

EFFECT OF Al_2O_3 NANOPARTICLES ON THE PERFORMANCE OF B20 BLEND OF RICE BRAN BIODIESEL IN CRDI ENGINE

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

by

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SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

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

Accredited with grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of S RIYAZ MOHAMED (Reg No. 37150157) and G SARATH (Reg No. 37150167) who carried out the project entitled "**EFFECT OF Al_2O_3 NANOPARTICLES ON THE PERFORMANCE OF B20 BLEND OF RICE BRAN BIODIESEL IN CRDI ENGINE**" under my supervision from November 2020 to March 2021

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ABSTRACT

Operating a CRDI Engine with bio-diesel has seen much advancement. Doping Nano additives are one among them. In the present study Alumina Nano particles are prepared and doped to the High performance fuel blend. High performance fuel blend consists of 80% Diesel+20%Bio-diesel. Three varieties of additive fuel blends are prepared with 30 ppm, 60 ppm and 90 ppm Alumina Nano oxides. The results are compared between with and without these Nano additives. The performance characteristics stated the prepared blends shows slightly lesser performance values compared with diesel, but on a contrast all the emission values are reduced by adding these additives.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbols	Abbreviations
B20	20% biodiesel and 80% diesel
ASTM	American Society for Testing and Materials
BSFC	Brake specific fuel consumption
BTE	Brake Thermal Efficiency
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
CP	Cylindrical Pressure
EGR	Exhaust Gas Re circulation
EGT	Exhaust gas temperature
HCC	Hemispherical Combustion Chamber
HC	Hydro carbons
Net HR	Net Heat Release rate
NO _x	Oxides of nitrogen
DP/Dq	Pressure Rise
SFC	Specific fuel Consumption

CHAPTER 1

INTRODUCTION

1.1 HISTORY AND BACKGROUND.

E.F. Aransiola et al (2012)[1] The population has been steadily growing in recent years, and as a result, energy demand has been increasing at a steady pace. The appetite for fossil resources has skyrocketed, as these fuels play a significant role in the world's energy supply. Around the same time, fossil fuels are nonrenewable energy sources, resulting in increased carbon emissions into the atmosphere. It has been estimated that fossil fuel consumption is responsible for 98 percent of carbon emissions.

Aside from the fact that petrol is becoming more costly, every country in the world has begun searching for the cheapest source of an alternative fuel. Furthermore, burning fossil fuels has detrimental consequences for our world as a whole; they contribute to climate change, which is caused by particles released into the environment when these fuels are burnt. Chemicals such as carbon dioxide and methane penetrate our atmosphere and absorb the heat of the sun, resulting in a steady increase in average global temperatures. This temperature rise has the potential to impact anything from natural habitat to sea level rise. Each country share of CO₂ emissions are shown in Fig 1.1. To overcome these type of situations we need to find an alternative fuel which will be low cost, nonedible and renewable. Many alternative fuels have been discovered to either replace diesel fuel partially or completely. Bio fuels can be used as a promising alternatives to diesel. In the year 1853 scientists E. Duffy and J. Patrick conducted the transesterification of a vegetable. This was many years before the first diesel engine even become serviceable. The history of bio diesel began in 1890's when "Rudolf Christian Karl Diesel" designed the compression ignition engine. Rudolf's first exhibition of the diesel engine was put on display on the World's fair in Paris 1898 and ran the engine with peanut oil .

