

PERFORMANCE ANALYSIS OF BIOSYNTHESIS CEO₂ ON DIESEL ENGINE, PERFORMANCE USING HYDRO PROCESSED PLASTIC PYROLYSIS OIL (HPPO-M)

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
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SATHYABAMA

**INSTITUTE OF SCIENCE
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(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**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
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OF BIOSYNTHESIS CeO_2 ON DIESEL ENGINE PERFORMANCE USING
HYDRO PROCESSED PLASTIC PYROLYSIS OIL(HPPO-M)" under our
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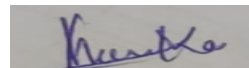
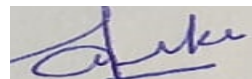
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DECLARATION

We **D.V.S.S.ASHOK VARDHAN** and **Y.MANIKANTA AJAY** hereby declare that the Project Report entitled PERFORMANCE ANALYSIS OF BIOSYNTHESIS CeO_2 ON DIESEL ENGINE PERFORMANCE USING HYDRO PROCESSED PLASTIC PYROLYSIS OIL (HPPO-M) done by me under the guidance of Dr.S.GANESAN at SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI-600119 is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY**.

DATE: 26-04-2023

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ABSTRACT

When the population of the world grows, fossil fuels are supplied less, which makes petrol and diesel smaller. This generation is therefore looking at or pushing towards fossil-fuel alternatives. Many scientists say biodiesel has the same properties as petrol and diesel, Bio fuels help in lessening the reliance on unrefined petroleum and encouraging a cleaner climate. It likewise creates extra pay and work for rustic regions. This won't just assist with meeting India's rustic energy needs yet additionally satisfy the rising requests for transportation. The utilization of carbon energizes will decrease fossil fuel byproducts and meet the energy prerequisites of the 21st century. This paper gives a near benchmark to look at biodiesels with respect to fuel properties, motor execution, and outflow qualities. bio fuel are climate amicable powers and their usage would address worldwide worries about control of fossil fuel byproducts. bio fuel are gotten from inexhaustible bio-mass assets and, in this manner, give a competitive edge to elevate supportable turn of events and to enhance customary energy sources in gathering the quickly expanding necessities for transportation powers related with high financial development, just as in gathering the energy needs of India's tremendous provincial populace. This Experimentalwork investigates the performance analysis of Biosynthesis CeO₂ on Diesel Engine Performance Using Biodiesel. As the power by the diesel engines employed in all the transport and power generation sectors. Biodiesel releases more amounts of gases such as CO, HC, NOX which are harmful for the environment. Engine performance characteristics brake thermal efficiency (BTE), brake-specific fuel consumption (BSFC), and NO_x, CO, HC, and CO₂ emissions have been analysed.

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LIST OF ABBREVIATIONS

- DIESEL ENGINE
- PLASTIC
- PYROLYSIS
- CERIUM OXIDE
- TRANSESTERIFICATION
- BIODIESEL
- EMISSIONS
- BIOSYNTHESIS

CHAPTER – 1

1.1 INTRODUCTION OF BIOFUEL

Diesel engines are extensively used for power generation and transportation sectors across the globe. Despite the high torque capacity, high thermal efficiency, and lower NO_x emissions, they emit high CO, HC, and smoke emissions, which create an immense environmental concern. Ever increasing emission standards around the world have forced the researchers to explore new methods or to improve existing methods to reduce these emissions from diesel engines. Due to the fossil fuel crisis in past decade, mankind has to focus on developing the alternate energy sources such as biomass, hydropower, geothermal energy, wind energy, solar energy, and nuclear energy. The developing of alternative-fuel technologies are investigated to deliver the replacement of fossil fuel. The focused technologies are bioethanol, bio-diesel lipid derived bio-fuel, waste oil recycling, pyrolysis, gasification, dimethyl ether, and biogas. On the other hand, appropriate waste management strategy is another important aspect of sustainable development since waste problem is concerned in every city. Unrefined petroleum is used to make oil-based products that we use to fuel planes, vehicles, and trucks, to heat homes, and to make drugs and plastics. Despite the fact that oil-based commodities save time, finding, creating, and stirring raw petroleum may have an impact on the climate. At the moment, the day's oil provinces are requests at the oil cost populaces increment oil requests are expanded. Oil-based commodities influence the climate and cause dangerous atmospheric deviations. The world's nations are now moving toward elective sources that are sustainable or non-inexhaustible. Many countries are concentrating on biofuels, which are made from waste natural products, vegetable squanders, and vegetable seeds. Biofuels are being considered as generally accessible and least expensive materials for elective energises. Currently, India's oil prices are higher than in other countries, so we are shifting to alternative sources. This Experimental

