

**EFFECT OF NANO ADDITIVE ADDITION ON THE
PERFORMANCE AND EMISSION CHARECTERISTICS
OF CI ENGINE OPERATED WITH USED COOKING
OIL BASED BIO DIESEL**

Submitted in partial fulfillment of the requirements for the award of

**Bachelor of Engineering Degree in
Mechanical Engineering**

BY

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ARJUN P (38150015)**, and **JAYASURYA J (38150041)** who carried out the project entitled **"EFFECT OF NANO ADDITIVE ADDITION ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF CI ENGINE OPERATED WITH USED COOKING OIL BASED BIO DIESEL"** under my supervision from 01.11.2021 to 10.05.2022.

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We **ARJUN P (38150015)** and **JAYASURYA J (38150041)** hereby declare that the Project Report entitled "**EFFECT OF NANO ADDITIVE ADDITION ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF CI ENGINE OPERATED WITH USED COOKING OIL BASED BIO DIESEL**" done by me under the guidance of **Mr. S. VENKATESH, M.E., (Ph.D.,)** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering in Mechanical Engineering.

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ABSTRACT

Biofuel can replace petroleum energy, reduce poisonous emigrations, also restrain the life cycle emigration of CO. In the present study, the use of biodiesel as an indispensable diesel machine energy is adding fleetly. Still, due to specialized scarcities, they're infrequently used purely or with high probabilities in unmodified diesel machines. In the performance, emigration and combustion of a CI machine is experimentally studied. The set mix can be used in a CI machine by pre-mixed ignition for perfecting the performance and combustion characteristics. Identification of next generation biodiesel like pentanol has emerged as an appropriate answer to accumulated demand for alternate fuel of energy. The current work deals with the impact of pentanol addition at completely different concentrations with vegetable oil biodiesel on performance and emission characteristics of diesel engines. The experiments were conducted in an exceedingly single cylinder, water cooled direct injection diesel motor fuelled with vegetable oil biodiesel blends along side pentanol addition of 100 percent and two hundredth by volume. The brake thermal potency was found to be accumulated and brake specific fuel consumption belittled with pentanol addition to vegetable oil biodiesel. moreover, the diesel motor fuel with ventilated fuel blends reduced the CO, HC, smoke emission along side Roman deity emission and EGT because of the upper heat of transformation of vaporization of pentanol and increase in CO₂.

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LIST OF ABBREVIATIONS

Al ₂ O ₃	-	Aluminum oxide nanoparticle
ASTM	-	American Society for Testing and Accoutrements
BMEP	-	Boscage Mean Effective Pressure\
BSEC	-	Brake Specific Energy Consumption
BTE	-	Brake Thermal Effectiveness
CI	-	Compression Ignition
CN	-	Cetane Variety
CO	-	Carbon monoxide
CO ₂	-	Carbon dioxide
DAS	-	Data Acquisition System
DI	-	Direct Injection
FAME	-	Fatty Acid Methyl Ester
FFA	-	Free Fatty Acid
FTIR	-	Fourier Transform Infra-Red
GC	-	Gas Chromatography
HC	-	Hydrocarbon
HRR	-	Heat Release Rate
ID	-	Ignition delay
MFB	-	Mass Fraction burnt
N ₂	-	Nitrogen
NO _x	-	Oxides of Nitrogen
O ₂	-	Oxygen
PBD	-	Palm Biodiesel
POME	-	Pongamia Oil Methyl Ester
RFS	-	Renewable Energy Standard
RMS	-	Root mean square
SEM	-	Scanning Electron Microscope
SFC	-	Specific Energy Consumption
TEM	-	Transmission Electron Microscope
TRCC	-	Toroidal Re-entrant Combustion Chamber
ULSD	-	Ultra Low Sulfur Diesel
WCO	-	Waste Cooking Oil

CHAPTER 1

INTRODUCTION

1.1. BASE FUEL AND BASE ALCOHOL

Biodiesel may be a renewable, perishable fuel manufactured in the United States from edible fat, animal fats, or recycled edifice grease. A base derived from the triglycerides of edible fat that is being considered as the primary feedstock for biodiesel production. It meets the renewable fuel standard's biomass-based diesel and overall advanced biofuel demand. It replaces a portion of the organic compound oil import and reduces the cost of waste management. One of the most important raw materials required for the production of biodiesel is alcohol. Before adding the oil, the alcohol is mixed with the catalyst. Primary and secondary monohydric open chain alcohols with 1-8 carbon atoms are squarely measured as alcohols. A wide range of alcohols are being investigated for biodiesel production, with the most commonly used acyl group acceptors being alcohol, ethanol, propanol, butanol, alcohol, feet-butanol, and pentanol branched alcohols. In addition to its reaction with triglycerides, alcohol is frequently simply dissolved in NaOH. NaOH is a catalyst used in the transesterification of triglycerides with alcohol for the production of diesel.

1.2. NANO PARTICLE WITH CONSTRUCTION

Nanoparticles are frequently used as catalysts in the production of biofuels, from feedstock pretreatment to chemical change. The overall results revealed that adding nanoparticles resulted in a significant reduction in brake specific fuel consumption ranging from one-hundredth to one-twentieth when compared to biodiesel–diesel blends with and without alcohol as additives. Furthermore, because nanoparticles have a high thermal physical phenomenon, the addition of nanoparticles increased the method of combustion and will increase the brake power by 2.5% to 4%. Emission results revealed that in most studies, NO_x emissions are increased by up to one-fifth, whereas HC, CO, and PM are reduced significantly. According to the findings of the study, a diesel engine can be run efficiently and with greater

performance. They effectively control emissions when using additional nanoparticles with biodiesel and their blends as fuel in a CI engine. Metal nanoparticles (Fe, Al, Mg, Mn, Ag, Au, Cu, B, Si, and so on), gilded oxides (Al₂O₃, Co₃O₄, CeO₂, TiO₂, ZnO, CuO, and so on), and gilded combos (Mg–Al, Carbon nanotubes (CNT)) Area unit used as an additive chemical in the production of biofuel. This utilisation is used to improve the physiochemical properties and performance of fuel..

