

ANALYSIS ON THE IMPACT OF BIODIESEL–ETHANOL– DIESEL FUEL ON THE PERFORMANCE AND EMISSIONS OF A DIESEL ENGINE

Submitted in partial fulfillment of the requirements for the award of
**Bachelor of Engineering Degree in
Mechanical Engineering**

BY

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SATHYABAMA

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

Accredited with Grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **P SRIHARIHARAN (38150111)**, and **B ROHITH (38150093)** who carried out the project entitled **“ANALYSIS ON THE IMPACT OF BIODIESEL ETHANOL DIESEL FUEL ON THE PERFORMANCE AND EMISSIONS OF A DIESEL ENGINE”** under my supervision from November 2021 to May 2022.

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DECLARATION

We **P. SRIHARIHARAN (38150111)** and **B. ROHITH (38150093)** hereby declare that the Project Report entitled “**ANALYSIS ON THE IMPACT OF BIODIESEL ETHANOL DIESEL FUEL ON THE PERFORMANCE AND EMISSIONS OF A DIESEL ENGINE**” done by us under the guidance of **Dr. S.P.VENKATESAN. M.E., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to **Dr. S. PRAKASH, M.E., Ph.D.**, Dean of School of Mechanical Engineering and **Dr. G. ARUN KUMAR, M.E., Ph.D.**, Head of the Department, Dept. of Mechanical Engineering, for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. S.P. VENKATESAN, M.E., Ph.D.**, Associate Professor, Dept. of Mechatronics, for his valuable guidance, suggestions, and constant encouragement that paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Mechanical Engineering who were helpful in many ways for the completion of the project.

I would like to thank my parents, sister, brother-in-law, well-wishers, and friends who were very supportive throughout the tenure of my project phase.

ABSTRACT

Based on the physical and chemical properties of biodiesel, ethanol and diesel fuels, biodiesel-ethanol-diesel fuel (abbreviated as BED) was produced by compounding. The compatibility and stability of the BED and its compact diesel engine performance and emissions were experimentally studied with six different BED fuels. The results show the following findings. First, the components of biodiesel, ethanol, and diesel can remain soluble in certain proportions when the volume ratio of biodiesel is 25% to 55% of BED fuels. Second, engine power decreases slightly and the reduction amplitude increases as the proportions of ethanol and biodiesel increase at medium speeds and high loads. In addition, the power of the engine using the B30E10D60 fuel decreases by 10.2% when the engine is running at maximum torque conditions. Third, there is no significant variation in the equivalent fuel consumption rate at low loads, and the fuel consumption rate becomes lower with increasing oxygen content at high loads. Therefore, the equivalent fuel consumption rates of BED fuels are lower than those of pure diesel (petrochemical diesel). Finally, the CO emission of the BED is almost the same as that of pure diesel at low loads, but becomes less at high loads. The NO_x emission of the BED is slightly lower than that of pure diesel at low loads, but increases at high loads. The NO_x emission increases with the increase in the proportion of biodiesel and decreases with the increase in the proportion of ethanol. The THC emission of BED is almost the same as that of pure diesel at low loads and is reduced at high loads. THC emission decreases when the proportion of biodiesel increases and increases when the proportion of ethanol increases. Keywords Diesel engine; BED fuel, stability, performance, emission characteristics.

Keywords

Diesel engine; BED fuel, stability, performance, emission characteristics.

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LIST OF ABBREVIATIONS

BED	-	Biodiesel-Ethanol-Diesel
BSFC	-	Brake Explicit Fuel Utilization
BTE	-	Brake Thermal Efficiency
CO and CO ₂	-	Oxides of Carbon
HC	-	Hydrocarbons
HLB	-	Hydrophilic-Lipophilic Equilibrium
IC	-	Internal Combustion
NO and NO ₂	-	Oxides of Nitrogen
SFC	-	Specific Fuel Consumption
SO ₂ and SO ₃	-	Oxides of Sulfur
VCR	-	Variable Compression Ratio

CHAPTER 1

INTRODUCTION

1.1 IC ENGINE

The internal combustion (IC) engine has been the dominant main engine in our society since its invention in the last quarter of the 19th century [for more details, see, eg, Heywood (1988)]. Its purpose is to generate mechanical power from the chemical energy contained in the fuel and released through the combustion of the fuel within the engine. It is this specific point, that fuel is burned within the work-producing part of the engine, that gives internal combustion engines their name and distinguishes them from other types, such as external combustion engines. Although gas turbines satisfy the definition of an IC engine, the term has traditionally been associated with spark ignition (sometimes called Otto, gasoline or gasoline engines) and diesel engines (or compression ignition engines). Internal combustion engines are used in applications ranging from marine propulsion and power generator sets with a capacity greater than 100 MW to hand tools where the power supplied is less than 100 W. This implies that the size and characteristics of the engines Current ranges vary widely from large diesel engines with cylinder diameters in excess of 1000mm and reciprocating engines at speeds as low as 100rpm to small two-stroke petrol engines with cylinder diameters of around 20mm. Within these two extremes are medium-speed diesel engines, heavy-duty automotive diesel engines, truck and passenger car engines, aircraft engines, motorcycle engines, and small industrial engines. Of all these types, gasoline and diesel engines for passenger cars have a prominent position as they are by far the most produced engines in the world; as such, its influence on social and economic life is of paramount importance.

1.2 FOUR STROKES

A four-stroke engine (also four-stroke) is an internal combustion (IC) engine in which the piston completes four separate strokes while the crankshaft rotates. A stroke refers to the complete travel of the piston through the cylinder, in any direction. The four separate strokes are called intake, compression, combustion, and exhaust.

1.3 BIODIESEL

Biodiesel may be a clean-burning different fuel created from domestic, renewable resources. This biofuel may be a mixture of carboxylic acid alkyl radical esters made of vegetable oils, animal fats, or recycled greases. Wherever on the market, biodiesel is utilized in compression-ignition (diesel) engines in its pure kind with very little or no modifications. Diesel engines these days solely remotely correspond to the engine that applied scientists designed. His engine was initially designed to run on coal dirt. Moreover, for the primary few decades, they may run on the subject of something that will burn. While later because the 1970's, automotive diesel engines were very tolerant once it involves the fuel they may use. Today's diesel engines are unit way more economical and cleaner than the first versions, partially as a result of they run on a narrowly outlined fuel. It permits the engine manufacturers to tune the equipment for improved potency. Biodiesel and fuel are unit terribly similar in their physical and chemical characteristics. They're similar enough that trendy diesel engines will run on biodiesel. We can mix Biodiesel with fuel at any magnitude relation. We can discover biodiesel blends like B20, that is two hundredth biodiesel and eightieth diesel, at truck stops and gas stations. Mixing biodiesel with fuel ends up in a fuel that burns cleaner than diesel alone. Everybody has seen those black clouds, or soot, gushing from the exhaust of a diesel truck once it's beneath load. However, after we mix biodiesel with diesel, the soot is reduced, and dirty diesels will become clean diesels. Biodiesel is created through a method within which organically derived oils are unit combined with alcohol (ethanol or methanol) within the presence of a catalyst to make alkyl group or alkyl radical organic compound. The biomass-derived alkyl group or alkyl radical esters is mingling with typical fuel or used as a neat fuel

(100% biodiesel). Biodiesel is made of any oil, animal fats, waste vegetable oils, or microalgae oils. There are a unit 3 basic routes to biodiesel production from oils and fats:

- Base catalyzed trans-esterification of the oil.
- Direct acid catalyzed trans-esterification of the oil.
- Conversion of the oil to its fatty acids and so to biodiesel

1.4 OUTLINE OF THE PROJECT

The NO_x outflow of the BED is marginally lower than that of unadulterated diesel at low loads, however becomes higher at high loads. The NO_x outflow increments with the increment of biodiesel extent furthermore, diminishes with the increment of ethanol extent. The THC outflow of the BED is practically equivalent to that of unadulterated diesel at low loads and becomes lower at high loads. The THC discharge diminishes when the biodiesel extent endlessly increments when the ethanol extent increments.