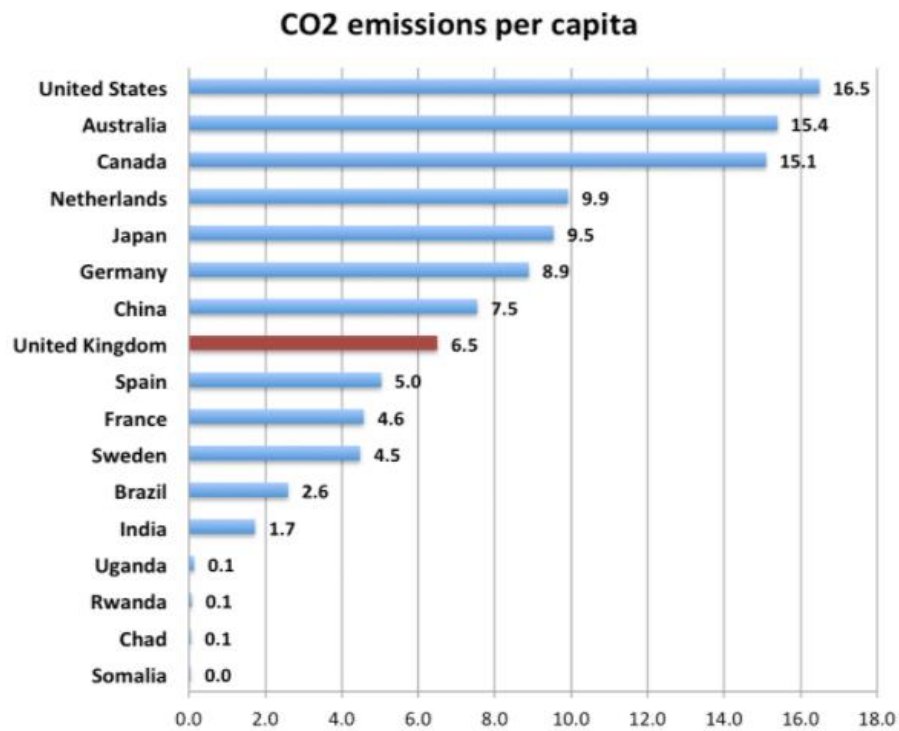


Fig 1.1: Each Countries Share of CO₂ Emissions.

The rising cost of gasoline and its depletion have sparked interest in alternative fuels for internal combustion engines. Among the different replacements, triglyceride-based fuels (vegetable oils/animal fats) tend to be a potential substitution for fossil diesel fuels. According to experts, vegetable oil has several concerns when used in compression ignition engines for long periods of time due to its high viscosity. Experiments were planned to research the impact of low viscous rice bran oil on engine combustion in this study. By raising the fuel temperature, the viscosity of the oil was minimized. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine typically used in stationary operation was used for the experiments. The acquired data were analyzed for various parameters, such as brake thermal efficiency, brake specific fuel consumption, exhaust emission of CO, CO₂, HC, and NO_x gases. While operating the engine on rice bran oil performance was found to be very close to that of mineral diesel for lower blend concentrations.

1.2 BIODIESEL AND NECESSITY FOR BIODIESEL:

C.W. Mohd Noor and others (2018)[10], The mono alkyl esters of long chain fatty acid oils derived from green lipoids such as vegetable and animal fats are known as biodiesel. B100 is a term that has been used to describe 100 percent biodiesel. Biodiesel-to-petroleum-diesel mixes are generally referred to as BXX, with XX denoting the proportion of biodiesel in the mix. B60, for example, is 60 percent bio diesel and 40 percent petroleum diesel.

J.Jayaprabakar,et.al (2014)[6] Biodiesel can be extracted in 4 ways, transesterification, direct use and blending, thermal cracking, micro emulsion. Out of these mentioned process transesterification process is the most common and widely used method for the extraction of bio diesel from vegetable oils. It is a chemical reaction process where the oil is converted to fatty ester. With alcohols to form esters and glycerol. The detailed explanation of transesterification is shown in the Fig 1.2 where the catalyst is being used to improve the conversion and process responses.