1.3. FOSSIL FUEL DEPLETION

In contrast to fossil fuels, which are finite resources, biofuels are produced from renewable raw materials. As a result, their product and use could, in theory, be sustained indefinitely. While GHG emissions from biodiesels occur at several stages of the process, the EPA's (2010) analysis of the Renewable Energy Standard (RFS) predicted that several types of biodiesels could produce lower lifecycle GHG emissions than gasoline over a 30-year time horizon. Academic studies using other profitable models have also found that biodiesels can lead to lower lifecycle GHG emissions when compared to conventional energy sources. Second and third generation biofuels have a significant implicit reduction in GHG emissions when compared to conventional energies because raw materials can be produced on marginal land. Biofuels can be produced in the United States, potentially reducing the need for imported fossil fuels. However, if biodiesel product and use reduces our consumption of imported reactionary energies, we may become less vulnerable to the negative effects of force dislocations. Reducing our demand for petroleum may result in lower prices, generating profitable benefits for American users services while potentially increasing petroleum consumption abroad. Some contaminant emissions may be reduced by using biodiesels. Pentanol, in particular, has the ability to ensure complete combustion, lowering nitrogen oxide emissions. It is important to note that biodiesel production and consumption will not reduce GHG or conventional contaminant emissions, reduce petroleum significances, or relieve pressure on finite coffers. For these benefits to accrue, biodiesel product and use must coincide with reductions in product and use of fossil fuels. These advantages would be enhanced if biodiesel emigrations and resource demands augmented, rather than replaced, those of fossil fuels.

1.4 ALTERNATE FUEL BIODIESEL 1ST & 2ND GENERATIO

1.4.1 First-generation Biofuels

Pentanol and biodiesel are examples of first-generation biofuels that are closely related to a biofuel that is frequently edible. Pentanol is typically produced by fermenting C6 sugars (mostly glucose) with traditional or genetically modified yeast strains such as *Saccharomyces cerevisiae*. Only a few different feedstocks, primarily sugarcane or corn, are used to produce first-generation biopentanol. Other marginal feedstocks used or considered for first-generation biopentanol production include, but are not limited to, whey, barley, potato wastes, and sugarbeets. Sugarcane is a common feedstock for biomass production, with Brazil being one of the most prominent users. The process for producing pentanol from sugarcane is relatively simple. Sugarcane is crushed in water to extract sucrose, which is then purified to produce either raw sugar or pentanol. Corn is the other major source of carbohydrates for pentanol production, but unlike sugarcane, corn requires a preliminary hydrolysis of starch to liberate sugars that can then be fermented to pentanol. Depending on process efficiency, the corn market value will result in the production of 400 to 450 L of pentanol. Furthermore, the value of by-products, such as post-distillation spent grain used for livestock feed, is a net asset for the process's overall economic balance.

1.4.2 Second Generation Biofuel

Second-generation biodiesel is made from different raw materials, which may necessitate the use of different technology to extract useful energy from them. Lignocellulosic biofuel or woody crops, agricultural residues or waste, and dedicated non-food energy crops grown on marginal land unsuitable for food production are examples of second generation raw materials to supply. The term "second-generation biodiesel" is used loosely to describe both the "advanced" technology used to process feedstocks into biofuel, as well as the use of non-food crops, biofuel, and waste cooking oil as feedstocks in "standard" biofuels processing technologies when appropriate. This causes a great deal of consternation. Therefore it is important to distinguish between second-generation feedstocks and second-generation biodiesel processing technologies. The development of second-

generation biodiesel has seen a stimulus since the food vs. fuel dilemma regarding the risk of diverting farmland or crops for biodiesel production to the detriment of food supply. The biomass and food price debate involves wide-ranging views, and is a long-standing, controversial one in the writing.

1.5 TRANSESTERIFICATION

1.5.1 Preparation of Biodiesel

Transesterification is a process that uses methanol (CH_3OH) in the presence of a catalyst (Potassium hydroxide KOH) to chemically break down the molecule of raw oil into ester and glycerol. This method involves reacting the oil with an alcohol to remove the glycerin, which is a byproduct of biodiesel production.

1.5.2 Procedure for Transesterification

The steps taken are as follows: A container is filled with 1000 ml of Mahua oil. Weighing 18 grammes of potassium hydroxide alkaline catalyst (KOH). In the beaker, 300 mL of methanol is taken. KOH is combined with alcohol and stirred until completely dissolved. When the temperature of the raw Mahua oil reaches 60°C , the KOH -alcohol solution is poured into the raw oil container and the container is tightly sealed with an airtight lid. The solution is now being stirred at high speeds (720 rpm). It is important to keep the temperature below 60°C because methanol evaporates at temperatures above 60°C . Also, because heat is generated when KOH and alcohol are mixed together, the KOH -alcohol solution is only mixed with the raw oil at 60°C . After two hours of stirring at 60°C , the oil- KOH -alcohol solution is transferred to a glass container. Now, separation occurs, with biodiesel collecting in the upper portion of the glass container and glycerin collecting in the lower portion. This glycerin is extracted from its container. The biodiesel is then washed with water. Glycerin is separated from the biodiesel once more and removed. The biodiesel is washed with water several times until there is no glycerin left in it. This biodiesel is now heated to 100°C in order to vaporise the water content in it.

CHAPTER 2

LITERATURE SURVEY

Biodiesel is commonly referred to as vegetable canvas-based energy with low levels of adulterants. Biodiesel is produced from unctuous shops (similar to waste cuisine fat), animal fats, vegetable wastes, and so on. It produces less hothouse gas, nitroxide, and carbon monoxide. When compared to gasoline and diesel, biodiesel frequently saves money and improves performance. Alcohols such as methyl alcohol, ethanol, propanol, pentanol, and butyl alcohol are the most commonly used alcohols for automotive energy. Although the high volatility, low viscousness, and high O content of short-chain alcohols may improve spray performance and emigrations, numerous disadvantages such as high heat of metamorphism of vaporisation, low heating price, and low cetane variety (CN) result in lower proportion operations in contraction ignition (CI) machines. As a result, the use of upper alcohol or long-chain alcohols mixed with diesel canvas has recently received a lot of attention as alternative energies for diesel engines. The term "advanced alcohol" is sometimes used to refer to a group of straight-chain alcohols with four or more carbon tittles. Among many advanced alcohols, pentanol isomers have recently received special attention as alternative energies for diesel engines because they emit lower hothouse feasts and dangerous adulterants. Although propyl alcohol (C_3H_7OH) cannot be considered a better alcohol, it was included in the use of advanced-alcohol biofuels in diesel engines because it is used as a detergent. Alcohol use in diesel engines was primarily discussed, and pentanol and other advanced alcohols in diesel engines were briefly introduced. Sarathy evaluated the feasibility of using alcohol, pentanol, and octanol as energy sources for burning machines. Nonetheless, only two machine studies with n-pentanol as a diesel canvas cover for CI machines had been introduced. It is also possible to achieve advanced CI machines by using neat alcohol or pentanol beneath high in CI machines. Zaharin also reviewed the effects of various alcohols as a cumulative in biodiesel/diesel composites on diesel performance, combustion, and emigration characteristics. The presence of O in alcohol energy promotes a lot of complete combustion.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

The main objective of the project of analysis on the impact of biodiesel–pentanol–diesel fuel on the performance and emissions of a diesel engine.