CHAPTER 2

LITERATURE REVIEW

Since ongoing years, it has been found that biodiesel can be utilized as a cosolvent of ethanol and diesel mix fuel. The fuel properties of bioethanol, bio-diesel, and diesel are reciprocal. Hence, a few researchers concentrated on the qualities of ethanol-biodiesel-diesel mixed fills and the effect on motor execution and emanations. Shi et al. (2006) fostered an ethanol-methyl soyate-diesel fuel mix (called BE-diesel, with a mix proportion of 5:20:75), and explored its outflows attributes with a Cummins-4B diesel motor. Their outcomes showed that the BE-diesel empowered a huge decrease of PM outflows and 2-14% expansion of NO_x discharges. The CO discharge was not decisive and relied upon working circumstances. The complete hydrocarbon (THC) was lower than that from diesel fuel under most test conditions. The discharges of formaldehyde, acetaldehyde, propionaldehyde, and CH₃)₂CO were additionally estimated. A limited quantity of ethanol was recognized in the fumes gas from the BE-diesel motor. Kwanchareon, Luengnaruemitchai, and Jai-In (2007) considered a stage chart of diesel-biodiesel-ethanol mixes with various purities of ethanol at various temperatures. They likewise concentrated on the discharges execution with a diesel motor. Their outcomes showed that the fuel properties were near the standard furthest reaches of a diesel fuel. The high cetane worth of the biodiesel made up for the reduction of the cetane number of the mixes, which was brought about by the presence of ethanol. The warming up sides of the mixes containing under 10% ethanol were not fundamentally unique in relation to those of traditional diesel fills. Contrasted with the CO and HC emanations of diesel energizes, the CO and HC of the mixes were fundamentally diminished at high motor loads, yet the NO expanded. It was tracked down that a mix of 80% diesel, 15% biodiesel and 5% ethanol was the most appropriate synthesis in diesel creation for satisfactory outflows decrease and fuel properties (with the exception of blaze point). Hulwan and Joshi (2011)

explored the attainability of utilizing high rates of ethanol in diesel-ethanol mixes with biodiesel as a co-dissolvable and properties enhancer. Their outcomes showed that propelling fuel infusion timing nearly multiplied the NO emissions and expanded top terminating pressure, and the ignition cycles of these blends were delayed at low loads, however, they appeared to be like the ignition cycle of diesel fuel at high loads. Fuel utilization was fully expanded, engine thermal effectiveness was marginally improved, and smoke haze was dramatically decreased at high loads. The range of NO outputs depended on operating conditions, and CO outputs expanded radically at low loads. The above survey of previous works shows that most specialists have used blends of biodiesel, ethanol, and diesel with different blend ratios, but their reviews are not accurate. In this paper, BED blends with various proportions of biodiesel, ethanol, and diesel are examined in an efficient manner, accounting for the effects of miscible property and safety at various temperatures for various blend grades of the BED blend fuel. The impact of the BED energizes on exposure and emissions from a diesel engine are covered by the tests. Two organic additives were selected for their different physical-chemical parameters to study the behavior of a diesel-ethanol mixture. These compounds had a glycerol backbone containing heteroatoms and aminoether, hydroxyl, nitrate, and nitramine functional groups. Properties directly related to engine parameters (viscosity, cetane number, heat content, volatility) and those that characterize fuel quality (homogeneity, cold properties, anticorrosivity and volatility) were investigated. Fuel formulations with 2% additive and ethanol content between 10 and 20% by volume in relation to diesel were prepared. Mixtures are compared, with or without additive, in two direct and indirect injection diesel engines. The behavior of the engine seemed to improve in the presence of additives with a reduction in polluting emissions in the exhaust gases, cyclical irregularities and delay in ignition. No troubleshooting, knocking, or vapor lock phenomena were found during this study. q 2001 Elsevier Science Ltd. In this work, we study the phase diagram of diesel-biodiesel-ethanol mixtures at different ethanol purities and different temperatures. The fuel properties (such as density, heat of combustion, cetane number, flash point, and pour point) of the selected blends and their emissions performance of a diesel engine was examined and compared to that of the base diesel. The fuel properties were found to be close to the standard limit for diesel fuel; however, the flash point of the ethanol-

containing blends was quite different from that of conventional diesel. The high cetane number of biodiesel could compensate for the decrease in the cetane number of the blends caused by the presence of ethanol. The calorific value of blends containing less than 10% ethanol was not significantly different from that of diesel. Regarding the emissions of the mixtures, it was found that CO and HC were significantly reduced at high engine load, while NO_x increased when compared to diesel. Considering these facts, a blend of 80% diesel, 15% biodiesel and 5% ethanol was the most suitable ratio for diesel production due to acceptable fuel properties (except flash point) and reduced emissions. 2006 Elsevier Ltd. All Rights Reserved. Ethanol is an attractive alternative fuel because it is a biobased, renewable resource and is oxygenated, providing the potential to reduce particulate emissions in compression ignition engines. In this review, the properties and specifications of ethanol blended with diesel fuel are discussed. Special emphasis is placed on the critical factors for the potential commercial use of these mixtures. These factors include blend properties such as stability, viscosity and lubricity, safety, and material compatibility. The effect of fuel on engine performance, durability and emissions is also considered. The formulation of additives to correct certain key properties and maintain mixture stability is suggested as a critical factor in ensuring fuel compatibility with engines. However, maintaining vehicle safety with these blends may involve modifications to the fuel tank. More work is required to specify acceptable fuel characteristics, confirm long-term effects on engine durability, and ensure the safe handling and storage of ethanol-diesel blends.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 AIM

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

3.2 SCOPE

Ethanol 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 ethanol are unique, ethanol 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-ethanol blend. In this way, the use of ethanol 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. P. Satgé De Caro et al. (2001) chose two natural specialists for a diesel-ethanol combination fuel and concentrated on the physical and synthetic boundaries of the blend, such as consistency, cetane number, heat content, unpredictability, homogeneity, low-temperature 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. Eliana Weber De Menezes et al. (2006) concentrated on the impacts of ether added substances (ETBE and TAE) in diesel mixes and ether/ethanol/diesel mixes on their physical and synthetic properties and motor execution by motor testing. Their outcomes showed that the ETBE and TAE ethers went about as co solvents of ethanol in diesel, and 5% of TAE/ethanol/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. Lei et al. (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 "hydrophilic-lipophilic 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 ethanol-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.

3.3 PROBLEM STATEMENT

The primary gadgets for BED fuel planning and ignition execution incorporate the accompanying a QTH-2P-B test office of consistent temperature and moistness, a ultrasonic emulsifier, a thickness meter, an equal light source, an equilibrium, deferent glass instruments. The particulars of the motor also, estimation instruments are displayed in Table 3.1.

Table 3.1 Estimation Instruments

Diesel engine specifications		Measurements instruments and testing environment	
Engine type	Horizontal, water-cooled, four stroke, naturally	Hydraulic dynamometer	WE31, maximum speed 5500r/m, maximum brake power 120kW, maximum brake torque 400N·m
Displacement	2.5 L	Fuel flow measurement device	FCM, measuring range:0 ~ 40kg/h; accuracy: less than $\pm 0.05\%$
Rated power	37 kW	Smoke meter	AVL415S, smoke value:0 ~ 10 FSN; resolution:0.001FSN
Rated speed	2400 r/min	Exhaust gas analyzer	AVL SESAM FTIR i60, relative error $\leq 1\%$, frequency 1 Hz
Maximum torque/speed	167 N m at 1600 r/min	Environmental conditions	Altitude 1920m, atmospheric pressure 81.5kPa, environmental temperature 20 ~ 25°C, relative humidity 20%~35%

CHAPTER 4

EXPERIMENTAL AND METHODS USED

4.1 STUDY OF FUEL AND EMISSION

As currently referenced significant exhaust emanations are

- (i) unburnt hydrocarbons, (HC)
- (ii) Oxides of carbon, (CO and CO₂),
- (iii) Oxides of nitrogen, (NO and NO₂)
- (iv) Oxides of sulfur, (SO₂ and SO₃)
- (v) Particulates
- (vi) Sediment and smoke.