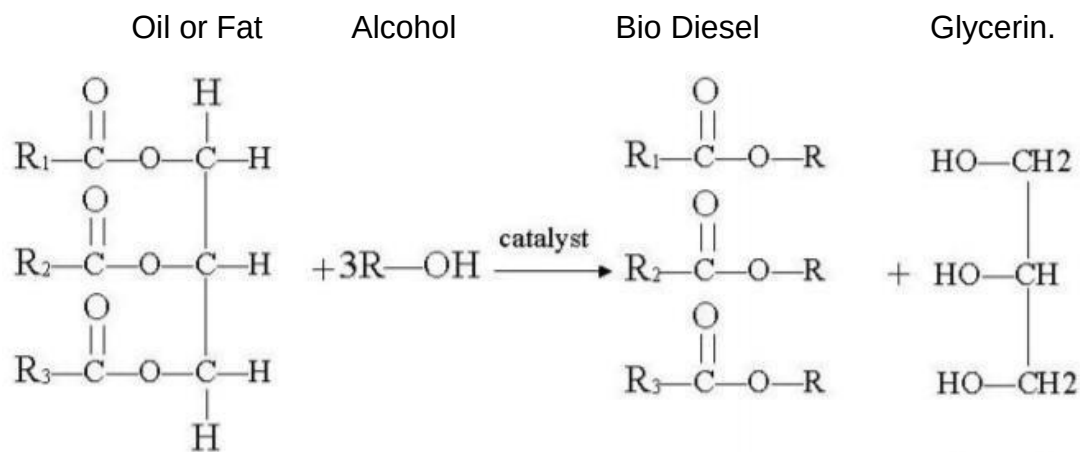


Fig 1.2: Transesterification process

1.2.1 NECESSITY FOR BIO DIESEL

H.K.Rashedul, et.al (2014)[4], Biodiesel is prepared to mainly use it in diesel engines, because the engine performance has to be compared with conventional diesel. The main usage of bio diesel is used to reduce the emissions and also these fuels give a number of advantages where these fuels are not explosive, nonflammable and non-toxic and also bio degradable. Compare to these advantages there are some disadvantages too. Some bio diesels give NO_x emission which are so harmful to environment, and the flow properties are very poor in low temperatures. The usage of biodiesel can be one form of considering economic factors where the conventional fuel prices are high and also they affect to the environment and cause damage to the ozone layers causing to severe accidents. It is so difficult for the poor countries to buy these conventional fuels so there is a need to use bio fuel which are economical in terms of cost and not causing harm to environment. Due to this reason biodiesel has to be used.

1.3 BIODIESEL SOURCES AND ITS CLASSIFICATION.

Since there is a tremendous need to monitor the use of non-renewable fossil fuels, alternative sources of fossil fuels are being investigated. Biofuels can be divided into two categories: primary and secondary origins. Firewood, wood chips, pellets, animal wastes, woodland and crop residues, and landfill gas are the main sources of biofuels. For older generations, these main sources are also in use. In the modern age the secondary sources are used for generating bio diesel and they are classified into first, second, third generations respectively.

1st generation bio fuels are made up by the bio ethanol or butanol which are produced from the fermentation of starch such as wheat, barely, corn, potato, sugar. And also from the oil crops, waste cooking oil, animal fats etc.

2nd generation bio fuels are produced from the oil plants such as Jatropha, Cassava, elephant grass and also from lignocellulosic materials like straw, wood and grass.

John R.P, et.al. (2011)[7] 3rd generation bio fuels are produced from the extracting oil of algae sometimes referred as "Oilgae". Its production is supposed to be low cost and high yielding. Algae is the most economical and environmental

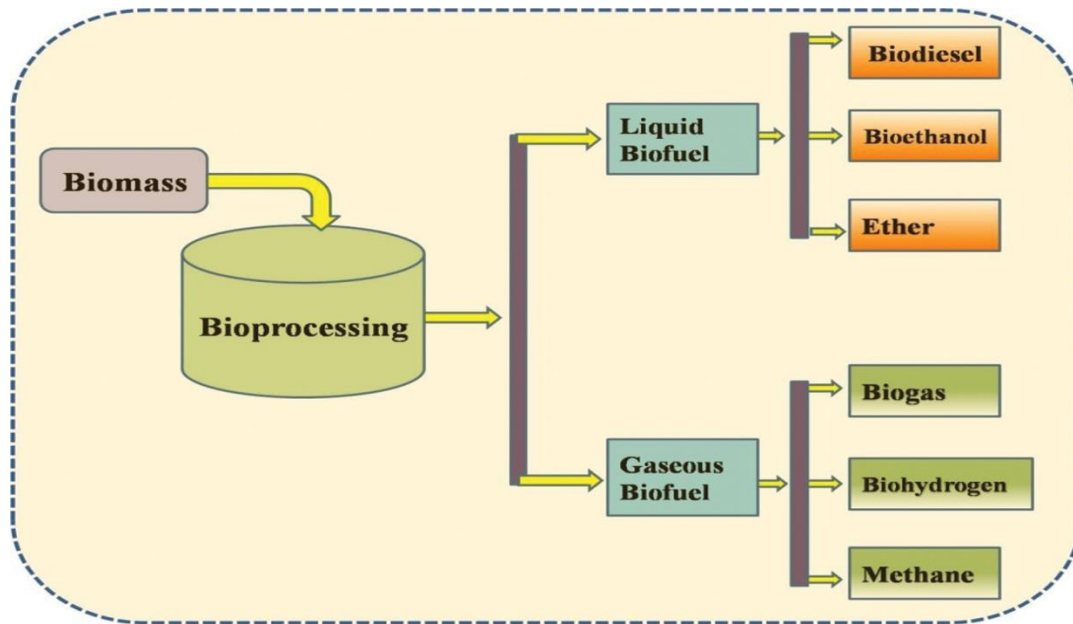


Fig 1.3: Classification of Biofuels.

sustainable and also renewable source of bio mass which can be used in the production of bio fuels. Y.Zhang,et.al (2003)[25], Rice bran oil is used to produce bio diesel which leads to the reduction of raw material cost.