3.2 SCOPE

Pentanol fuel is broadly utilized in gas motors in numerous nations, like Brazil, the United States, and China. Because of the physical and synthetic properties of diesel and pentanol are unique, pentanol and diesel are inadequately miscible, their blend is temperamental, and delamination might be brought about by a limited quantity of water converged in the diesel-pentanol blend. In this way, the use of pentanol fuel utilizing in the diesel motor is as yet in the exploration stage, and there have been no huge scope business applications (Hansen, Zhang, and Lyne 2005; Rakopoulos et al. 2008). Noboru Noguchi, Terao, and Sakata (1996) fostered a double fuel farm vehicle motor that was furnished with an electronic control framework to control the stream paces of diesel and liquor powers, also, examined the impacts of the infusion timing and stream control arrangement of a fuel infusion siphon on ignition and execution. (2001) chose two natural specialists for a diesel-pentanol combination fuel and concentrated on the physical and synthetic boundaries of the blend, such as consistency, cetane number, heat content, unpredictability, homogeneity, lowtemperature properties, and consumption opposition. The exhibition effects of combinations having various extents with and without added substances were analyzed for an immediate diesel motor and roundabout infusion diesel motor. (2006) concentrated on the impacts of ether added substances (ETBE and TAAE) in diesel mixes and ether/pentanol/diesel mixes on their physical and synthetic properties and motor execution by motor testing. Their outcomes showed that the ETBE and TAAE ethers went about as co solvents of pentanol in diesel, and 5% of TAAE/pentanol/diesel showed good consequences of the physical and synthetic properties and motor warm proficiency. They showed that the ethanol/diesel fuel

with ETBE fundamentally modified the qualities of instability (i.e., streak point and refining bend), decreased the cetane number, and corrupted fuel execution in motor tests. (2012).concentrated on the emulsification execution and solidness of a solitary and blended emulsifiers and the impacts of temperature on emulsification properties in ethanol-diesel mixes as indicated by the hypothesis of "hydrophiliclipophilic equilibrium (HLB)" and an emulsification rule. A blended emulsifier named "CLZ" was created in view of biofuel and castor oil, and the CLZ had the option to keep its physical security inside a wide scope of temperature. Their diesel motor test showed that the utilization of anol-diesel mixes with CLZ further developed motor warm productivity and diminished comparable brake explicit fuel utilization (BSFC). The smoke discharge was diminished altogether, and the NO_x emanation was decreased marginally, while the THC discharge expanded, and the CO emanation expanded at light loads furthermore, diminished at weighty burdens.

CHAPTER 4

ENGINE

4.1 ENGINE TESTING AND ANALYSIS

The system consists of a single-cylinder, four-stroke diesel engine coupled to an eddy current type dynamometer for loading. It is outfitted with the necessary instruments for measuring combustion pressure and crankangle. For PV diagrams, these signals are interfaced to the computer via the engine indicator. There is also provision for integrating airflow, fuel flow, temperature, and load measurement. The setup includes a stand-alone panel box that houses an air box, a fuel tank, a manometer, a fuel measuring unit, transmitters for measuring air and fuel flow, a process indicator, and an engine indicator. Cooling water and calorimeter water flow are measured using rota metres. For performance evaluation, the setup enables the study of engine performance-based Analysis software package "Engine soft" is provided. Optionally, a computerized Diesel injection pressure measurement is provided.

4.1.1 *Load Condition Process*

Biodiesel is already a viable option for addressing the transportation sector's current reliance on fossil fuels while minimizing its negative potential environmental impact, particularly GHG and different waste product emissions because it is dioxide and stuff. In terms of assembly processes, the vast majority of production units currently in operation, or under construction, use the alkali homogeneous catalyzed method, which operates in batch mode and takes a long time to ensure complete reactant conversion. On the horizon, it's anticipated that the biodiesel production method will be further integrated into an ever-increasingly bio-based economy. Biomass conversion processes are increasingly being used to produce fuels, electricity, and all of the chemicals required for current and future generations.

4.2 ENGINE DETAILS

The specifications of the engine that was used to carry out the various test are mentioned in the Table 4.1.

Table 4.1: Engine specifications

Cooling	Water-Cooled Engine
Model	Kirloskar TV1
No. of Cylinders	1
Cubic Capacity (litre)	0.661
Rated Speed (rpm)	1500
Governing	Class"A2 / B1"
Power	5.20Kw
Power rating	7 hp.
Cylinder Bore	87.50 mm
Stroke Length	110.00 mm
Connecting Rod Length	234 mm
Compression Ratio	17.50
Swept Volume	661.45 cc
Overall Dimensions	Width 2000 x Length 2500 x Height 1500 mm

4.2.1 Engine Specification

To use the load, the standard ICE includes a swing field electrical steam-powered eddy current measuring system. The combustion chamber pressure variation was measured using an AVL Pressure electrical device GH14D/AH01, which has a sensitivity of 18.99 pC/bar, dimensionality of 0.3 percent, a live vary of 250 bar, a temperature vary of 400 C, and a natural frequency of 115 kilocycle per second and is mounted on the plate. The outputs of the charge electronic equipment and the encoder were connected to an AVL INDIMICRA 602- T10602A, which converts

analogue input to digital output, and software system version V2.5 for knowledge acquisition system was used to analyse the output knowledge. The change in generated pressure crank angle and warmth unleash rate at each crank angle will be analysed and recorded.

4.2.2 Combustion Parameters

The combustion parameters of the engine are mentioned in Table 4.2.2.

Table 4.2: Combustion Parameters

The Specific Gas Constant (kJ/kgK)	1.00
Air density (kg/m ³)	1.17
Adiabatic Index	1.41
Polytrophic Index	1.09
Cycles	10
Cylinder Pressure Reference	6
Smoothing	2
TDC Reference	2

4.2.3 Performance Parameters

The performance parameters of the engine are mentioned in Table 4.3.