work says that Biodiesel with biosynthesized CeO₂ nanoparticle can improved combustion when compared to diesel fuel

1.2 BIO FUEL

The bio fuel are environmentally friendly for all nations. They are made from vegetable waste and natural product seeds oils... For a long time, the ready availability of reasonable petrol centre distillate energises provided little incentive to explore different avenues.

In terms of alternative, long-term power sources for diesel engines. The OPEC oil embargo of the 1970s, fuel shortages, and rapidly rising fuel costs rekindled interest in gaining elective powers. Nonetheless, the achievement of oil preservation measures and the genuine possibility.

Bio fuel for diesel engines (i.e., biodiesel) is a promising alternative fuel for diesel engines that can be used after the exhaustion of petrol-powered engines. Bio fuel contains methyl esters and is derived from crude oil. They are derived from a variety of bio-sources, including vegetable oils, used cooking oils, and green growth. Many types of bio fuels can be obtained from crude bio-sources, including Jatropha oil, cottonseed oil, palm oil, used oil oils, used vehicle tyres, coconut oil, soybean oil, rapeseed oil, microalgae, waste creature fat, Crambe oil, elastic seed oil, castor oil, and waste cooking oil. Squander biomass has also been used to produce bio ethanol or bio methane. Bio fills must have specific physical and chemical properties.

In reality, transesterification is the process by which bio fuel is produced from unrefined components. The physical and chemical properties of the bio fuel produced are influenced by the blending temperature and time, as well as the amount of impetus or the type of added substances that may be added to the delivered bio fuel. One distinguishing feature is the stream conduct in terms of fuel thickness at various shear rates (i.e., the overall speed of the oil film between the moving parts). When the fuel is infused into the ignition chamber at high tensions and temperatures, this trademark influences the shower conduct.

Furthermore, bio fuel, like diesel fuel, is dependent on the working temperature for

consistency. Several previous studies anticipated determining the rheological properties of bio fuel derived from vegetable oils. Rheological properties of various bio powers derived from waste cooking oil, castor oil, and elastic seed oil have been studied. They were compared to their crude oils and were also mixed with unadulterated diesel fuel and learned at various temperatures and shear rates. The bio powers are environmentally friendly for all nations and are made from vegetable waste and natural product seeds oils. According to history, Rudolph Diesel, the inventor of the diesel engine, used vegetable oils as a fuel in his engines as early as 1900. For a long time, the ready availability of low-cost oil centre distillate energises provided little impetus to investigate alternative, inexhaustible power sources for diesel engines. The OPEC oil embargo of the 1970s, fuel shortages, and rapidly rising fuel costs rekindled interest in finding alternative fills. Regardless, the achievement of oil preservation measures and the genuine possibility.



Fig 1.1 Plastic Pyrolysis Oil

1.3 PYROLYSIS

Thermal Pyrolysis

It is the process of heating of plastic material in an inert atmosphere, a process that decomposes the organic part of the plastic polymer material and generates liquids and gases that are used as fuels and/or raw materials. This method is suitable for complex polymer waste that contains a number of highly mixed materials and prior

separation step is not needed. Thermal pyrolysis is done at temperatures ranging

between 400 to 800deg shows that fuel oil yield is highest at reaction temperatures between 400 to 450degC.