1.4 INFORMATION ABOUT BLENDS

Rodica Nieuleacu,et.al,(2019)[20] Bio diesel can be mixed in a variety of quantities and used in a variety of concentrations. B20 (20 percent bio diesel) are the most widely used bio diesel blends; B100, which is the pure type of bio diesel used as a blend stock for lower blends but cannot be used for transportation, is seldom used. Blending diesel with biodiesel increases the biodiesel's properties and has a range of advantages. Bio diesel can be mixed up to 30% of diesel fuel and used in CRDI. engines without any modifications. The use of a B20 diesel blend in bunks is illustrated.

Lapuerta,M.et.al (2010)[9],The diesel and bio ethanol blend can be used as alternative as a renewable fraction in automobiles which will grow attention in economic and environmental advantages. The stability will increase when biodiesel is added to the diesel fuel and while adding the alcohols to the blend will loss lubricity of the fuel blend. Alpaslan Atmanli (2016)[3].,Higher alcohols such as propanol, n-butanol and 1-pentanol can be added to diesel-biodiesel blend for improving cloud point, cold filter plugging point and leads to the reduction of density, lower heating value, kinetic viscosity, Cetane number, and flash point . Nadir Yilmaz,et.al (2014)[16] By adding the rice bran oil to diesel- biodiesel-alcohol blends can increase the CO and HC emissions but it reduces the NOx emission . A.Anderson, A Prabhu, et.al (2019)[1].The properties of biodiesel can be increased by adding the nanoparticles to the diesel-biodiesel blends. The Nano metal additives like zinc oxide, aluminum oxide, iron oxide and titanium oxide can be added for the better performance of the fuel and this also can improve the combustion characteristics, lowers the ignition delays, increase the density, and emissions can be reduced . These blends are commonly known as high performance blends as their performance characteristics like volumetric efficiency, exhaust gas temperatures, specific fuel consumption and brake thermal efficiency producing better results while compared to other blends.

1.4.1 Nano Additives

Ribeiro N M ,et.al (2007)[19] Nano additives are nanoparticles that will improve the properties of biodiesel when blended with gasoline. Through using these Nano additives, the fuel enrichment process can be improved, and several studies have shown that these Nano additives are very effective in enhancing fuel properties, enhancing efficiency characteristics, and lowering exhaust emissions. Vijay Kumar Chandrasekaran and his colleagues (2016), The surface area of nanoparticles is higher than that of bulk particles, and since their size is smaller, they can be conveniently blended into biodiesel and used in CRDI engines without modification. These nanoparticles improve the reaction rates. Some of the Nano additives explored as additives to the biodiesel are elaborated as follows

- ALUMINA OXIDE.
- CNT OXIDE.
- CERIUM OXIDE.
- MAGNESIUM OXIDE.
- COBALT OXIDE.
- COPPER OXIDE.
- IRON OXIDE.
- COBALT OXIDE.
- ZINC OXIDE.
- TITANIUM OXIDE.
- GOLD OXIDE.
- SILVER OXIDE.



Fig 1.5: Types of Nano Additives.

1.5 PRESENT STUDY

Rice bran is a byproduct of the rice milling process (the conversion of brown rice to white rice), and it contains various antioxidants that impart beneficial effects on human health. In the present study we choose rice bran oil to prepare biodiesel through transesterification process where this rice bran oil reacts with methanol, to produce glycerol and methyl ester (Biodiesel). For the further investigation of this study we collected materials like Diesel, Pentanol, and Rice bran oil and Alumina Nano additives. So the prepared biodiesel is blended with Diesel and Pentanol to increase the performance characteristics and reduce the exhaust emissions. We have blended the materials collected in different identified proportions into three blends as follows,

- 80%Diesel+20%RBOBD
- 80%Diesel+20%RBOBD+30ppm+Alumina Nano additives
- 80%Diesel+20%RBOBD+60ppm+Alumina Nano additives.
- 80%Diesel+20%RBOBD+90ppm+Alumina Nano additives.

The prepared blends are mixed with 30ppm,60PPM and 90ppm Alumina Nano additives in Ultrasonicator. Ultrasonicator is a device in which the sound energy is used at high frequencies to mix the Nanoparticles with the blend thoroughly. We investigated the Performance, Combustion and Emission properties by pouring the identified blends into the CRDI engine. The results obtained from this engine testing are studied and analyzed.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION.