Table 4.3: Performance parameters

Orifice Diameter (mm)	20.00
Orifice Coefficient of Discharge	0.60
Dynamometer Arm Length (mm)	185
Fuel Pipe (mm)	12.40
Ambient Temperature (°C)	27

Pulses Per Revolution	360
Fuel Type	Diesel

4.2.4 Performance Characteristics

The goal is to demonstrate the parcels, machine performance, and emigration characteristics of biodiesel – diesel composites used in CI machines under various conditions around the world, as well as the environmental and financial impacts of biodiesel product. Due to the global reactionary energy extremism and emigration issues, biodiesels are gaining importance as a promising indispensable energy resource. According to the findings of the investigation, composites containing up to 30 percent biodiesel have nearly the same parcels as diesel. Maximum investigation results show that, when compared to diesel, biodiesel – diesel mix has a shorter ignition detention and a lower heat release rate, as well as a slightly advanced effectiveness by immolating a small quantum of energy. The next parameter that will indicate whether or not a machine is performing well is machine performance.

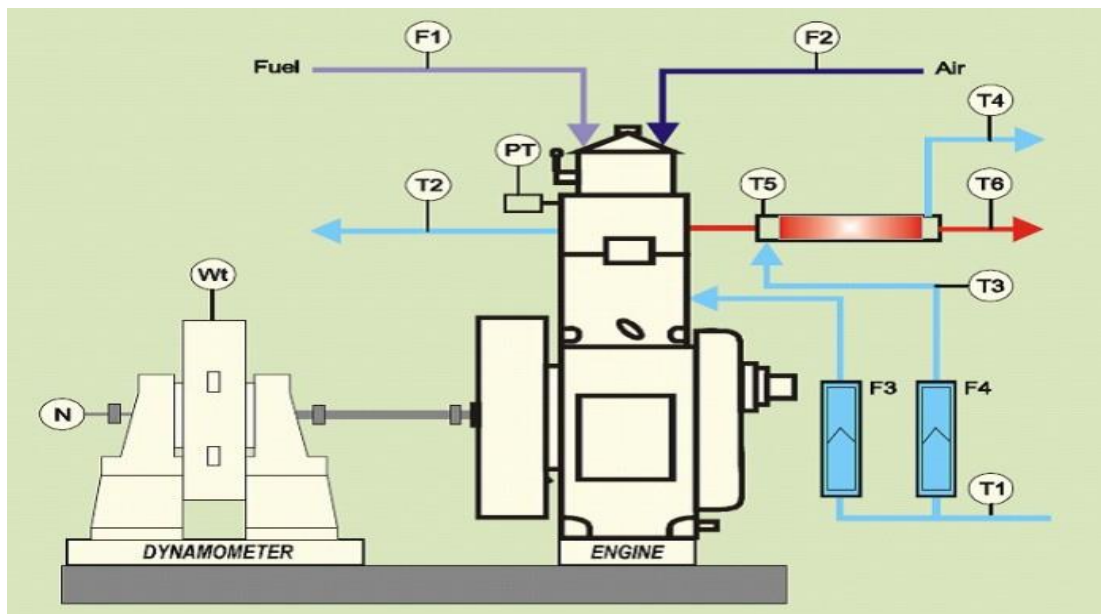


Fig. 4.1: Schematic Diagram of Compression Ignition engine used

CHAPTER 5

PROJECT TABLE AND GRAPHS

5.1 PERFORMANCE GRAPHS AND TABLE

5.1.1 Exhaust Gas Temperature

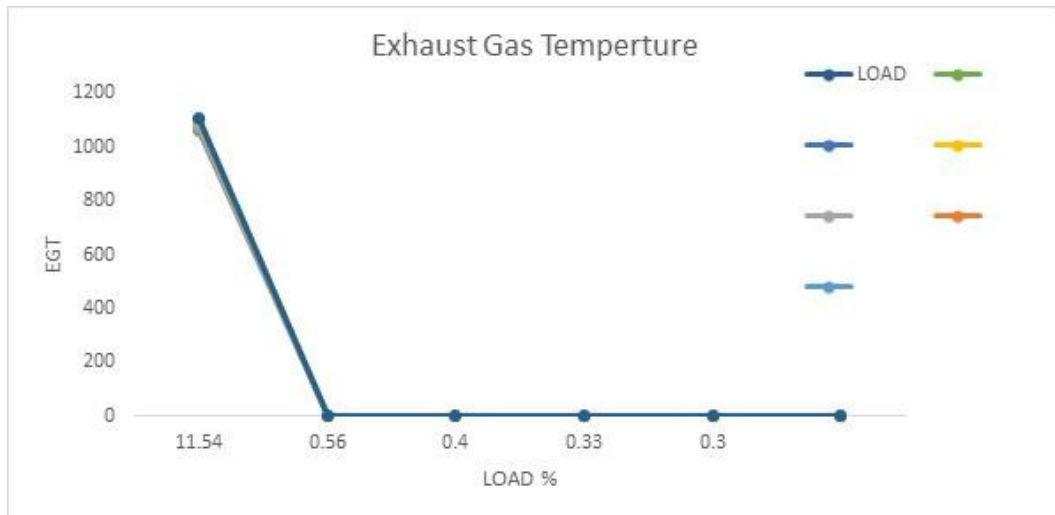


Fig. 5.1: Exhaust Gas Temperature

Table 5.1: Exhaust Gas Temperature

LOAD	DIESEL	B2020	B2023	B2026	B2020* AL2O3	B2023* AL2O3	B2026* AL2O3
0	104.69	119.5	110.07	154.14	128.21	135.27	131.85
25	165.03	173.54	163.19	186.52	170.2	174.79	168.54
50	213.97	212.39	208.84	224.79	213.9	216.4	216.3
75	270.7	263.79	263.57	267.87	257.84	271.78	264.48
100	342.63	331.69	352.46	316	314.74	324.11	316.56

An exhaust gas temperature gauge is a meter used to monitor the exhaust gas temperature of a internal combustion engine in conjunction with a thermocouple type pyrometer. EGT gauges are found in certain cars and aero

planes. Generally, temperatures of 500-700 degree Celsius are produced in the exhaust gases from diesel cycle engines at 100% load to 200-300 degree Celsius with no load. It normally discharges at a temperature of around 420 degrees Celsius. From our current experiment we can observe that EGT is high with the particular calculations from the table.

