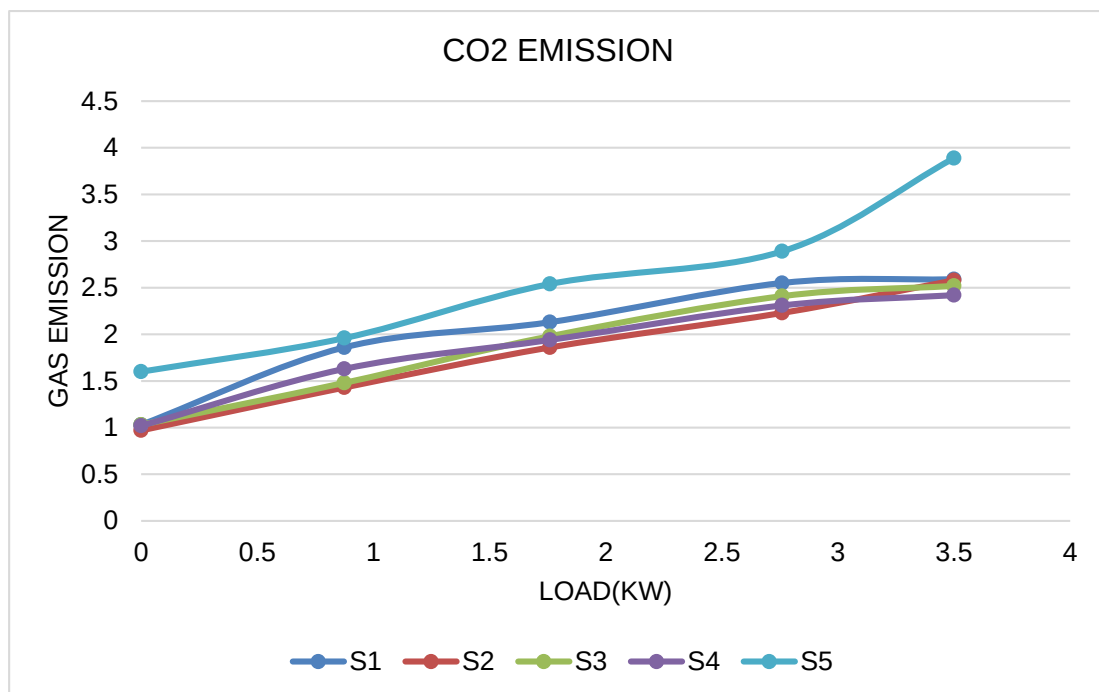


Figure 5.2 Co₂ (ppm) vs BP(kw)

5.3 CO EMISSION RESULT ANALYSIS

Table 5.3 CO Emission vs Engine Load

BP(KW)	S1	S2	S3	S4	D
0	1.03	0.97	1.03	1.02	1.6
0.87	1.86	1.43	1.48	1.63	1.96
1.76	2.13	1.86	1.98	1.94	2.54
2.76	2.55	2.23	2.41	2.31	2.89
3.5	2.59	2.58	2.52	2.42	3.89

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. The Neat diesel emits less CO than the other samples. From fig 3.3 CO vs BP the CO emission levels from biodiesel mixed samples are quite high in relative to the sample with neat diesel.