Many number of researches have already done to the production of biofuels, properties and their performance in diesel engine, even so many number of researches have done on the biodiesel preparation from rice bran oil but very few number of literature reviews are investigated on the usage of rice bran oil biodiesel blends in

Around 190 research papers on the performance, combustion, and emission characteristics of biodiesel-diesel blends have been published in prestigious international journals and conferences using the CRDI engine. We looked at a number of academic papers before settling on high-performance fuel as our primary blend. Despite the fact that several experiments have been undertaken on this fuel, only a handful have focused on applying Alumina Nanoparticles to this high-performance fuel blend in order to enhance performance characteristics such as volumetric quality, basic fuel intake, exhaust gas temperatures, and carbon monoxide (CO), NO_x, HC, and smoke exhaust emissions.

2.2 EFFECT OF BIODIESEL IN A CRDI ENGINE.

Maginlapuerta, Jose M. Herreros (2008)[12] reported that the alcohol derives biodiesel fuels like methyl ester and ethyl ester extracted from Rice bran oil. About 30% and 70% biodiesel blend with diesel on Volume basis and tested in common rail direct injection Compression Ignition engine. This report shows the results of slight increase in consumption of fuel, less difference in NO_x emission and tremendous control of hydrocarbon emissions, smoke and particle emissions.

Mangesh G Kulkarni and Ajay K Dalai (2006)[11] stated that biodiesel is a non-toxic and bio degradable alternative fuel which is prepared from the renewable sources. Out of the many economical sources for biodiesel Rice bran oil is the best Source as its cost is comparatively very less than petroleum based Diesel fuel. Rice bran oil biodiesel when tested on Commercialized diesel engines shows better engine performance and very low emissions.

Ozer Can (2014)[17] have performed the research on rice bran oil biodiesel blends with diesel fuel in Compression Ignition engine. The performance of engine and combustion results showed that at all engine loads while adding the biodiesel the ignition delay occurs due to biodiesel fuels having high cetane number. Also addition of biodiesel results in less increase on Brake specific fuel consumption and reduces the Brake thermal efficiency but the HC and smoke emissions are reduced highly.

Xiangmei Meng, Guanyi Chen, Yonghong Wang (2008)[24] have tested the B20 (20% Biodiesel), blends of rice bran oil bio diesel in a CRDI engine and analyzed the performance, combustion and emission characteristics. This investigation revealed that B20 blend fuels showing the reduced HC and CO emissions. Jayaprabakar and Karthikeyan (2014)[6] reported that the biodiesel blends shows the higher brake thermal efficiency values while compared to pure diesel. The amount of heat released during biodiesel combustion is more whereas the diesel gives very less heat. The results showed that the algae blends of B20 Can act as a promising alternative for the diesel fuel in CRDI engine without any modification.

2.3 EFFECTS OF HIGH PERFORMANCE FUEL IN A CRDI ENGINE.

Li, Li, Wang, Jianxin, Wang, zhi, Xio, Jianhua (2015)[8] in a test they have studied that the addition of Pentanol to diesel and biodiesel blends in different proportions in the single cylinder direct injection diesel engine and reveal the effects of performance, combustion and emission. The Pentanol blends shows the high indicated thermal efficiency than pure diesel for all tested loads from 0.5 to 1 mpa. Finally it has resulted that with 80% diesel- 20% biodiesel – 30%pentanol gives the better combustion and emission characteristics along with economy performance compared to other fuels.

Alpaslan Atmanli (2016)[3] did his work on to investigate and compare higher alcohols adding to diesel biodiesel blends results in positive economic and environmental outputs due to high cetane number and calorific value. The cloud point and cold filter plugging point improved where the density, heating value, kinetic viscosity, cetane number and flash point decreases slightly. Especially higher alcohol like 1-pentanol, has the most effective results which reduces the oxides of nitrogen while compared to n- butanol and propanol.

Nadir yalmaz, et al (2017)[16] completed an experimental investigation on 1-Pentanol, a higher alcohol while adding to diesel – biodiesel blend in C.I. engine. According to the results obtained from the engine test the brake specific fuel consumption and exhaust gas temperature increased as we adding the 1-pentanol to diesel – biodiesel blend. Engine testing results also shows that there is a decrease in brake thermal efficiency for the blended diesel fuels.