5.1.2 Volumetric Efficiency

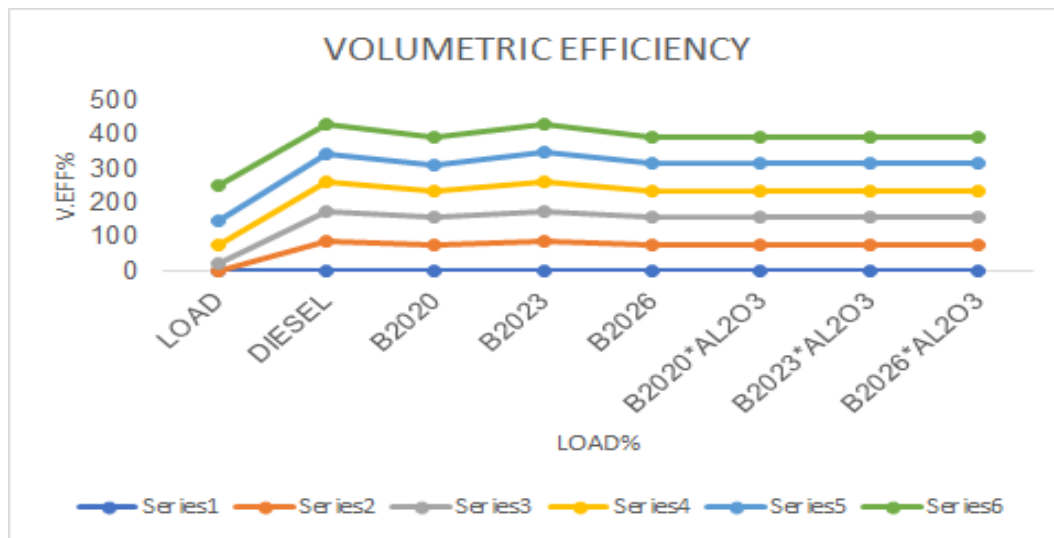


Fig. 5.2: Volumetric Efficiency

Table 5.2: Volumetric Efficiency

LOAD	DIESEL	B2020	B2023	B2026	B2020* AL2O3	B2023* AL2O3	B2026* AL2O3
0	87.27	78.45	87.6	78.85	78.69	78.93	78.49
25	86.56	78.28	86.41	78.36	78.34	78.47	78.43
50	85.53	77.91	86.06	78.25	78.21	78.08	78.38
75	84.7	78	85.27	77.96	78.1	78.08	78.34
100	83.31	77.7	83.72	77.75	77.94	78.06	77.91

Volumetric efficiency is the ratio of fluid actually displaced by a piston or plunger to its swept volume. It is an internal combustion engine engineering is

defined as the ratio of the mass density of the air- fuel mixture drawn into the cylinder at atmospheric pressure to the mass density of the same volume of air in the intake manifold. From our experiment we can conclude that volumetric efficiency is steadily increased.

5.1.3 Specific Fuel Consumption

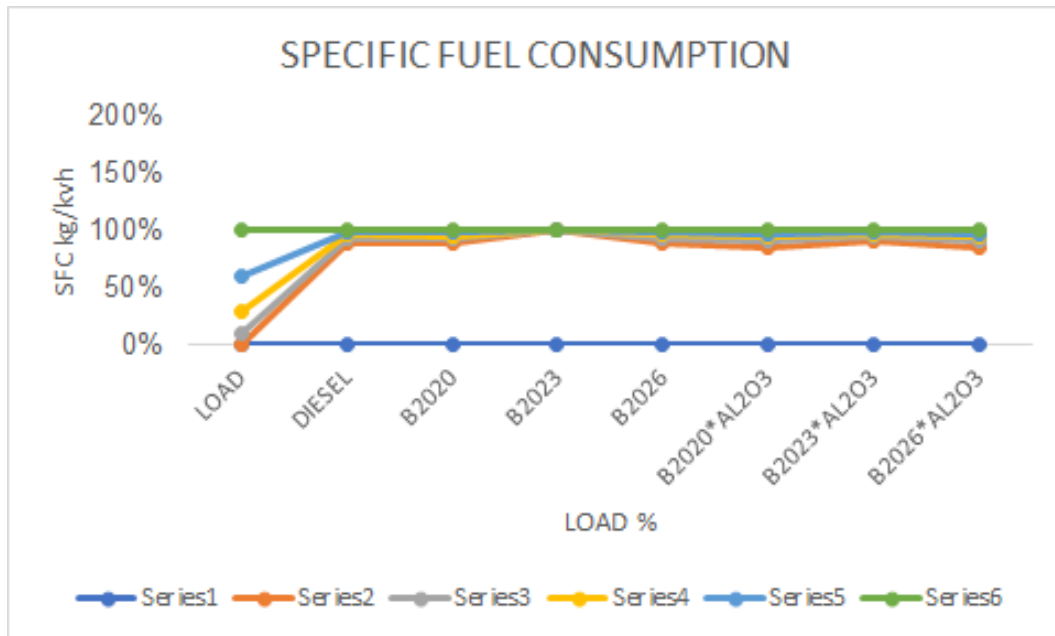


Fig. 5.3: Specific Fuel Consumption

Table 5.3: Specific Fuel Consumption

LOAD	DIESEL	B202 0	B2023	B2026	B2020* AL2O3	B2023* AL2O3	B2026* AL2O3
0	11.36	11.54	1058.61	14.13	9.54	15.58	9.82
25	0.46	0.56	0.48	0.63	0.57	0.56	0.58
50	0.32	0.4	0.35	0.4	0.41	0.41	0.4
75	0.27	0.33	0.31	0.33	0.33	0.33	0.33
100	0.25	0.3	0.29	0.3	0.3	0.31	0.3

SFC is defined as the quantity of fuel burned in unit time required to produce a given engine output. Specific fuel consumption is a technical figure of merit that includes how efficiently the engine converts fuel into power. There is an increase in the SFC with the load percentage.