Catalytic Pyrolysis

It is the process of heating of the material in an inert atmosphere in the presence of catalysts, a process that decomposes organic part of the plastic polymer material and generates liquids and gases that are used as fuels and /or raw materials. This method is done at temperatures ranging between 350 to 550 °C states that the catalytic pyrolysis has following advantages over thermal pyrolysis,

- (a) Reduction of time and temperature of the reaction, with the consequent decrease in energy consumption,
- (b) Better selectivity to desired compounds depending on the characteristics of the catalyst,
- (c) Avoiding the formation of undesired compounds, for example, inhibiting the formation of halogenated compounds from samples containing PVC. had stated the disadvantages of using catalysts as follows

- (a) cost of the catalysts
- (b) recoverability of the catalysts
- (c) reusability of the catalysts.

Catalytic Hydrogenation

Pyrolysis

Experiment using hydrogen atmosphere along with catalytic conversion to increase saturated compounds in resulting fuel oil.

Performance of Thermal Pyrolysis Oil as Fuel in Diesel Engines.

Waste plastic pyrolysis oil obtained from thermal pyrolysis as fuel in diesel engines. The following observation had been given,

- (a) Ignition delay higher
- (b) higher heat release rate
- (c) NO_x higher by 25% at peak loads
- (d) Higher un burnt hydrocarbon and increased smoke levels. Waste plastic pyrolysis oil obtained from thermal pyrolysis. As fuel in marine diesel engines. Delayed ignition, Increased exhaust temperature and there by a 19% Increase in NO_x were observed. Since waste plastic oil has almost almost zero compared to Heavy Fuel Oil used in marine engines carried thermal pyrolysis of waste plastics and

subsequently distillate those to observe better performance as fuel. It is found that increase in NO_x, even in light phase oil. An experiment on waste plastic pyrolysis oil

and used silica as catalyst in the production of waste plastic oil. Waste plastic pyrolysis oil was blended with diesel and used as fuel in diesel engine. The Cylinder peak pressure was found higher along with increased heat release rate.

The ignition delay was found increasing with higher blending ratios.

Performance of Catalytic Pyrolysis Oil as Fuel in Diesel Engines. An attempt using waste HDPE plastic pyrolysis oil obtained from catalytic pyrolysis as fuel, blended with diesel in diesel engines. Catalyst in the experiment. The following observation has been given

(a) NO_x is higher by 30% when compared to diesel fuel at peak loads.

(b) Unburnt hydrocarbons and smoke were observed at higher levels.

Plastics through catalytic pyrolysis was tested as a blend with Ultra Low Sulphur Diesel. Increased PM emissions and decreased NO_x emissions were observed. Better results were attributed to be increased.

CHAPTER – 2

LITERATURE SURVEY

R. Mohsin, Z.A. Majid ¹, A.H. Shihnan, N.S. Nasri, Z. Sharer title as Effect of biodiesel blends on engine performance and exhaust emission for diesel dual fuel engine

This study focused on investigating the exhaust emission and engine operation reliability test on a 6-cylinder, 6278 cc HINO H07C dual fuel engine using CNG and biodiesel fuelling. This test was conducted to discover the improvement of the exhaust emission and engine performance. Several types of emitted pollutant gases had been investigated, including NO_x, carbon monoxide (CO), CO₂, and unburned hydrocarbons (UHC). Meanwhile, the measured parameters to represent the engine performance were engine power and engine torque.

Purnachandran Ramakrishnan^{1,2} & Ramesh Kasimani³ & Mohamed Shameer Peer⁴ & Sakthivel Rajamohan¹ title as Assessment of n-pentanol/Calophyllum inophyllum/diesel blends on the performance, emission, and combustion characteristics of a constant-speed variable compression ratio direct injection diesel engine The performance, emission, and combustion characteristics of the pentanol, biodiesel, and diesel blends in a computerized single-cylinder variable compression ratio DI diesel engine were experimented at constant speed, high load, and varying compression ratio conditions. The results were compared with those of neat diesel fuel and CI20 fuel blend.