A. Prabhu, M Venkata Ramana (2018)[18] in their report stated that higher alcohol like Pentanol has enrichment in oxygen during combustion process which can act as the catalyst to the fuel for the better combustion. In their study they blended Pentanol with diesel blends in various proportions and the results concluded that Pentanol can act as oxidizing catalyst and can reduce the Carbon monoxide and hydrocarbon emissions and it also increases the brake thermal efficiency and the consumption of fuel is reduced.

Prabhu Appavu, et al (2019)[18] in their investigation stated that quaternary blends (diesel- biodiesel-alcohol-vegetable oil).can replace the fossil fuels to a higher extent. This current research work focuses on various proportions of Pentanol mixing with diesel- biodiesel-vegetable oil blend and resulted that brake specific fuel consumption and brake specific energy consumption are reduced while we increasing the addition level of Pentanol. While coming to the emission results the emissions like hydro carbons, carbon monoxide, and smoke are reducing while oxides of nitrogen slightly increases. The characteristics of combustion revealed that 40% Pentanol blended with diesel- vegetable oil, has the maximum peak pressure with increased heat release rate. Hence the addition of the Pentanol to diesel-biodiesel-vegetable oil acts as a promising alternative mixture of fuel in improving the performance characteristics and reducing the emissions level.

2.4 EFFECT OF ADDITION OF NANO ADDITIVES TO HIGH PERFORMANCE FUEL. T.Shaafi, R.Velraj (2015)[22] investigated the characteristics like Performance, Combustion and emission of two modified fuel blends, B20 (80% Diesel 20% Biodiesel) and

compared the outcome results with neat diesel. The results showed that cylindrical pressure and heat release rate are higher in Nano additive blend and the exhaust gas temperature is reducing while compared to neat diesel.

J. Sadikbasha and R.B.Anand (2011)[21] researched on their biodiesel blends and their blends comprises of 83%JBD+15%W+2% of surfactants and their blends are mixed with alumina Nano additives in the proportion of 25ppm, 50ppm, 100ppm with the help of ultrasonicator and they have tested these blends in a Compression Ignition engine, where the performance has been improved and emissions were reduced when it is being compared to the neat diesel.

Manzoore Elahi M.Soudagar, et al (2018)[13] stated that the addition of Nano sized particles with diesel-biodiesel blends have thermo physical properties in an improved way and also improvisation in heat transfer rate and their stability of fuel mixtures. By the addition of these Nano sized particles the performance of engine has been improved and exhaust emissions were reduced depending upon dosage of these Nano additives.

Mina Mehregan, Mohammad Moghiman (2018)[14] investigated that effects of addition of Manganese oxide and Cobalt oxide Nano additives in a diesel-biodiesel fuel. And their blends comprises of B20 (20% of Rice bran oil) and the remaining is 80% of diesel, these blends are mixed up with 30ppm, 60ppm and 90ppm of Nano additives their experimental results have shown that the Brake specific fuel consumption and brake thermal efficiency of the blended fuel having Nanoparticles are improved. Whereas the Carbon dioxide and Nitrogen oxide emissions were relatively decreased when it is compared with the base fuel.

2.5 SUMMARY OF LITERATURE REVIEW

Many literatures have been reviewed and studied thoroughly and the group of results have arrived from the literatures. The current research work has many methodological facts and based on that the conclusions are incorporated. The outcome results and conclusions are as follows:

1. Without any modification in CRDI engines the biodiesel obtained from the renewable sources like animal fats and plant seeds can act as an alternative fuel.
2. To replace the harmful fossil fuels the alternative biofuels should be produced from low cost feed stock and renewable sources like Rice bran oil.
3. B20 blend which consists of 80% diesel and 20% biodiesel is best blend as it reduces the CO,HC,NOX emissions highly when compared to diesel fuels
4. The performance characteristics like brake thermal efficiency decrease and specific fuel consumption increases but the emission levels are controlled in a great level on addition of biodiesel to diesel fuels.
5. Addition of higher alcohols to diesel-biodiesel blends can results in positive economic and environmental results due to high cetane number and calorific value
6. Higher alcohols like 1-pentanol has most effective results compare to n-butanol and n-propanol as it reduces the NOX emissions more and decreases the cloud point, density, viscosity and flash point
7. The blends with 80%diesel,20%biodiesel,20%pentanol,10%rice bran which is known as high performance fuel as it gives the better performance and emission results compared to other blends
8. Nano additives can also acts as an additive source to high performance fuel blend as they decrease the exhaust gas temperature
9. Addition of alumina Nano particles to the high performance fuel blend can increase the brake thermal efficiency and reduces the harmful exhaust gases.