5.1.4 Thermal Efficiency

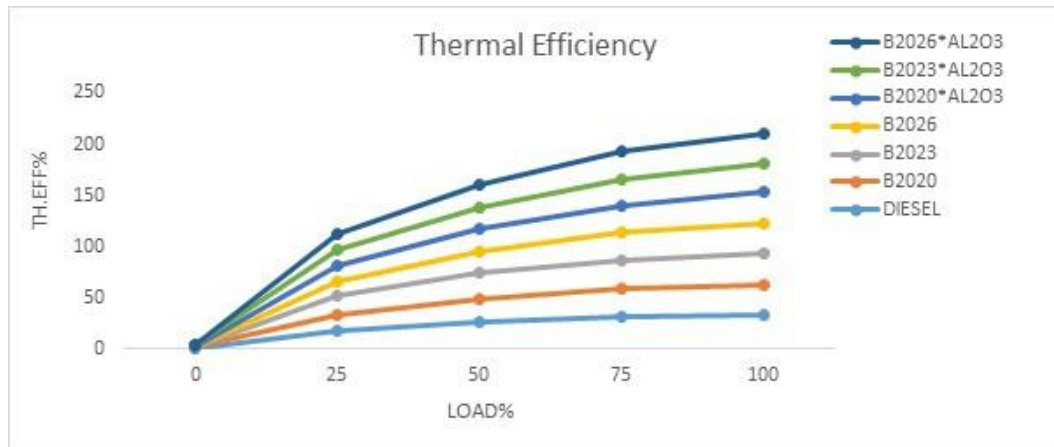


Fig. 5.4: Thermal Efficiency

Table 5.4: Thermal Efficiency

LOAD	DIESEL	B2020	B2023	B2026	B2020* AL2O3	B2023* AL2O3	B2026* AL2O3
0	0.75	0.76	0.01	0.62	0.91	0.56	0.89
25	18.24	15.53	18.38	13.92	15.34	15.65	15.14
50	26.79	21.76	25.62	21.78	21.5	21.51	21.69
75	31.91	26.4	29	26.46	26.18	26.46	26.23
100	33.34	29.52	31.07	29.51	29.37	28.23	29.57

The Thermal efficiency is defined as the efficiency of a heat engine measured by the ratio of the work done by it to the heat supplied to it. In thermodynamics, the thermal efficiency is a dimensionless performance measure of a device that uses thermal energy, such as internal combustion engine and

refrigerator. In the experiment conducted thermal efficiency increase with the load percentage.

5.2 EMISSION GRAPH AND TABLE

5.2.1 Carbon Monoxide

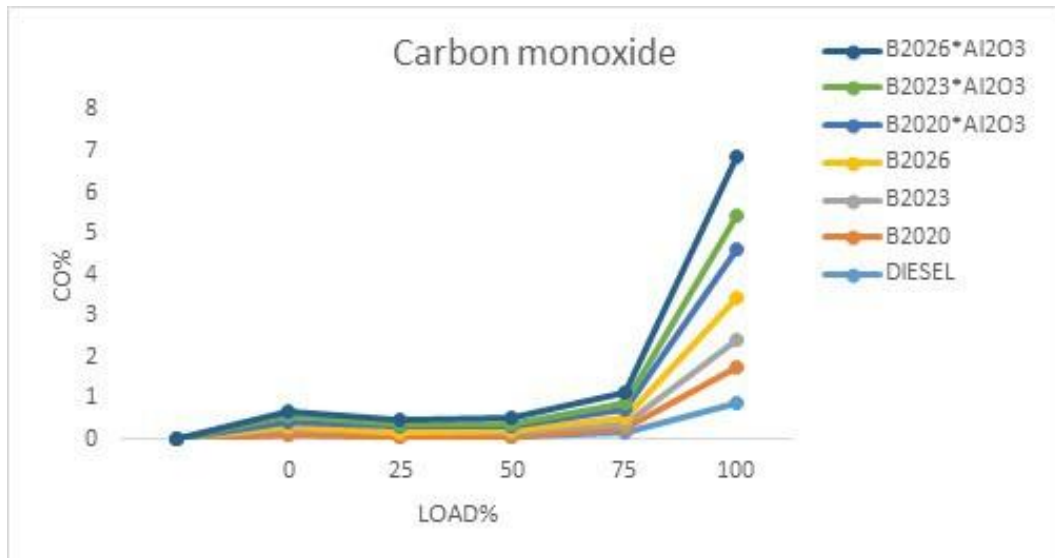


Fig. 5.4: Carbon Monoxide

Table 5.4: Carbon Monoxide

LOA D	DIESE L	B2020	B2023	B2026	B2020* Al2O3	B2023* Al2O3	B2026* Al2O3
0	0.092	0.041	0.136	0.052	0.121	0.112	0.128
25	0.071	0.004	0.084	0.027	0.111	0.081	0.104
50	0.071	0.013	0.087	0.031	0.117	0.073	0.125
75	0.152	0.105	0.134	0.114	0.248	0.131	0.26
100	0.875	0.877	0.693	0.983	1.196	0.831	1.415

Carbon monoxide is a colorless odorless very toxic gas CO that is formed as a product of the incomplete combustion of carbon or a carbon compound. It is produced when fuels such as gas, oil, coal and wood do not burn fully. Burning

charcoal, running cars and the smoke from cigarettes also produce carbon monoxides gas. Gas, oil, coal and wood are sources of fuel used in many household appliances. We found an increase in the CO.

5.2.2 *Hydro Carbon*

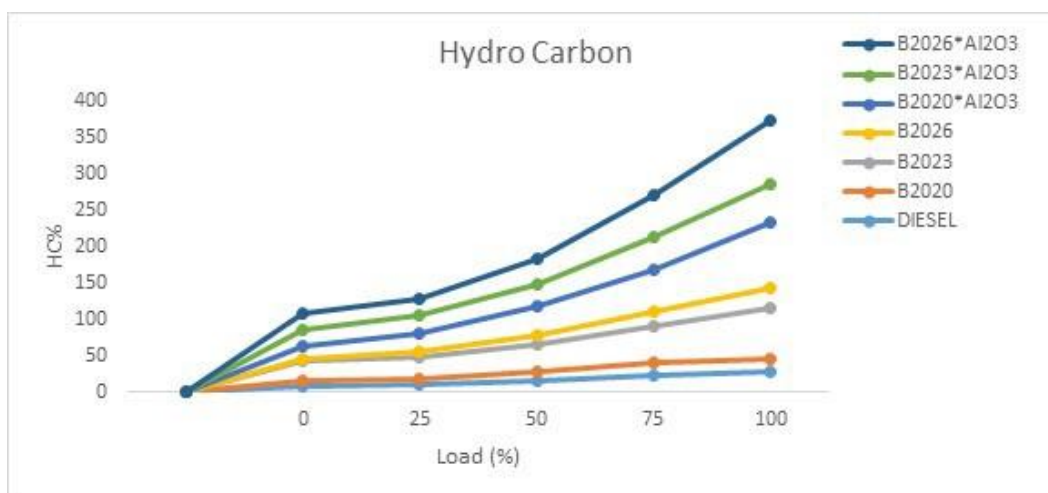


Fig. 5.5: Hydro Carbon

Table 5.5: Hydro Carbon

LOAD	DIESEL	B2020	B2023	B2026	B2020* Al ₂ O ₃	B2023* Al ₂ O ₃	B2026* Al ₂ O ₃
0	9	8	26	4	16	24	21
25	11	8	29	7	25	25	25
50	17	12	38	12	39	31	35
75	24	16	52	19	59	45	56
100	29	16	72	26	91	53	87

Hydrocarbon is a compound of hydrogen and carbon, such as any of those which are the chief components of petroleum and natural gas. The experiment concluded with an high increase in the hydrocarbon.