Prabhu & M. Venkata Ramanan title as Emission and performance analysis of pentanol/diesel blends in unmodified diesel engine.

The inclusion of pentanol to diesel and its effects on emission and performance parameters have been studied experimentally and compared with neat diesel. The observed details from the experimental work have been summarised here. • Diesel and pentanol blends have higher BTE compared to neat diesel fuel. However, BTE of diesel-pentanol blends is marginally lower than neat diesel at all loads. • The inclusion of pentanol to diesel reduces its energy content and specific fuel

consumption due to its enhanced oxidation effect. • Higher calorific value and the effect of oxidation of pentanol put into augments oxidation capacity of fuel blend and it reduces the NO_x, HC and CO emissions

Obed M. Ali, Rizalman Mamat Title as Improving Engine Performance And Low Temperature Properties Of Blended Palm Biodiesel Using Additives. The world's vast agrarian terrains are not completely benefited. As a result, cultivating should include the production of nonfood items that are appropriate to the climate states of these grounds. This motivates the development of biodiesels as an inexhaustible fuel for the domestic energy market in order to reduce reliance on petroleum derivatives. Biodiesel has gotten a lot of attention from researchers in the last couple of years, with the main motivation being the growing concern about ozone harming substance impacts and ecological guidelines. Numerous exploratory studies are being conducted to assess the impact of various added substances.

Duran Altiparmak , Ali Keskin, Atilla Koca, Metin Gürü Title as Alternative fuel properties of tall oil fatty acid methyl ester-diesel fuel blends. Tall oil methyl ester-diesel fuel blends were investigated as alternative fuels for diesel engines in this study. Tall oil methyl ester was created by optimally reacting tall oil fatty acids with methyl alcohol. Tall oil methyl ester-diesel fuel blends increased engine torque and power output by up to 6.1% and 5.9%, respectively. With the new fuel blends, CO emissions were reduced by 38.9% while NO_x emissions increased by up to 30%. The opacity of the smoke did not vary significantly.

Al-Dawody MF, Jazie AA, Abbas HA. Experimental and simulation study for the effect of waste cooking oil methyl ester blended with diesel fuel on the performance and emissions of diesel engine. Alexandria Eng J 2019.

CHAPTER –

3 AIM AND SCOPE OF WORK

3.1 AIM

The aim of conducting this experimental study performance analysis of biosynthesis CeO_2 on diesel engine performance using hydro processed plastic pyrolysis oil, to prove nanoparticles mixed fuel mixture enhances the performance characteristics and reduce the harmful emissions.

3.2 SCOPE OF WORK

The main Scope of the work to produce and test the obtained Bio diesel from the biosynthesis CeO_2 on the diesel Engine and its performance using hydro processed plastic pyrolysis oil, This Experimental work says that Biodiesel with biosynthesized CeO_2 nanoparticle can improved combustion when compared to Biodiesel fuel.

The bio fuel is experimenting with different mixing proportions as well as the execution of a single chamber diesel engine. The test can be directed with a mixture of diesel and pyrolysis oil. The oil blends contain B10, B20, B25, and B30. The fills are used to reduce the need for diesel. Vegetable oils are widely available in the world and can be used in transportation and vehicles. The dwindling of petroleum derivatives, rising energy demands, and the development of ozone-harming substance discharges all have an impact on the importance of considering biodiesel. Normal diesel energizers are only available in certain parts of the world. All nations are pursuing easily accessible oils for biofuel energy. Biodiesel created by combining liquor with vegetable oil, animal fat, or recycled cooking oils.

CHAPTER – 4

4.1 INVESTIGATION ON A DIESEL ENGINE

Diesel engines are extensively used for power generation and transportation sectors across the globe. Despite the high torque capacity, high thermal efficiency, and lower NO_x emissions, they emit high CO, HC, and smoke emissions, which create an immense environmental concern. Ever increasing emission standards around the world have forced the researchers to explore new methods or to improve existing methods to reduce these emissions from diesel engines.