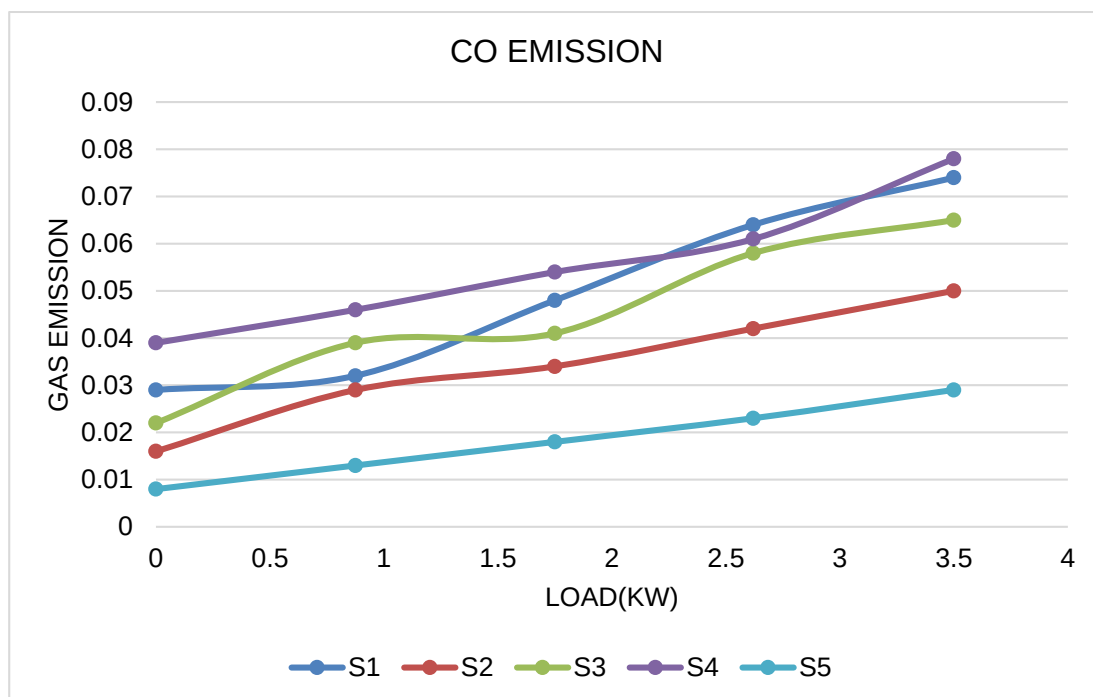


Figure 5.3 CO (ppm) vs BP(kw)

The main reason for this is the oxygen content in the biodiesel. The CO may also rise due to incomplete combustion. The sample 5 (neat diesel) has the lowest CO emission right from the 0 BP (kw) to 3.5 BP (kw) engine load ranging from 0.008-0.0029 ppm. The highest CO emission arise from sample 4 (40BD+60D) at 3.5 BP (kw). The lowest CO emission among the biodiesel is from sample 2 (20BD+80BD) ranging from 0.016 - 0.05 ppm throughout the engine loads.

5.4 HC EMISSION REUSLT ANALYSIS

Table 5.4 HC Emission vs Engine Load

BP(KW)	S1	S2	S3	S4	D
0	3	4	6	8	2
0.875	5	6	8	10	6
1.75	7	8	10	15	10
2.62	10	11	12	17	15
3.5	12	13	16	21	19

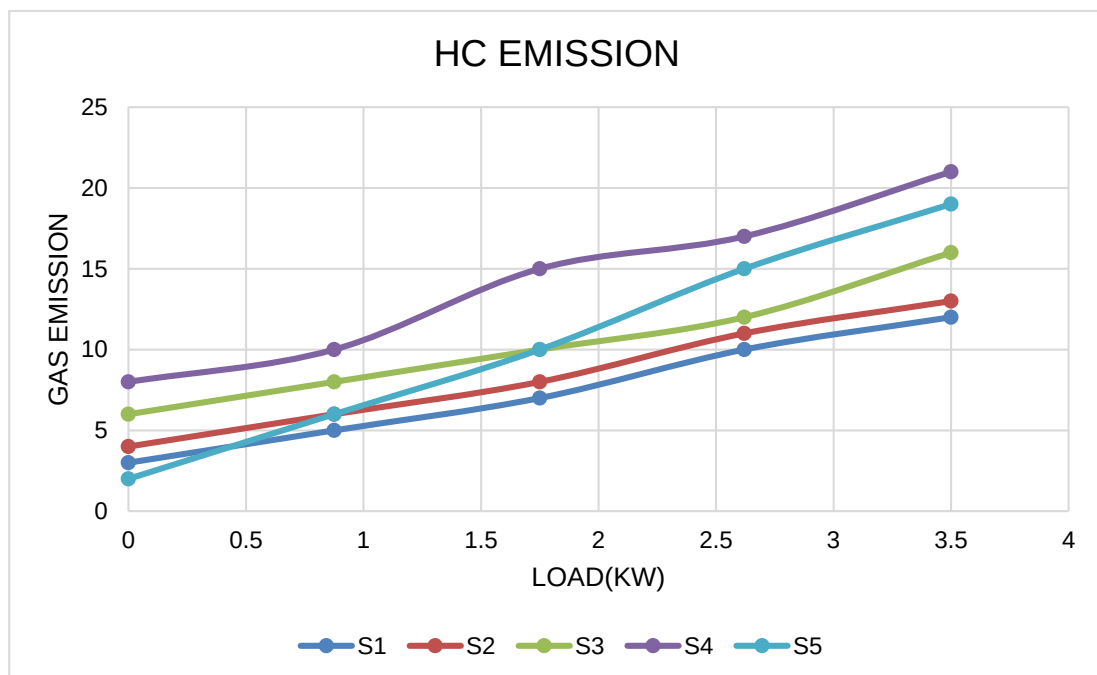


Figure 5.4 HC (ppm) vs BP (kw)