5.2.3 Carbon Dioxide

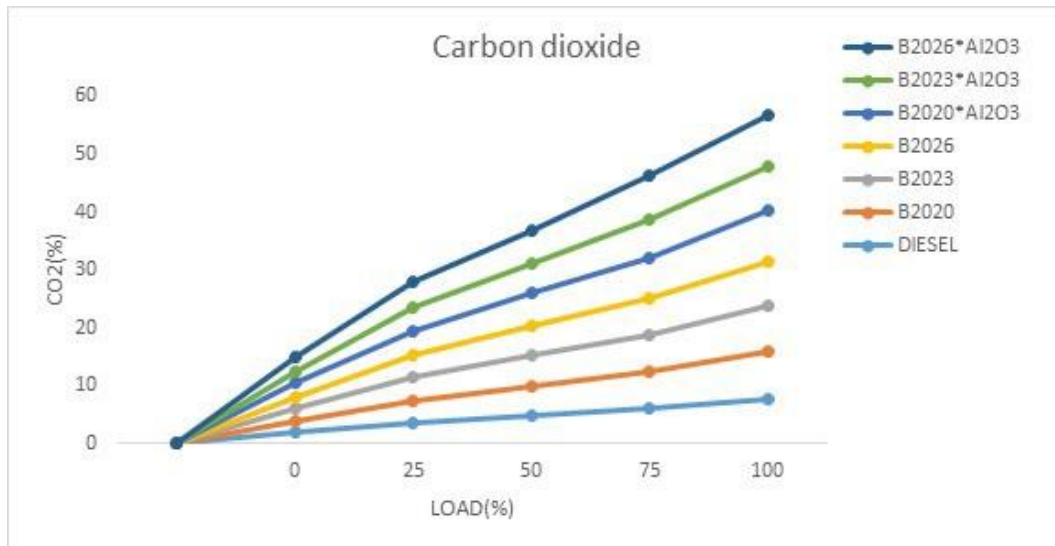


Fig. 5.6: Carbon Dioxide

Table 5.6: Carbon Dioxide

LOAD	DIESEL	B2020	B2023	B2026	B2020 *Al2O3	B2023 *Al2O3	B2026 *Al2O3
0	1.97	1.99	2.12	2.05	2.29	2.06	2.47
25	3.64	3.77	3.97	3.83	4.29	3.9	4.59
50	4.89	5.07	5.29	5.1	5.72	5.07	5.8
75	6.24	6.2	6.43	6.24	7.06	6.45	7.67
100	7.8	8.04	8.15	7.58	8.66	7.66	8.91

Carbon dioxide is a colorless, odorless gas produced by burning carbon and organic compounds and by respiration. It is naturally present in the air in about 0.03 percent and is absorbed by plants in photosynthesis. Carbon dioxide gets increased as the result.

5.2.4 Oxygen

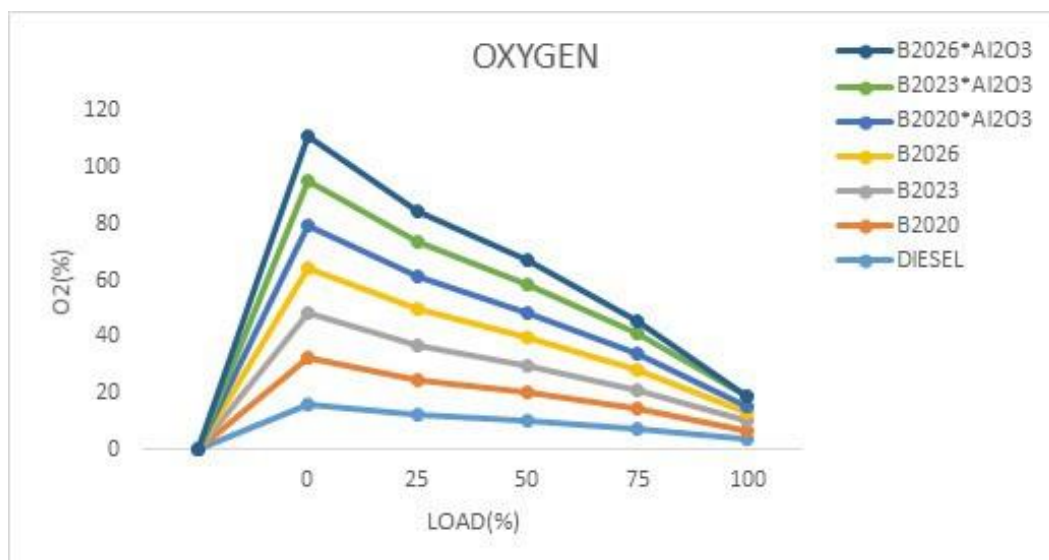


Fig. 5.7: Oxygen

Table 5.7: Oxygen

LOAD	DIESEL	B2020	B2023	B2026	B2020* Al2O3	B2023* Al2O3	B2026* Al2O3
0	16.2	16.2	15.87	15.95	15.5	16.03	15.37
25	12.54	12.56	12.16	12.47	11.58	12.23	11.31
50	10.17	10.03	9.63	10.03	8.93	9.87	8.54
75	7.12	7.24	6.96	7.11	5.85	7.06	4.61
100	3.57	3.21	3.25	3.51	1.81	3.46	0.36

Oxygen is a colorless, odorless reactive gas, the chemical element of atomic number 8 and the life supporting component of air. In the oxygen is the only component that gets steadily decreased.