After investigating many literatures we get to know that so much of research have already done on the biodiesel blends. But there is very limited research done on the Nano particles addition to the high performance fuel. So this study is focusing on the performance, combustion, emission characteristics of the different blends with and without adding alumina Nano additives.

CHAPTER 3

AIM AND SCOPE OF THE PROJECT

3.1 AIM OF THE PROJECT

- To prepare biodiesel from rice bran oil.
- To blend the rice bran oil biodiesel with diesel, Pentanol, and biofuel (high performance fuel).
- To mix the alumina Nano additives to the prepared blend in the identified proportions.
- To test the prepared fuel blends in Common rail direct Injection engine to study its properties.

To analyze the performance, combustion, and emission characteristics of prepared blends with and without addition of alumina Nano additives.

3.2 SCOPE OF THE PROJECT

Since fossil fuel emissions are growing every day and are non-renewable and detrimental to the climate, biodiesel can be seen as a renewable and environmentally friendly substitute. Rice bran oil biodiesel is the most cost-effective and environmentally friendly choice. The engine dynamics can be more accurate due to the mixture of gasoline, rice bran oil bio diesel, pentanol, and vegetable oil. Through applying alumina nano additives to a high performance mix, this research work offers a solution to how compression ignition engines work.

CHAPTER 4

MATERIALS AND METHODS

4.1 METHODOLOGY OF RESEARCH

With the information and facts learnt through various Literatures and study materials, the detailed experimental methodology proposed for the researched work is illustrated in the fig 4.1, the details of materials required, methods applied, specifications of the instruments used, working principles and the experimental procedures by which the research has been conducted are explained in this chapter. The first step explains Production of biodiesel from Rice bran oil. And the second step explains Preparation of high performance fuel blends (Samples) by blending biodiesel with diesel, Pentanol, rice bran and addition of alumina Nano additives. And the third step explains preparing the blends (samples) they have to be placed in an ultrasonicator bath. Where the blends are thoroughly mixed up. And the fourth step describes To Check the properties of fuel samples and perform engine testing, and the final step of the process is to perform the engine testing and analyze the Performance, Combustion and emission results.

4.2 MATERIALS REQUIRED

The materials required for our research work are, Alcohol – Methanol, Oil – Rice Bran oil, Catalyst – NaOH (Sodium hydroxide), Diesel, CRDI Engine

4.3 THE BIODIESEL PRODUCTION FROM RICE BRAN OIL

The rice bran oil is bought in shop. Then it is given to IRC in sathyabama institute of science and technology. They prepared the biofuels by using transesterification.. The detailed biodiesel preparation process is explained in this section.

4.3.1 Mixing of Catalyst to Alcohol

The work uses sodium hydroxide pellets (Caustic soda) as a catalyst. The methanol must be mixed in these dry caustic balls. Using a magnetic stirrer, roughly 5 grammes (0.5 weight percent of rice bran oil) of NaOH pellets are combined with 182 ml of methanol (molar ratio of 1:6 to rice bran oil) for about 90 minutes. It was made certain that the dry NaOH pellets were properly combined with the methanol.

4.3.2 Transesterification Process

First we need to check for the free fatty acid content present in the oil. If the free fatty acid content is greater than 4% then the process we have to choose is a Transesterification process. Transesterification is the process of exchanging the organic group R'' of an ester with the organic group R' of an alcohol. These reactions are often catalyzed by the addition of acid or base catalyst. It is a process in which the oil (tri glycerides) react with methanol in the presence of a catalyst of sodium hydroxide the gives rise to the methyl ester (biodiesel) and glycerin.



Fig 4.3 : Transesterification process

As this transesterification process produces about 98% of the biodiesel yield which requires only low pressures and temperatures this process is considered as a most economical one and almost all type of biodiesels can be produced from this process. Take a conical flask and mix the 1litre of oil and the mixture of methanol and NaOH by using magnetic stirrer for 3 hours at 300rpm. The reaction temperature should maintain about 60⁰c throughout the reaction.

4.3.3 Separation process

The reacted mixture is taken and poured into the two opening flask and settles down the mixture for about 15 minute. Due to the gravity and higher density glycerin settles down at bottom of the flask and the methyl ester or biodiesel stays at the top of the conical separator flask. The glycerin can be easily drained out by using the opening value at the bottom. As the two layers are clearly identified so we can easily separate the glycerin from methyl ester.