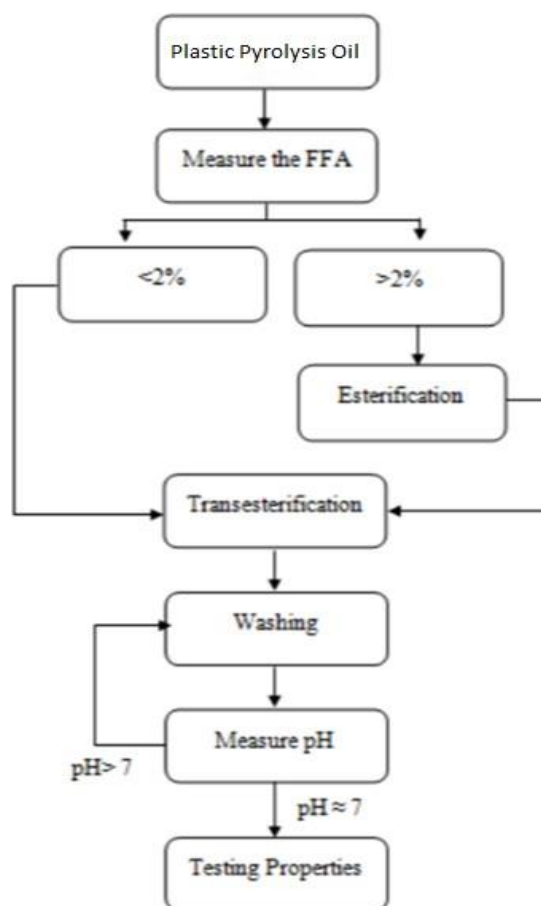
4.2 PREPARATION OF FUEL

The fuel used for the investigation is a bio diesel product. The viscosity, density, and Calorific value of the bio diesel were measured using standard equipment.. The modified fuel was utilized immediately after preparation, in order to avoid any settling or for sedimentation to occur.

4.3 DETERMINATION OF FUEL PROPERTIES

The viscosity, flash and fire points, and the pour and cloud points were measured using standard test methods. The viscosity was measured using the Redwood viscometer. A Cleveland open cup flash and fire point apparatus was used for measuring the flash point, and a standard cloud and pour point apparatus was used for measuring the cloud and pour points

4.4 METHODOLOGY



4.1 Biofuel Extraction process

4.5 TRANSESTERIFICATION PROCESS

The primary goal of the work is to optimise the transesterification process for biodiesel production in order to produce biodiesel with the best properties such

as

viscosity, cetane number, flash point, fire point, and calorific value. Biodiesel was created using jatropha oil (a non-edible vegetable oil). The base fuel for comparing the above properties of biodiesel was conventional diesel fuel. The effect of methanol and sodium hydroxide concentrations, as well as reaction time, were investigated in order to optimise the esterification process. In a twin-cylinder, water-cooled, four-stroke direct injection diesel engine, diesel, biodiesel blends, and neat biodiesel were tested. The engine's performance and emissions with conventional diesel fuel served as the basis for comparison. Viscosity, free fatty acid content, density, water content, etc factors should be checked before using biofuel in the engine because if the water content is high then the engine will get corrosion and high viscosity will affect the injection system and combustion chamber because of gum formation.