The initial four are normal to both SI and CI motors and the last two are primarily from CI motors. The primary non-exhaust emanation is the unburn hydrocarbons from gas tank and crankcase blow by. Figure 4.1 shows the variety of HC, CO and NO_x emanations as an element of proportionality proportion for a SI motor. It is plainly seen that every one of the three outflows are a solid capacity of proportionality proportion. As can be seen from the Figure 4.1 that a rich blend doesn't have sufficient oxygen to respond with all the carbon and hydrogen, and both HC and CO emanations increment. For $\phi < 0.8$, HC outflows likewise increment because of unfortunate ignition and fizzle. The age of nitrogen oxide emanations is a component of the burning attitude nature, most elevated close to stoichiometric circumstances when temperatures are at the pinnacle esteem. Greatest NO_x emanations happen at somewhat lean conditions, where the burning temperature is high and there is an abundance of oxygen to respond with the nitrogen.

4.1.1 *Ethanol*

The United States, and China. Because of the physical and substance properties of diesel and ethanol are unique, ethanol and diesel are inadequately miscible, their blend is temperamental, and delamination might be brought about by a modest quantity of water converged in the diesel-ethanol blend. Hence, the use of ethanol fuel utilizing in the diesel motor is as yet in the examination 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 truck motor that was outfitted with an electronic control framework to control the stream paces of diesel and liquor energizes, what's more, explored the impacts of the infusion timing and stream control arrangement of a fuel infusion siphon on burning and execution. P.Stagé De Caro et al. (2001) chose two natural specialists for a diesel-ethanol blend fuel and concentrated on the physical and synthetic boundaries of the combination, such as consistency, cetane number, heat content, instability, homogeneity, low-temperature properties, and consumption opposition. The exhibition effects of combinations having various extents with and without added substances were looked at for an immediate diesel motor and backhanded infusion diesel motor. Eliana Weber De Menezes et al. (2006) concentrated on the impacts of ether added substances (ETBE and TAAE) in diesel mixes and ether/ethanol/diesel mixes on their physical and synthetic properties and motor execution by motor testing. Their outcomes demonstrated that the ETBE and TAAE ethers went about as co-solvents of ethanol in diesel, and 5% of TAAE/ethanol/diesel showed palatable aftereffects of the physical and substance properties and motor warm productivity. They showed that the ethanol/diesel fuel with ETBE fundamentally modified the attributes of unpredictability (i.e., streak point and refining bend), decreased the cetane number, and corrupted fuel execution in motor tests. Lei et al. (2012) concentrated on the emulsification execution and security of a solitary and blended emulsifiers and the impacts of temperature on emulsification properties in ethanol-diesel mixes as per the hypothesis of "hydrophilic-lipophilic equilibrium (HLB)" and an emulsification standard. A blended emulsifier named "CLZ" was created in light of biofuel and castor oil, and the CLZ had the option to keep its physical solidness inside a wide scope of temperature. Their diesel motor test showed that the

utilization of ethanol- diesel mixes with CLZ further developed motor warm effectiveness and decreased identical brake explicit fuel utilization (BSFC). The smoke discharge was decreased essentially, and the NO_x emanation was diminished somewhat, while the THC emanation expanded, and the CO outflow expanded at light loads furthermore, diminished at weighty burdens.



Fig. 4.1: Fuel blends

4.1.2 Transesterification Process (Mustard oil)

Transesterification is a chemical reaction used for the conversion of triglycerides (fats) contained in oils (raw material) into usable biodiesel. The biodiesel produced by the transesterification process has a much lower viscosity, making it capable of replacing petroleum diesel in diesel engines.

The biodiesel production method applied worldwide at industrial level is the alkoolysis (transesterification) of triglycerides which are the main component of vegetable oils and animal fats. The most common type of esters are methyl esters, mainly because methanol is usually the cheapest alcohol. In Brazil, however, the dominant esters produced are ethyl esters since ethanol is even cheaper than alcohol. The reaction is catalyzed by bases, acids and enzymes and can take place either at low or high temperatures. The produced methyl esters of fatty acids are characterized as biodiesel while glycerol is received as a reaction byproduct.

Firstly to check strategy content that much be below 4 but we got a result 0.2 So its a Transesterification. Secondly we should take 1:6 small ratio of Transesterification and combine catalyst of sodium hydroxide and methanol in which sample were heated in 60C for 120 min ratio time it get rotate. After rotation of sample it get divide into two layers. The upper layer is crude biodiesel and another layer is crude glycerol we should separate the both layer.

Finally we should take 1tra biodiesel and 1tra water mixed together leave for 10 to 15 min setting time and check the pH till it come neutral and heat in 110c. Then product is ready

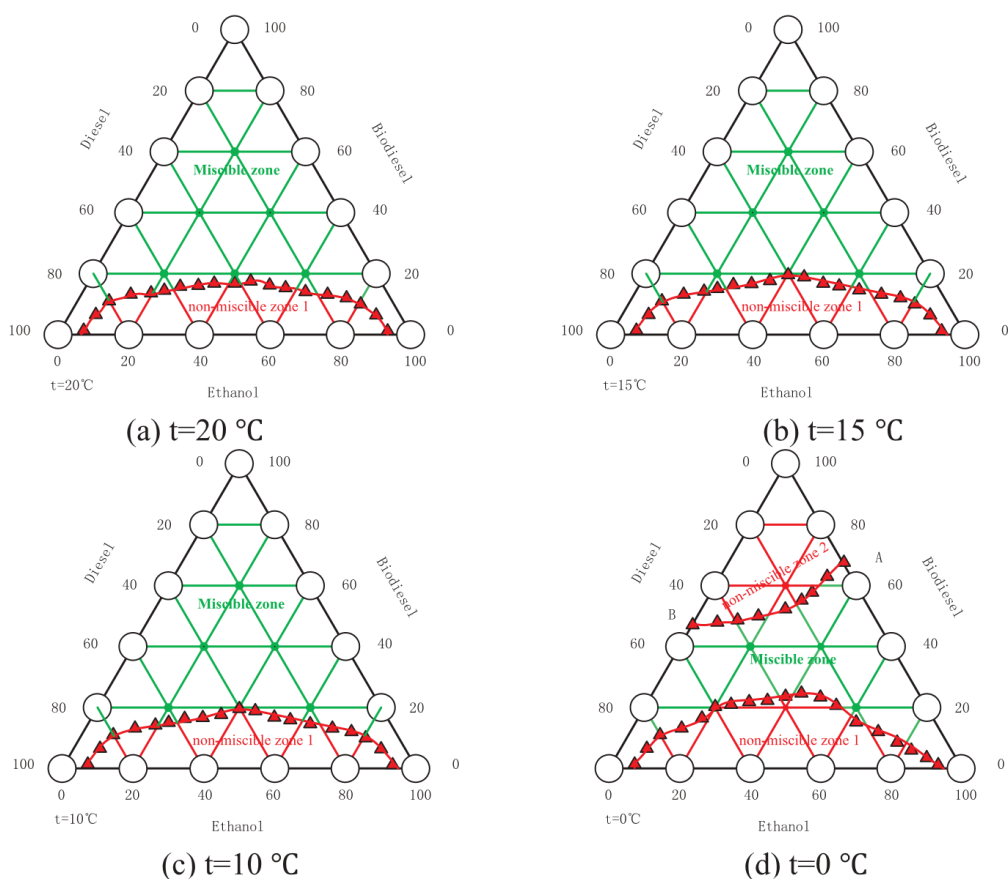


Fig. 4.2: Three-phase diagram of the compatibility of BED fuels

4.2 BLENDS AND THEIR PROPERTIES

Made the blends was done at international research Centre Satyabhama Institute Science and Technology Chennai.