5.2.5 Nitrogen Oxide

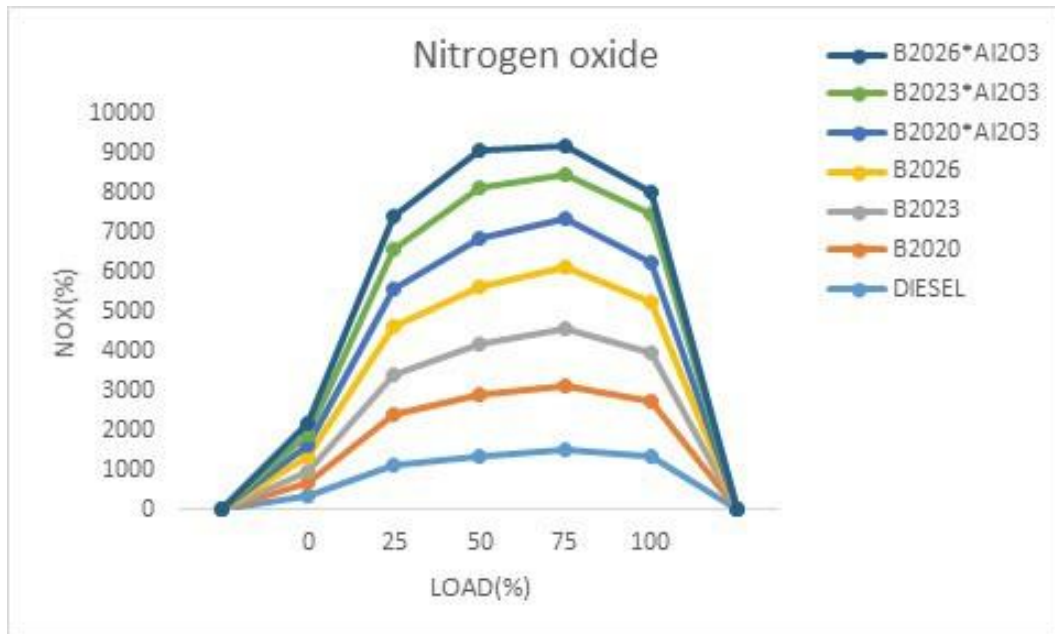


Fig. 5.8: Nitrogen Oxide

Table 5.8: Nitrogen Oxide

LOAD	DIESEL	B2020	B2023	B2026	B2020* Al2O3	B2023* Al2O3	B2026* Al2O3
0	336	341	277	382	271	308	272
25	1131	1261	1051	1178	950	1051	785
50	1375	1519	1320	1435	1213	1320	925
75	1517	1615	1442	1572	1208	1142	725
100	1367	1357	1250	1279	985	1250	567

NOX is defined as the oxides of nitrogen, especially as atmospheric pollutants. It increases with the load percentage.

5.2.6 Smoke

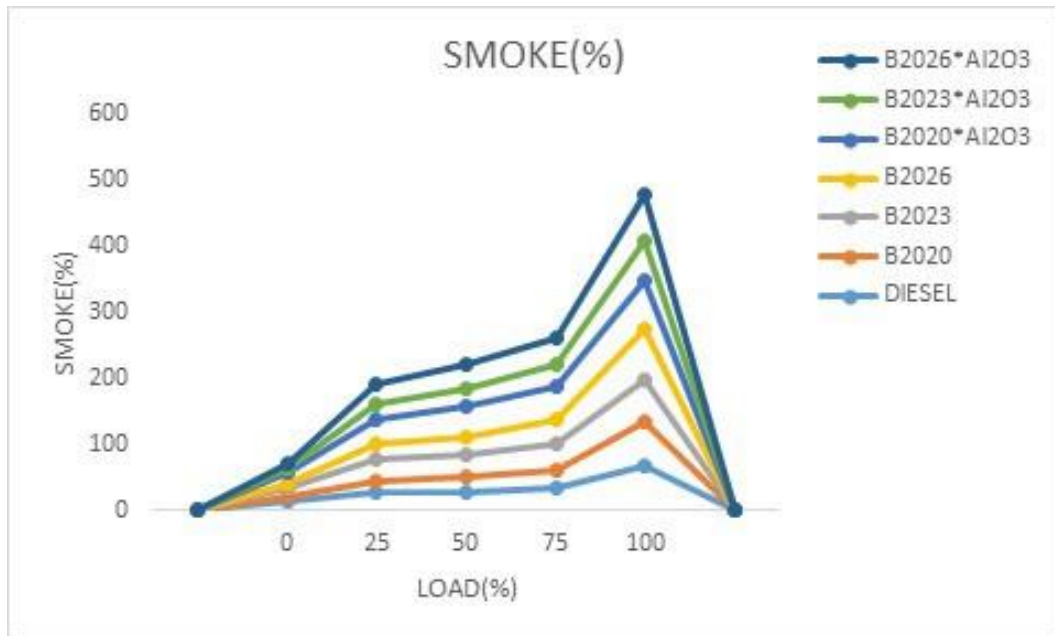


Fig. 5.9: Smoke

Table 5.9: Smoke

LOAD	DIESEL	B2020	B2023	B2026	B2020* Al ₂ O ₃	B2023* Al ₂ O ₃	B2026* Al ₂ O ₃
0	13.7	6.2	12.9	6.9	16.8	7.1	8.9
25	26.8	19	31.2	24.8	37.6	23.25	29.3
50	28.9	21.3	34.5	26.6	48.3	25.9	35.6
75	36.1	25.6	40.5	34.8	51.2	32.36	42.3
100	68.9	64.7	63.3	78.9	73.1	60	71.4

Smoke is a visible suspension of carbon or other particles in air, typically one emitted from a burning substance. It is evident that an abundant increase in the resultant smoke.

CHAPTER 6

CONCLUSION

Biodiesel is a renewable, environmentally friendly resource. It is an environmentally friendly alternative fuel for compression ignition engines. It is one of the alternative fuels in internal combustion engines, and it has been demonstrated that pollutants in vehicular emissions have significant impacts on ecological systems as well as human health. As a result, there is a growing emphasis on tightening motor vehicle emission standards and lowering emissions in service vehicles. Biofuel can be used to replace petroleum fuel, reduce toxic emissions, and limit CO emissions throughout the life cycle. According to the current study, the use of biodiesel as an alternative diesel engine fuel is rapidly increasing. However, due to technical limitations, they are rarely used purely or in high concentrations in unmodified diesel engines. The performance, emission, and combustion of a CI engine are being investigated experimentally. A fuel blend (20% biodiesel, 80% diesel, and a NaOH catalyst) is being prepared. The prepared blend is tested for properties in accordance with American Society for Testing and Materials (ASTM) guidelines. The engine study was carried out with three different types of injections: 10% PM, 20% PM, and 30% PM (pre-mixed). When the injection pressure is increased, the brake thermal efficiency (BTE) improves. Because higher injection pressures promoted better combustion, NO_x emissions were increased as a penalty. However, at higher injection rates, the Specific Fuel Consumption (SFC) is lower. At higher charge, the CO₂ hydrocarbon emissions and smoke opacity values increased. By using pre-mixed ignition, the prepared blend can be used in a CI engine.

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