The high acidity of fuel also reduces the life of the engine (de Araújo et al., 2013). To avoid these failures several approaches should be used to produce biodiesel from waste cooking oils. Biodiesel of waste cooking oil will extract from used cooking oil by the Transesterification Process to reduce the viscosity of waste cooking oil. In the transesterification process, waste cooking oil will react with ethanol alcohol. In this process, a catalyst should be used because it will improve the reaction rate and yield, as a catalyst Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH) is used to increase reaction speed, increase product weight and increase the yield of the final product. In this process, one mole of triglyceride reacts with three moles of alcohol to produce three moles of mono-alkyl ester and one mole of glycerol. Transesterification is the process by which fats or vegetable oils are transformed into FAME and glycerol at a specific temperature while being in the presence of a specific quantity of alcohol and catalyst. The process is also known as alcoholysis. Transesterification is commonly used to reduce the viscosity during the production of biodiesel. If this FFA value is less than or equal to 2, conduct the transesterification process directly. If not, we must take it into the Esterification process to reduce the FFA content (mg KOH/g) to a value less than or equal to 2. For the production of biodiesel, the transesterification reaction is used using fats or waste/vegetable oils. It is preferred to use a lot of alcohol to increase biodiesel production. The choice of catalysts is crucial since the reaction will result in greater soap formation if an appropriate catalyst with a defined amount is not employed. Different kinds of

catalysts, including acid, base, enzyme, and nanocatalysts, can be utilized in this reaction. Alkali acid and base catalysts can be homogeneous or heterogeneous. The third generation of biodiesel includes WCO. Approximately 30% of the edible oil consumed by each person is wasted.

The yield of biodiesel produced from transesterification reaction is highly influenced by the reaction parameters in order of; catalyst type > catalyst concentration > alcohol to oil molar ratio > reaction pressure and temperature > time of reaction. The physicochemical properties of WCO biodiesel are comparable with conventional diesel. The most effective technology for industrial-scale biodiesel synthesis with a high biodiesel output and low cost is two-step transesterification.



Fig:4.2 Transesterification process

SAMPLE PREPARATION

Sample 1: 90% Diesel + 10% Plastic pyrolysis oil

Sample 2: 80% Diesel + 20% Plastic pyrolysis

oil **Sample 3:** 75% Diesel & 25% Plastic pyrolysis

oil **Sample 4:** 70% Diesel + 30% Plastic pyrolysis

oil

4.6 EXPERIMENTAL WORK

The biodiesel blends were prepared and samples are ready for testing. The samples of biodiesel are connected with venturimeter to diesel pump and testing the fuel to

engine. The testing was conducting and readings are taken for one by one samples.
The emission testing was conducting The engine was conduct on various load tests

and readings are taken. All the readings exports from the system software reading are taken from engine system and gas analyzer meter.

CHAPTER - 5

RESULTS AND DISCUSSIONS

The Plastic Pyrolysis oil biodiesel arranged in the four examples and they were individually filled a compartment which is appended to the venturimeter toward the front of motor siphon. The venturimeter shows the measure of fuel precisely shipped off the motor. The exhaust is connected with smoke meter to get the measure of poisons delivered. The outcomes got from every one of the mix are analyzed in a graphical arrangement



***Fig:5.1: Isopropyl alcohol for
FFA***

The Free Fatty Acid procedure is to take 5gm of Plastic Pyrolysis Oil, 25ml of Isopropyl alcohol, and 4 drops of 0.1 normality NaOH. It should be heated to 60 degrees temperature and allowed the room temperature. After allowing it at room temperature add 2 drops of phenolphthalein indicator and keep stirring, pink color appearance will appear at the endpoint



Fig:5.2 Free Fatty Acid endpoint

Once FFA content reading shows $2\% <$ then it is the Transesterification process For the Transesterification process take 1lt of WCO heated at 60 deg temperature and add methoxide in the ratio of 1:3



Fig:5.3: Methanol

1lt of WCO, 182 ml of methanol, and 5gm of NaOH are the apparatus required for the Transesterification process.



Fig:5.4 Biofuel with glycerol

When it reached 60 degrees temperature we added methoxide maintain it at 60 degrees and allow the time for 90 minutes. Transferring to the separating funnel 2 layers will form



Fig:5.5 Biofuel

The extraction of Biofuel from Waste cooking oil has been extracted with the transesterification process.

CHAPTER – 6

SUMMARY AND CONCLUSIONS

SUMMARY

The transesterification process is successfully completed with positive results

CONCLUSIONS

By using the above process. We can obtain the purest form of biodiesel by using of transesterification process through various temperatures, used to check the performance of engine.

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