Table 4.1: Properties of Biodiesel, Ethanol, Diesel B10 E10 D80

S.No	Parameters	Results
1	Density	0.830 g/cc
2	Kinematic Viscosity @ 40°C	0.56 cSt
3	Flash point by PMCC method	40 °C
4	Fire point by PMCC method	48 °C
5	Calorific value	6903.002 Cal/g

Table 4.2: Properties of Biodiesel, Ethanol, Diesel B20 E10 D70

S.No	Parameters	Results
1	Density	0.830 g/cc
2	Kinematic Viscosity @ 40°C	0.57 cSt
3	Flash point by PMCC method	46 °C
4	Fire point by PMCC method	52 °C
5	Calorific value	6075.007 Cal/g

Table 4.3: Properties of Biodiesel, Ethanol, Diesel B30 E10 D60

S.No	Parameters	Results
1	Density	0.846g/cc
2	Kinematic Viscosity @ 40°C	0.68 cSt
3	Flash point by PMCC method	61 °C
4	Fire point by PMCC method	69 °C
5	Calorific value	6264.829 I/g

4.3 ENGINE SPECIFICATION

The arrangement comprises of a single cam, four stroke, VCR (Variable Compression Ratio), electric swing diesel engine associated with a vortex current rating dynamometer for stacking. The pressure ratio can be changed without stopping the engine and without changing the math of the ignition chamber using a uniquely planned change chamber block plan. The arrangement is provided with vital instruments for ignition pressure and additionally key point estimates. These signs interact with the PC through the motor marker for the P-V contours. Arrangements are also made to plug in wind current, fuel current, temperatures and load estimation. The configuration has a separate dash box comprising an air box, two gas tanks for mix testing, pressure gauge, fuel estimation unit, transmitters for fuel and air flow estimations, process pointer and engine marker. Rotameters are equipped with cooling water and calorimeter water flow. The arrangement allows investigation of EGR VCR engine performance for brake horsepower, displayed horsepower, frictional horsepower, BMEP, IMEP, hot braking efficiency, demonstrated hot performance, mechanical productivity, volumetric efficiency, explicit fuel utilization, A/F ratio and itch balance. "Enginesoft" lab view based engine performance analysis programming package is tailored for online execution evaluation.

Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel with EGR (Comp.)
Product code	234
Engine	Make Kirloskar, Type 1 cyl., 4 stroke Diesel, water cooled, power 3.5kW at 1500rpm, stroke 110mm, bore 87.5mm. 661cc, CR17.5, Modified to VCR engine CR 12 to 18. With electric start arrangement, battery and charger
Dynamometer	Type eddy current, water cooled,
Propeller shaft	With universal joints

Air box	M S fabricated with orifice meter and manometer
Fuel tank	Capacity 15 lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
EGR	Water cooled, SS, Range 0-15%
Piezo sensor	Range 5000 PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Piezo powering unit	Model AX-409.
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	RTD PT100, Range 0–100oC,3 Nos; Thermocouple, Range 0-1200 oC, 2 Nos
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC
Software	“EngineSoft” Engine performance analysis software
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Pump	Type Monoblock
Overall dimensions	W 2000 x D 2500 x H 1500 mm
Optional	Computerized Diesel injection pressure measurement with injection variation 0-25 deg BTDC

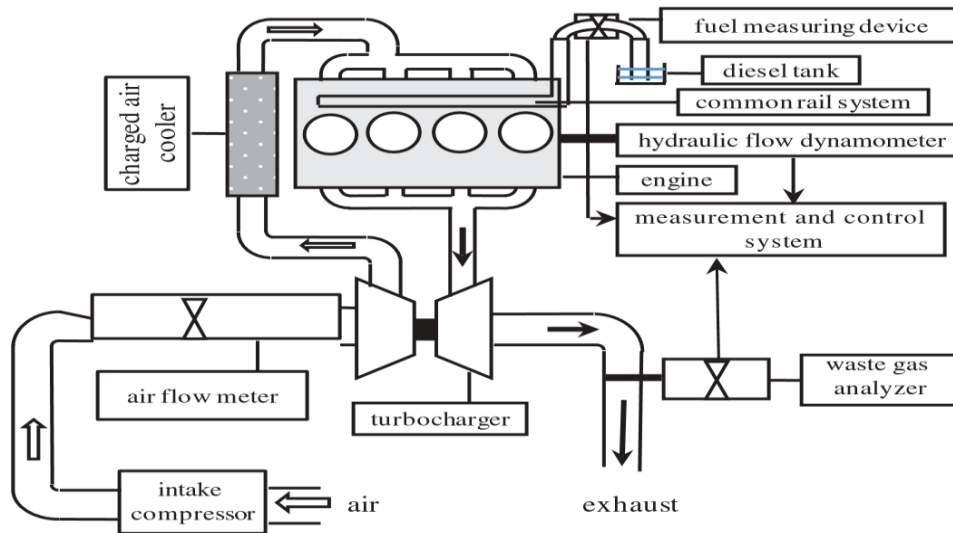


Fig. 4.3: Schematic diagram of the engine test

4.3.1 Engine Drive Setup

The Number of diesel was bought at a corner store. Anhydrous ethanol with a concentration of 99.5% and biodiesel (vegetable oil) used in the tests were purchased from competent production companies. The BED fuel was framed with various grades of biodiesel, ethanol, and diesel. Its actual strength was evaluated under various temperature conditions using an indoor buffer assembly with a standing time of 60 days. The schematic of the test is shown in Figure 1. As shown in Figure 1, the final test process is described in the accompanying previews. (1) It was decided that the most extreme volume part of ethanol breaks down to diesel without biodiesel. At an ambient temperature of 20 °C, 20 ml of diesel fuel was placed in a dry 100 ml test vessel, and then ethanol was added to the drop tube with a burette and shaken thoroughly until delineation occurred. The volume portion of the ethanol was recorded. (2) Registered the volume of biodiesel. Biodiesel was gradually added to the mixture of ethanol and diesel, and stirred thoroughly until the disposition was evident by turbidity. The mixture was fixed is more, put stop. It was seen to check if delineation occurred. The volume of the biodiesel was recorded when the mixture was clear after three days. (3) Record the volumes of biodiesel, ethanol, and diesel in the blend. I kept adding liquor to the mix and noticed changes in the mix. Assuming the mixture was cloudy, biodiesel was added and stirred until the mixture completely decomposed. Then,

the volumes of biodiesel, ethanol and diesel were recorded. This testing process continued until the volume of ethanol was equivalent to the volume of diesel (ie, 20 ml). The volume of diesel, ethanol and biodiesel in the latter was not completely liquidated. (4) The above cycle of steps (1) to (3) was repeated at ambient temperatures of 0°C, 10°C and 15°C. The volumes of biodiesel, ethanol and diesel were purchased in the BED blend. The physical and synthetic properties of six BED powers are presented in Table 2. As shown in Table 2, the thickness of the BED energizes is practically equivalent to the thickness of diesel. The oxygen content increases with the amount of biodiesel when the amount of ethanol is kept equivalent. The cetane amounts of all BED powers are not exactly those of diesel.



Fig. 4.4: Engine Drive Setup

4.3.2 *Engine Testing Software*

Engine soft is Lab view based programming bundle created by Pinnacle Innovations Pvt. Ltd. for motor execution observing framework. Engine Soft can serve a large portion of the motor testing application needs counting observing, revealing, information passage, information logging. The product assesses power, efficiencies, fuel utilization and hotness discharge. It is configurable according to motor set up. Different diagrams are acquired at different working condition. While on line testing of the motor in RUN mode fundamental signs are checked, put away and introduced in diagram. Put away information record is gotten to see the

information graphical and even designs. The outcomes and charts can be printed. The information in dominate arrangement can be utilized for additional investigation.