A lack of spark energy can be caused by a variety of ignition defects, such as dirty spark plugs, leaking or open-circuited spark plugs or wires, or defective ignition coils. 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 sample 1 emits less HC in relative to the other samples. From CO vs BP graph the CO emission levels from biodiesel mixed samples are quite high in relative to the sample with neat diesel. The main reason for this is the oxygen content in the biodiesel. The CO may also rise due to incomplete combustion. The sample 5 (neat diesel) has the lowest CO emission right from the 0 BP (kw) to 3.5 BP (kw) engine load ranging from 0.008-0.0029 ppm. The highest CO emission arise from sample 4 (40BD+60D) at 3.5 BP (kw). The lowest CO emission among the biodiesel is from sample 2 (20BD+80BD) ranging from 0.016 - 0.05 ppm throughout the engine loads.

5.5 NOX EMISSION ANALYSIS

The graph represent the emission of NOX gas produces during emission. The reason why NOX emission is bad for 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 (HNO₃) and small particles when it reacts with ammonium (NH₄⁺), water vapour, and other compounds. The Sample 1 by a big difference reduces the emission of NOX and is least among other samples. Sample 2 has similar has similar emission results with slight increment of NOX level.

Table 5.5 NO_x emission vs Engine Load

BP(KW)	S1	S2	S3	S4	S5
0	102	275	470	574	637
0.875	84	171	308	485	656
1.75	78	170	391	501	634
2.62	85	199	322	464	585
3.5	56	156	289	485	750

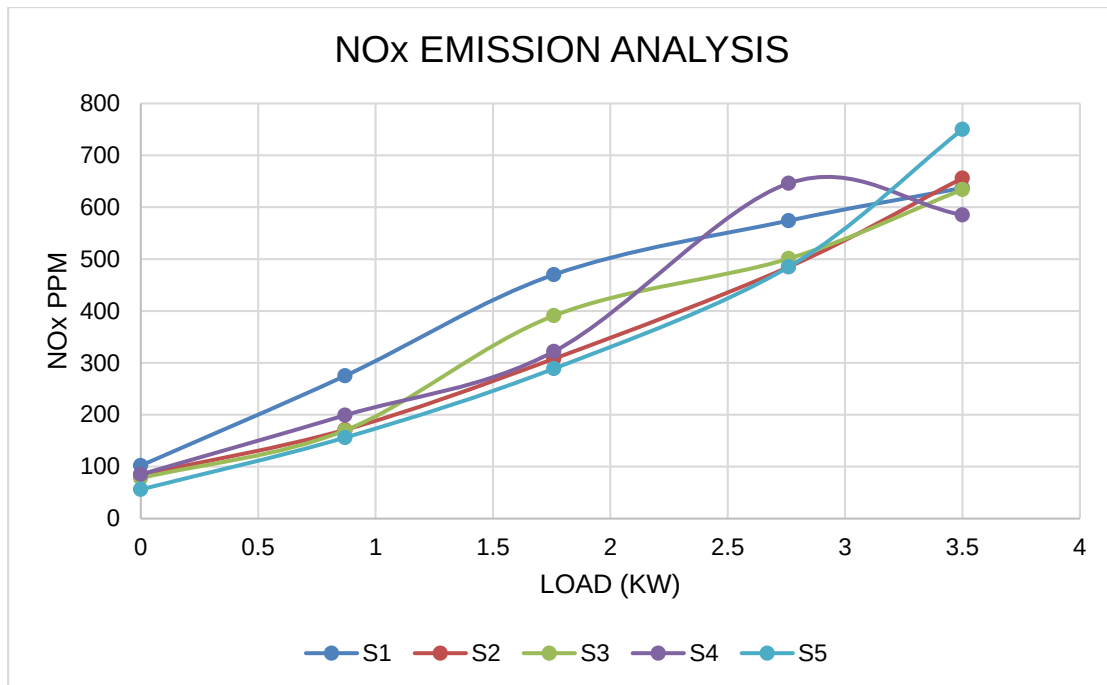


Figure 5.5 NO_x(ppm) vs BP(kw)