4.3.3 Gas Analyses

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

1. Kindly fill the details (Engine No. Model, Engine Type, Engine Speed) in respective text boxes given on the form.
2. 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 color "CO HC power not communicating." kindly check the following:
 - Be sure that gas analyzer settings in "MAHA Euro" mode
 - Check the COM port settings with PC and the software.
 - RS232 Cable is working properly and connected with equipment.
 - Readings are coming with equipment and display on panel.
3. After 6 seconds readings are automatically save in database and status bar strip moving according to readings save in database.
4. After taking the readings click on "Disconnect button" it disconnect the communication with equipment and show the message "Data Saved in Database".
5. Report: Click on report button to take the report of the test.
6. Print: Click on print button to take the printout of screen as bitmap image.

7. Export to MS Excel Sheet: To export data in excel sheet click on “EXPORT TO EXCEL” button. When pressing export button a excel file is generated in a path “C:\ AVL Folder\”. The file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_23).
8. Close Button : click on close button to exit from current active window or screen.



Fig. 4.5: Gas Analyses

4.3.4 Smoke Meter

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

1. 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 details " check box in Master data entry form all the textboxes related to (Engine No. Model, Engine Type, and Engine Speed) become disabled.

2. Click on "Connect button "to connect the PC with equipment and wait for 5- 10 seconds. if the readings are not coming it show the message in red color ""Unable to Communicate with Equipment."" kindly check the following:
 - a. Be sure that Smoke meter model name display on screen is same as your smoke meter model if not kindly change the model in "Master Data Entry Form"
 - b. Check the COM port settings with PC and the software in "Master Data Entry "form.
 - c. RS232 Cable for smoke meter is working properly and connected with equipment.
 - d. Readings are coming with equipment and display on remote of smoke meter.
3. According to "Time interval settings in selection box, readings are automatically saves in database.
4. After taking the readings click on "Disconnect button" it disconnect the communication the equipment and show the message "Disconnected"
5. Report: Click on report button to take the report of the test.
6. Print: Click on print button to take the printout of screen as bitmap image.
7. Export to MS Excel Sheet: To export data in excel sheet click on "EXPORT TO EXCEL" button. When pressing export button a excel file is generated at path "C:\ AVL Folder\". The file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_26).

8. Close button : click on close button to exit from current active window or screen, it takes time to close, so wait for 10-15 seconds for form window to close.



Fig. 4.6: Smoke meter

CHAPTER 5

RESULT AND DISCUSSION

5.1 DETERMINATION OF PERFORMANCE AND EMISSION

Motor tests were done at four consistent burdens with brake mean compelling tensions (bmep) of 0.0, 1.3, 2.6, 4, and 5.3 bar and at the greatest force speed of 1500 r/min. The test aftereffects of different motor burning, execution, and discharge boundaries are examined independently as sub-areas.

5.2 EFFECT OF BLENDS AND PERFORMANCE

The experiment was carried out without any changes to the diesel engine hardware or calibration settings. The results are shown in Figure 5.1. The power of the engine when burning BED fuels is less than the power when burning pure diesel under the same operating conditions. The power decreases when the proportions of ethanol and biodiesel increase. The calorific values of different BED fuels and their torque values are summarized in Table 5.1. From the above results, it is seen that the engine braking power when using the BED fuels decreases compared to diesel fuel. The reason is that the heating values of BED fuels are lower than those of diesel. The detailed differences are shown in Table 5.1. In the experiment, it was found that the engine power when using the BED fuels could be recovered by adjusting the fuel pump bolts. During the course of the experiment, engine tests were performed three times at each engine speed for any given BED fuel in order to analyze the uncertainty of the experimental data. As an example, the engine torque when using fuel B10E5D85 is shown in Table 5.2. The results show that the data has good and acceptable variations.

5.2.1 *Brake Thermal Efficiency (BTE)*

Since the warming up sides of the BED energizes are not exactly that of the diesel, brake explicit fuel utilization rate (BSFC) isn't utilized to assess the efficiency of the BED powers. A comparable fuel utilization rate be is utilized as follows : where ρ_{BED} is the thickness of a given BED fuel at 20°C in kg/m³ ; V_E , V_B , V_D are the apportions of ethanol, biodiesel, and diesel in the BED fuel, separately; the H_{VE} , H_{VB} , and H_{VD} are the volumetric warming up sides of ethanol, biodiesel, and diesel in MJ/cm³ , separately; H_{MD} is warming worth in MJ/g. Figure 5 shows the connection among be and oxygen mass substance in the BED energizes. Figures 5.5 and 5.6 present the impacts of the BED powers on mileage and motor warm effectiveness, separately.

As displayed in Figures 5.4 – 5.6. The BED energizes is lower than that of unadulterated diesel fuel. The same fuel utilization pace of B10E5D85, B20E5D75, B30E5D65, B10E10D80, B20E10D70, and B30E10D60 diminishes by 3.9%, 5.6%, 6.3%, 6.5%, 8.6%, and 9.2%, separately, at the greatest force condition, furthermore, 2.0%, 3.3%, 3.8%, 4.7%, 4.5%, and 6.0%, separately, at the 1000 r/min condition, and 0.5%, 0.8%, 1.4%, 1.4%, 2.1% and 3.6%, separately, at the 2400 r/min condition. Contrasted with the 10% oxygen content of biodiesel, the rough 34.8% oxygen content of the ethanol empowers the BED fuel to have the capacity to further develop the ignition interaction. Accordingly, the mileage of the BED-fuel led motor is gotten to the next level. In addition, in light of the fact that biodiesel has a high cetane number, bringing about a remuneration for the low cetane number of ethanol diesel. By and large, the start interaction and the motor warm proficiency can be gotten to the next level. It is additionally seen from the Figures 5-7 that the same fuel utilization paces of the BED fills with various extents lessen marginally when the diesel motor works at low loads, while diminishes altogether.

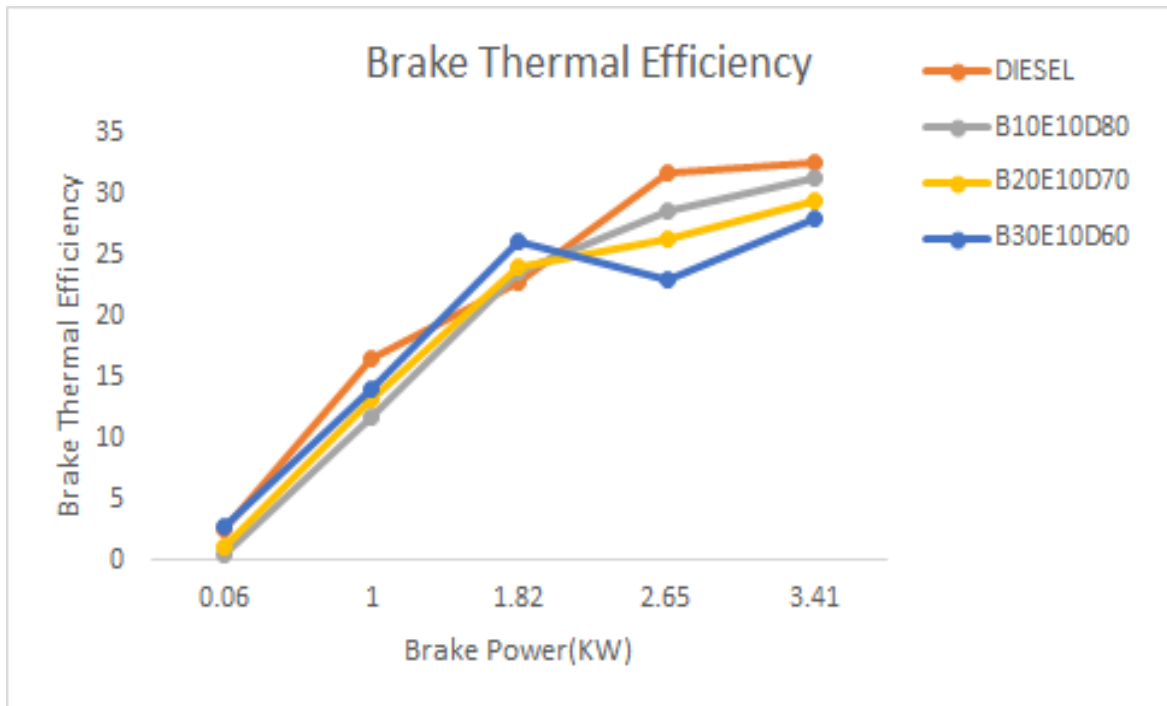


Fig. 5.1: BTE VS BP

Table 5.1: Brake Thermal Efficiency

Load	Diesel	B10 E10 D80	B20 E10 D70	B30 E10 D60
0.06	2.45	0.54	1.02	2.65
1	16.49	11.78	13.21	13.89
1.82	22.75	44.7	23/97	26.12
2.65	31.71	28.48	26.3	23.02

5.2.2 Specific Fuel Consumption (SFC)

Whenever the diesel motor works at high loads. The explanation is that ethanol has a more prominent vaporization dormant hotness whenever the motor works at the low-speed and low-load conditions, where in-chamber fuel temperature and gas pressure are low, and the ignition interaction is impacted. At low speed, the thickness of biodiesel is high furthermore, the admission swirl is powerless. Hence, atomization of the blended fuel is impacted, and ignition falls apart, bringing about an increment of the fuel utilization. At high velocity and high-load conditions, the in-chamber fuel temperature and gas pressure are high. With the assistance of the low consistency of ethanol to advance atomization, and with

the assistance of the great cetane number of biodiesel to further develop start, motor mileage moves along. Besides, the oxygen content of the BED fuel can extraordinarily work on the ignition interaction and efficiency.

The examination of comparable fuel utilization paces of various BED fills is complicated. Not even one of them enjoys a flat out upper hand over others. In outline, at high loads, the oxygen substance of the BED energizes significantly further develop ignition, prompting a decrease in the same fuel utilization rate. At low loads, the in-chamber fuel temperature and gas pressure are lower and the admission whirl is more fragile, contrasted with high loads. The ignition interaction is affected by many elements, for example, cetane number, atomization, vaporization heat, oxygen content, fuel infusion spout, fly fuel, and ignition chamber plan.

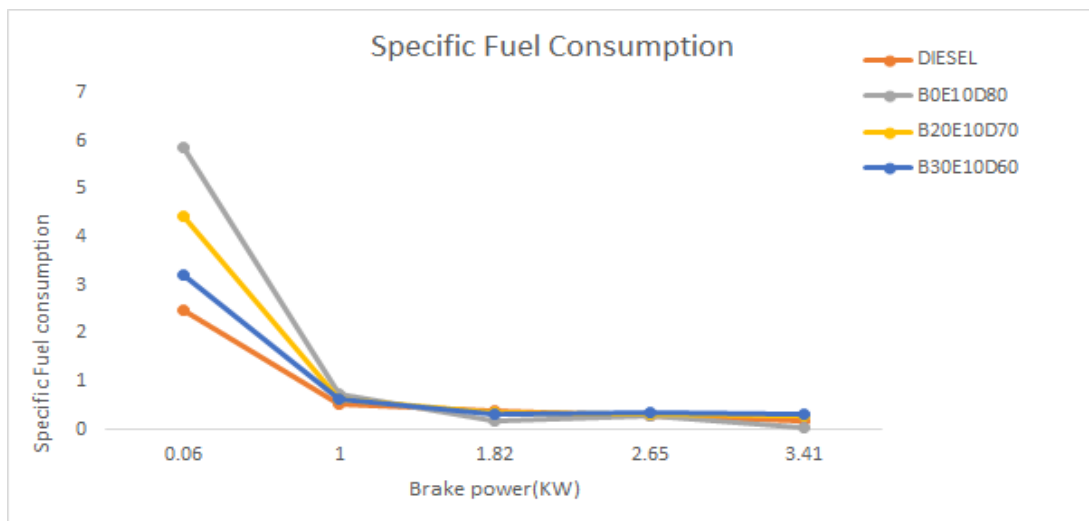


Fig.5.2: SFC VS BP

Table 5.2: Specific Fuel Consumption

LOAD	DIESEL	B10 E10 D80	B20 E10 D70	B30 E10 D60
0.06	2.48	15.85	8.44	3.23
1	0.52	0.73	0.65	0.62
1.82	0.38	0.19	0.36	0.33
2.65	0.29	0.3	0.33	0.37
3.41	0.2	0.06	0.29	0.31

5.3 IMPACT OF BLENDS ON EMISSION

The examination of emissions execution between the BED energizes and unadulterated diesel was learned at the most extreme force speed (1600 r/min) and the evaluated power speed (2400 r/min). The discharges incorporate NO_x, CO, and HC, and so on Figures 8-10 present the discharges information of CO, NO_x, and THC of copying the BED fills and unadulterated diesel. In Figure 8, the CO outflows of the BED powers are lower at low loads, and the proportion of CO discharges diminishes pointedly with the increments of oxygen content in the fuel. The CO outflows of the B10E5D85, B20E5D75, B30E5D65, B10E10D80, B20E10D70, and B30E10D60 decline by 10.9%, 22.8%, 32.8%, 48.4%, 58.4%, and 67.2%, individually, at the most extreme force condition (1600 r/min, 128 Nm), and 10.4%, 21.5%, 36.3%, 52%, 61.6%, and 70.1%, individually, at the evaluated power condition (2400 r/min, 110 Nm). The explanations behind the decrease incorporate the accompanying:

- (1) High vaporization idle hotness of ethanol at low loads, prompting decreases of in-chamber temperature and tension and their effects on ignition.
- (2) High thickness of biodiesel, prompting unfortunate atomization. In the B30E10D fuel, the proportion of biodiesel and consequently the oxygen content are the most noteworthy among all the BED energizes. Accordingly, its adequacy of CO emissions decrease is the best. As displayed in Figure, the NO_x discharges increment with the increment of the extent of biodiesel in the BED energizes, and diminishes with the increment of ethanol part. Contrasted with the NO_x emissions of diesel fuel, the NO_x of the BED energizes are somewhat lower at low loads and higher at high loads. The NO_x discharges of B10E5D85, B20E5D75, B30E5D65, B10E10D80, B20E10D70, and B30E10D60 increment by 14.2%, 22.2%, 36.8%, 9.2%, 19.5%, and 27.1%, separately, at the most extreme force condition (1600 r/min, 128 Nm), and increment by 13.4%, 19.7%, 33.6%, 8%, 16.9%, and 29%, separately, at the evaluated power

condition (2400 r/min), contrasted with diesel fuel. NO_x arrangement is advanced by plentiful oxygen and high temperature. Biodiesel has numerous HC free extremists, which are improving impetuses for NO_x outflows (Torres-Jimenez et al. 2009). The NO_x outflows increment with the increments of biodiesel content in the BED energizes. Ethanol has an extraordinary inert hotness esteem that causes the temperature decrease in the chamber. Hence, the NO_x emanations decline with the increment of ethanol division. At low loads, the burning temperature in the chamber is lower, and the extraordinary inactive hotness worth of the ethanol part in the BED fuel further diminishes the temperature inside the chamber. These impacts make the NO_x outflows of the BED energizes somewhat not exactly.