From fig 3.5 NO_x vs BP the NO_x emission from various samples have been interpreted. The sample 5 (neat diesel) does quite well than the biodiesel blended samples but reaches a maximum emission value of 750 ppm at 3.5 BP (kw). Most of the samples consisting biodiesel releases higher emission than Sample 5 (neat diesel) except Sample 2 (20BD+80D) which has a curve similar to that of the sample 5 (neat diesel) and has a max emission value of 656 ppm at 3.5 BP (kw) which is lesser than compared to the Sample 5 (neat diesel).

5.6 BRAKE THERMAL EFFICIENCY

Table 5.6 Brake Thermal Efficiency vs Engine Load

BP(KW)	S1	S2	S3	S4	S4
0	1	1.2	1.4	1.01	2.45
0.587	15.78	16.96	17.58	16.2	16.49
1.75	22.5	21.8	23.7	22.1	22.75
2.62	29.7	30.1	27.89	28.3	31.71
3.5	30.25	30.78	31.45	32.2	32.59

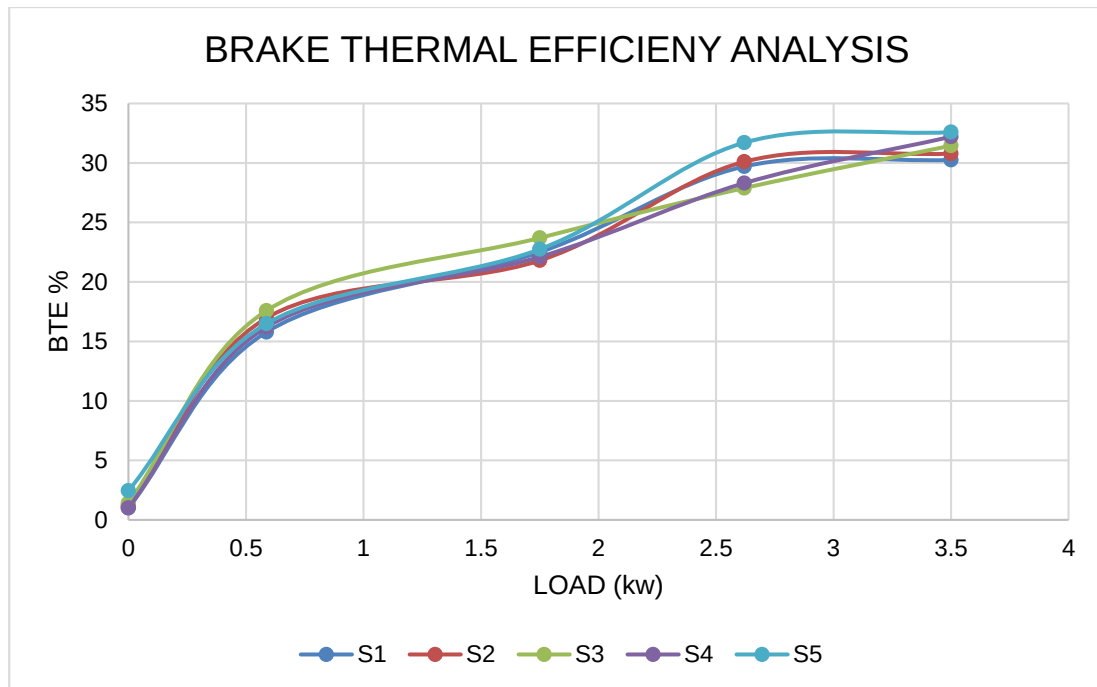


Figure 5.6 BTE(%) vs BP (kw)

The above graph indicates the brake thermal efficiency of a diesel engine using sample fuels and neat diesel. All the sample's performance are similar to that of neat diesel. Overheating, brake fade and brake pad degradation are just a few. Vapour lock and spongy pedal feel are serious brake efficiency issues and here we bring you our in-depth advice. The BTE vs BP (kw) graph shows the brake thermal efficiency (BTE) of the various samples used in the experiment. The sample 5 (neat diesel) and sample 1 (10BD+90D) has similar BTE which the sample 5 (neat diesel) has a slight edge over the other. The Best BTE was achieved by sample 2 (20BD+80D) at 2.62 BP (kw) engine load with the percentage of 30.1%. Even though it reduces to 30.78% when it reaches the engine load of 3.5 BP (kw) it doesn't differ largely from 32.59 which is the efficiency of that of Sample 5 (neat diesel).