5.4 NITROGEN OXIDE EMISSION

NO emissions are reduced by increasing the concentrations of ethanol and methanol in biodiesel, alcohol and diesel blends. Additionally, ethanol-blended fuels have been shown to exhibit lower emissions than methanol-blended fuels. Compared to standard diesel, ethanol-blended fuels reduce NO emissions, while methanol-blended fuels increase NO emissions if the methanol concentration is less than or equal to 20%. This may be because the lower concentration of methanol increases the oxygen content of the fuel mixture, leading to better combustion and higher combustion temperatures. As methanol concentration increases, the cooling effect of methanol becomes more effective, leading to lower combustion temperature and reduced NO_x emissions. Ethanol blends are expected to show higher NO emissions due to higher oxygen content and better combustion for very low values of ethanol concentration.

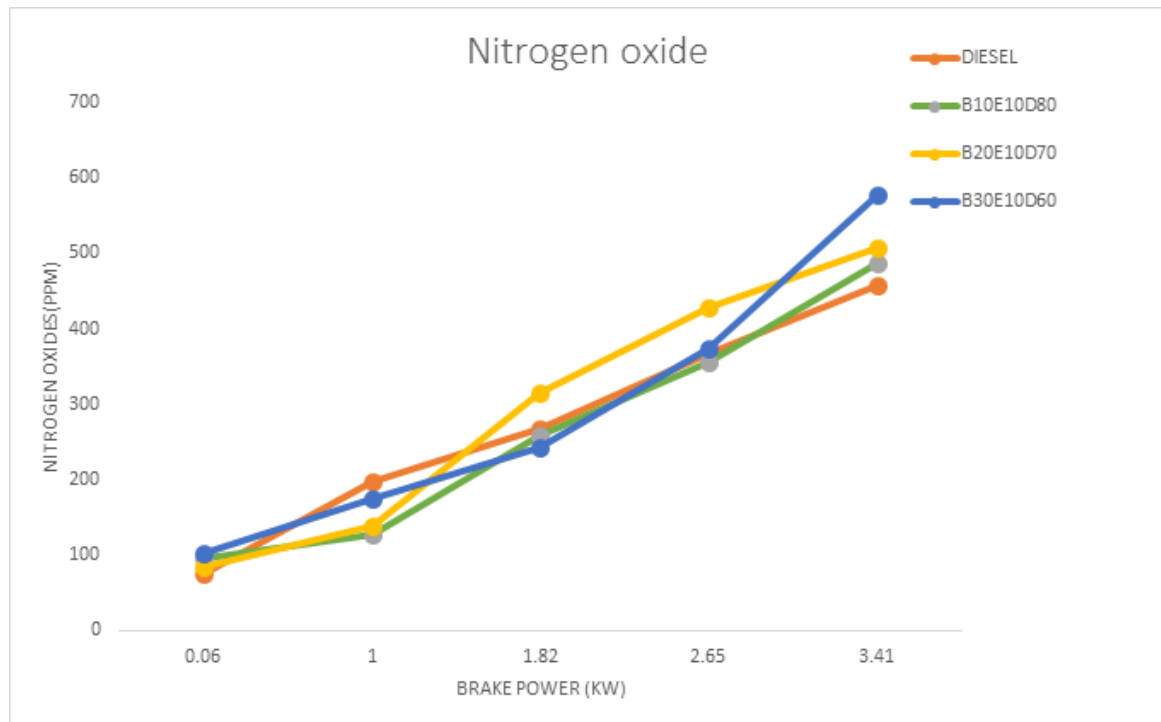


Fig. 5.3: Nox VS BP

Table 5.3: Nitrogen Oxide Emission

LOAD	DIESEL	B10 E10 D80	B20 E10 D70	B30 E10 D60
0.06	75	95	85	103
1	197	127	138	176
1.82	268	258	316	243
2.65	368	356	429	374
3.41	457	487	507	578

5.5 CARBON MONOXIDE EMISSIONS

CO emissions as a function of load for standard diesel and other char blends. It is clear from the figure that CO emissions increase with increasing concentration of ethanol and methanol. This is probably due to the low cetane number of alcoholic fuels, which increases ignition retardation, leading to incomplete combustion, thus increasing CO emissions. Another observation

indicates that biodiesel ethanol diesel blends result in higher CO emissions than biodiesel ethanol diesel. Compared to diesel fuel, ethanol blended fuels generate higher CO emissions and methanol blended fuels show lower CO emissions. However, it is expected that if the concentration of methanol in methanol-diesel biodiesel exceeds 20%, then biodiesel-methanol-diesel mixtures may generate more CO emissions than diesel. This is because adding small amounts of methanol improves the oxygen content of the mixture, leading to better combustion and a reduction in CO. But, as methanol concentration increases, the cooling effect of methanol lowers the gas temperature and leads to higher CO emissions. Therefore, the fuel mixture ratio and operating conditions play an important role in changing CO emissions.

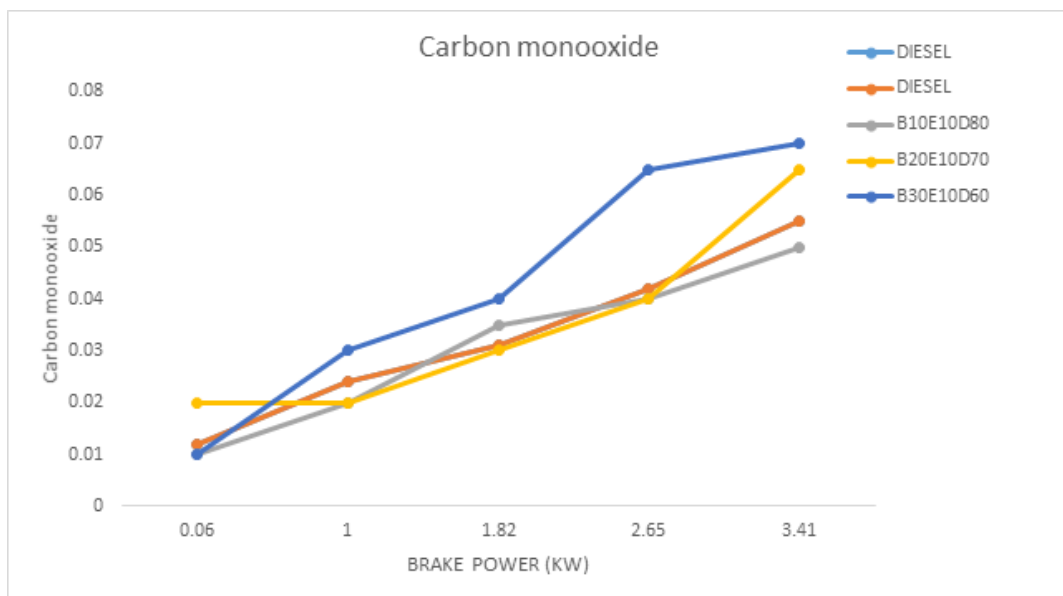


Fig. 5.4: CO VS BP

Table 5.4: Carbon Monoxide Emissions

LOAD	DIESEL	B10 E10 D80	B20 E10 D70	B30 E10 D60
0.06	0.012	0.01	0.02	0.01
1	0.024	0.02	0.02	0.03
1.82	0.031	0.035	0.03	0.04
2.65	0.042	0.04	0.04	0.065
3.41	0.055	0.05	0.065	0.07

5.6 HYDRO CARBON EMISSIONS

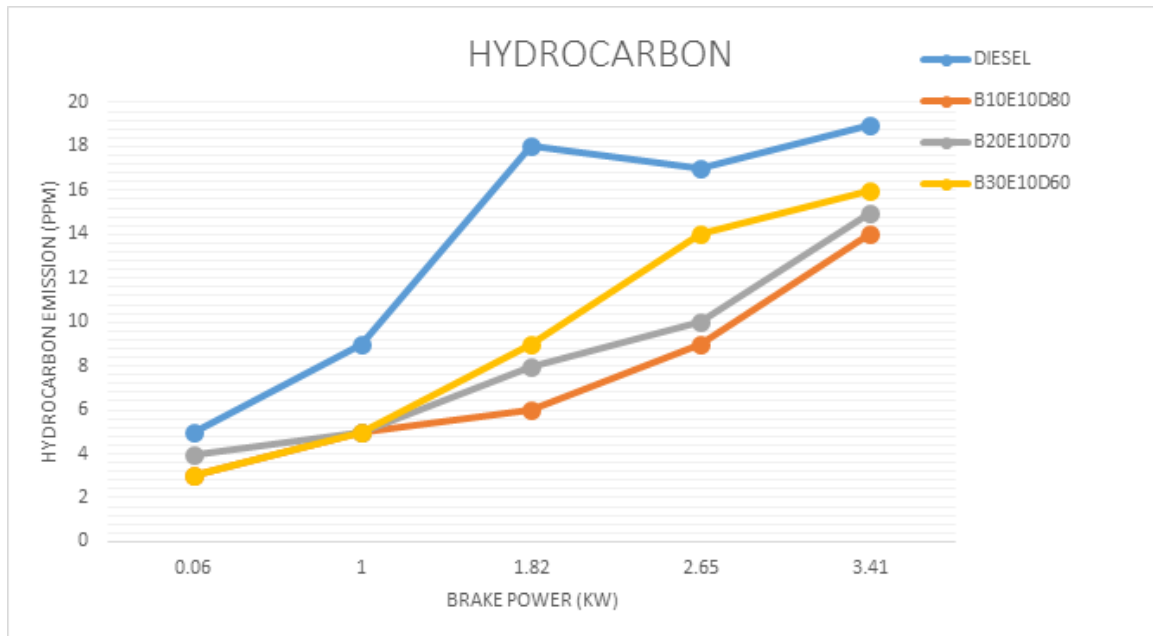


Fig.5.5: HC VS BP

Table 5.5: Hydro Carbon Emissions

LOAD	DIESEL	B10 E10 D80	B20 E10 D70	B30 E10 D60
0.06	5	3	4	3
1	9	5	5	5
1.82	18	6	8	9
2.65	17	9	10	14
3.41	19	14	15	16

5.7 SMOKE CAPACITY

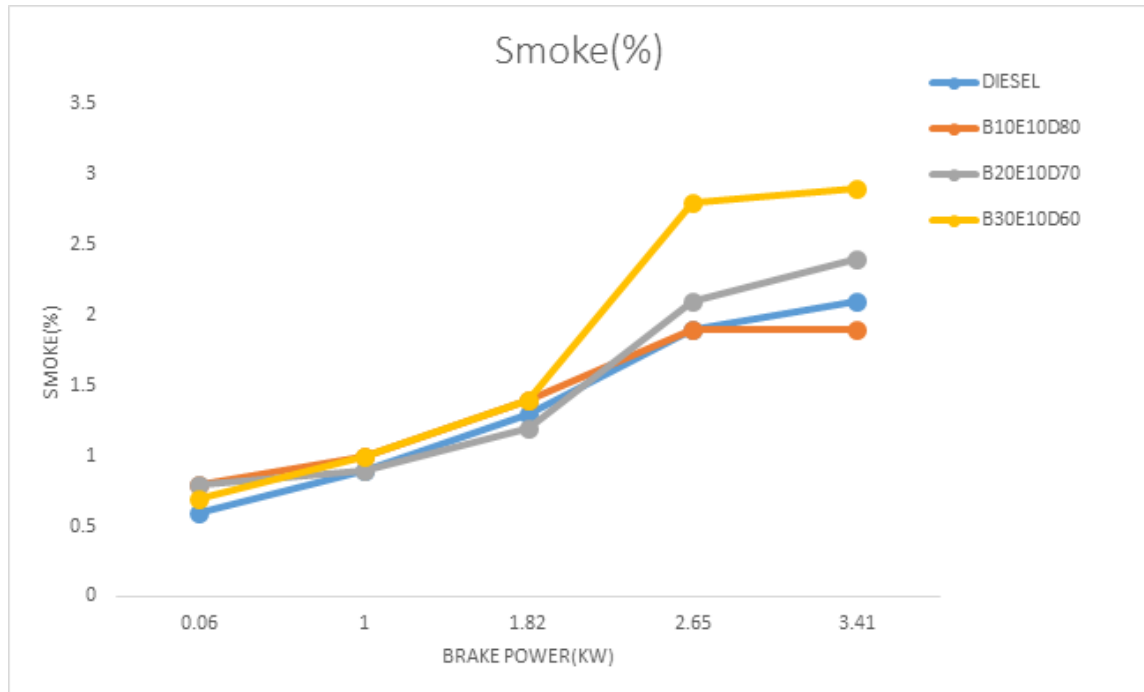


Fig.5.6: SMOKE (%) VS BP

Table 5.6 Smoke Capacity

LOAD	DIESEL	B10 E10 D80	B20 E10 D70	B30 E10 D60
0.06	0.6	0.8	0.8	0.7
1	0.9	1	0.9	1
1.82	1.3	1.4	1.2	1.4
2.65	1.9	1.9	2.1	2.8
3.41	2.1	1.9	2.4	2.9

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY AND CONCLUSION

In view of the physical and substance properties of biodiesel, ethanol and diesel, as well as the similarity and strength of the BED powers, the impact of the fills on diesel motor execution furthermore, discharges are researched tentatively. Ends are drawn as follows:

6.2 CONCLUSION

- (1) Because of the solubilizing impact of biodiesel on ethanol and diesel, great actual solidness of the BED fuel mixes having various extents of biodiesel, ethanol, and diesel can be kept up with inside a specific temperature range.
- (2) In the BED energizes, the disintegrated region diminishes with the lessening of encompassing temperature, and the common dissolvability of the BED powers is poor at 0°C. Whenever the proportion of the biodiesel is somewhere in the range of 25% and 55%, the ethanol and diesel can be broken up in any extent.
- (3) Because of the low warming worth of the BED fuel, the force of the diesel motor utilizing the BED fuel is lower than the force of utilizing diesel, and the power diminishes with the increment of the extents of ethanol and biodiesel, particularly at medium velocities and high loads. At the greatest force condition, the force of diesel motor utilized B30E10D60 fuel diminishes by 10.2%.

- (4) The same fuel utilization pace of the diesel motor utilized the BED fuel is lower than that of utilizing unadulterated diesel. At high loads, the upgraded ignition because of more oxygen of the BED fuel significantly further develops the ignition interaction. The same fuel utilization rate diminishes with the increment of the oxygen content in the BED fuel. At low loads, the temperature and strain in the chamber are low, and the admission whirl is feeble. The burning interaction is impacted by the cetane number of the BED fuel, fuel atomization, Inert hotness, oxygen content, fuel injector configuration, splash designs, ignition chamber coordinating, and different variables. The progressions in comparable fuel utilization rate are moderately complex, and there is no undeniable pattern.
- (5) The fundamental explanations behind the progressions in the outflows of the diesel motor utilizing the BED fills incorporate the accompanying: the idle hotness worth of ethanol, the high cetane number of the biodiesel fuel, and the physical and synthetic properties of twofold carbon bonds. Contrasted and unadulterated diesel, the CO discharges decline clearly with the increment of the oxygen content in the BED fills, and the NO_x outflows increment with the increment of biodiesel, and decline with the increment of ethanol. The NO_x is lower than that of utilizing diesel at high loads. The THC emanations decline with an increment of biodiesel content and increment with an increment of ethanol extent. The THC level is practically equivalent to that of utilizing unadulterated diesel at low loads, and the decrease abundance is somewhat huge at high loads.

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