5.7 SPECIFIC FUEL CONSUMPTION

Table 5.7: Specific Fuel Consumption vs Engine Load

BP(KW)	S1	S2	S3	S4	D
0	5.4	4.9	5.2	5.1	2.45
0.875	0.59	0.52	0.49	0.56	0.52
1.75	0.38	0.39	0.32	0.36	0.38
2.62	1.78	1.45	1.58	1.69	0.29
3.5	0.89	0.58	0.76	0.85	0.2

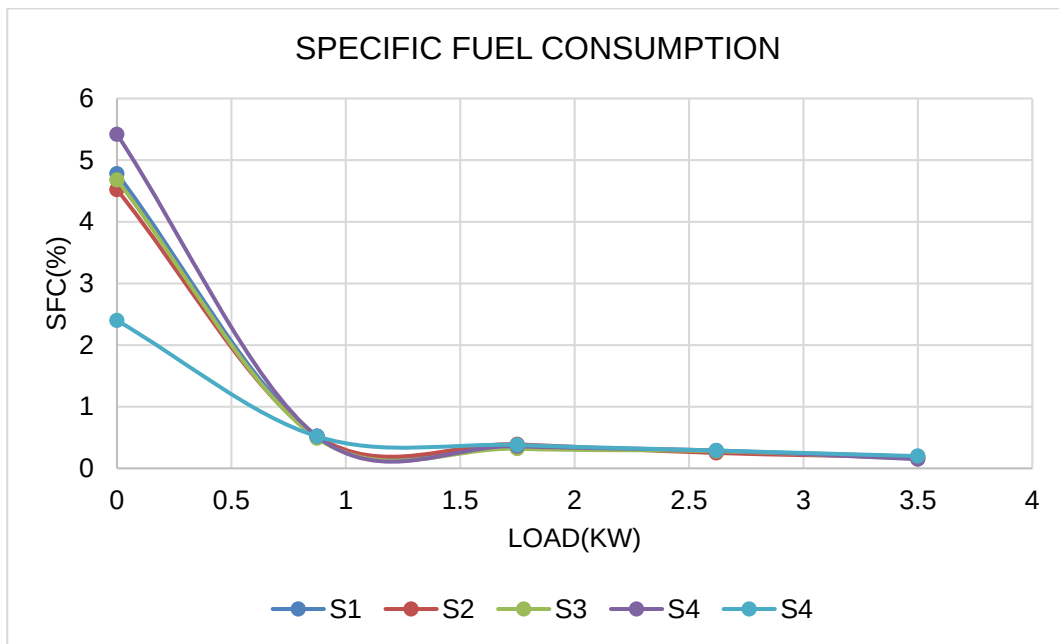


Figure 5.7 SFC(%) vs BP (kw)

The graph indicates the specific fuel consumption of a diesel engine using sample fuels and neat diesel. 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. 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.

The SFC vs BP (kw) shows the specific fuel consumption of the samples used in the experiment. The sample 5 has the lowest value of 2.4 at 0 BP (kw) engine load where the biodiesel samples's sfc percentage is double that of sample 5 (neat diesel). Although the initial specific fuel consumption is high for the biodiesel samples the specific fuel consumption lowers as the engine load increases. The specific fuel consumption of biodiesel samples are similar to that of Sample 5 (neat diesel) ending at a value of 0.2.

CHAPTER 6

CONCLUSION

The main objective of this study is to improve the characteristics of biodiesel by any possible means to replace it instead of conventional diesel. The newly used antioxidant DPPH played a major role in controlling the oxidative reactions taking place in the bio fuel. The formation of polymers would have led to some worst readings in the tests. The biodiesel blended samples performed as equal to the neat diesel and even better. Comprehending the overall test result data, the Sample 2 with 20% rubber seed oil biodiesel and 80% neat diesel with 30ppm of DPPH has the best performance characteristics and emission rates. There were some negatives to work like the high initial SFC in comparison with diesel (Figure 5.7), high CO emission. As the positives sidelining the negatives, rubber seed oil blend with DPPH and many other unexplored antioxidants provides scope for researches.

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