4.4 PROCESS OF PREPARING FUEL BLENDS

As the pure diesel is giving more emissions and also it is biodegradable non-renewable fossil fuel. The alternative rice bran oil is prepared by the transesterification process but that biodiesel cannot use directly in the compression ignition engine. So the biodiesel is blended with diesel and alcohol with some rice bran because this blend will give best performance, combustion and emission characteristics according to many literature papers. So the diesel is taken from the Indian petrol bunk near Sathyabhama University The rice bran was bought from the oil shop. 500ml of three blends are prepared by adding 400ml of diesel (80%), and 100 ml of rice bran oil biodiesel (20%) the components are measured by using measuring jar and using funnel the blends are prepared in a bottle. So totally 3 bottles of 500ml each blends are prepared.

4.5 PROCESS OF ADDING ALUMINA NANO ADDITIVES

For the better performance combustion and emissions the alumina Nano additives are added to the prepared blends by referring many journals the proportions of alumina Nano particles to be added are taken as 30ppm, 60ppm and 90ppm. Alumina Nano particles were bought from the chemical agency in Chennai. The addition of these alumina Nano particles to the prepared blends are done in the Ultrasonicator.

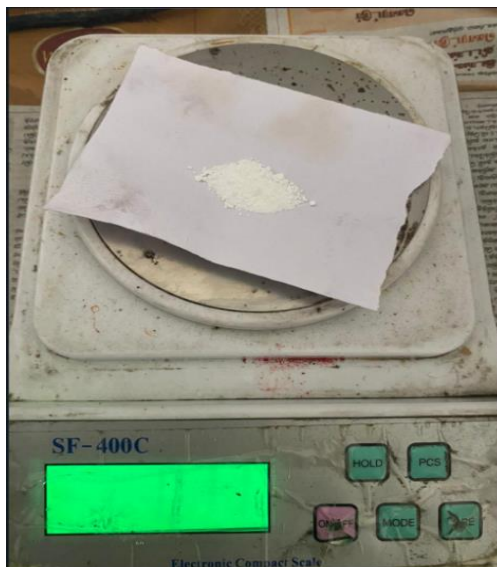


Fig 4.7: Weighing Of Alumina Nano Additives

4.5.1 Ultrasonication Process

Ultra-sonication is the process which will take place in the machine called Ultrasonicator. Ultra-sonication is used to speed dissolution, by breaking intermolecular interactions. When the sample cannot possible to stir with tubes then this process of ultra-sonication can be used to mix the samples by applying the sound waves to the particles present in the blend. For the addition of the alumina Nano particles to the prepared blends the ultra-sonication process is used. The Nano particles are measured in the proportions of 30ppm, 60ppm and 90 ppm into milligrams. The Nano particles measured are added to the blends by keeping the samples in the ultrasonicator. After some time the alumina Nano particles are completely mixed with the prepared blends with addition of 30,60 and 90 ppm alumina Nano particles are ready for the engine testing.



Fig 4.8: Ultrasonicator Bath

Table 1 4.1 Properties of Blends

PROPERTIES	RB20	RB100	D100
DENSITY @20C,kg m ³	0.8524	0.882	0.845
Kinematic viscosity	1.69	8.4	0.84
Flashpoint,°C	153	221	52
Calorific value cal/g	9842.6+	8642.63	10143.916

4.6 ENGINE TESTING AND ANALYSIS.

The experimental research is done in a single cylinder, four stroke diesel engine and it is connected to an eddy current type dynamometer for loading. For the combustion pressure and crank angle measurements it is provided with necessary instruments.

4.6.1 Engine Details.

The engine specifications that was used to carry out the various test are mentioned in the table 4



FIG 4.9: Testing Engine

TABLE 4.2: Engine specifications

Cooling	Water-cooled engine
Model	Kirloskar TV1
No.of.Cylinders	1
Cubic Capacity (liter)	0.661
Rated Speed (rpm)	1500
Governing	Class “A2/B1”
Power	5.20KW
Power Rating	7 hp
Cylinder bore	87.50mm
Stroke length	110.00mm
Connecting rod length	234mm
Compression ratio	17.50
Swept volume	661.45cc
Over all dimensions	Width 2000*length2500*height1500mm.

4.1.1 PROPERTY ANALYSIS

The property analysis of the engine are mentioned in Table 4.3

Table 4.3: Properties of D100

Parameters	Results
Acid Value	0.11 mg NaOH/g of oil
Density	0.845 g/cc
Kinematic Viscosity @40°C	0.84 cSt
Copper Strip Corrosion @ 60°C for 3hrs	1a
Fj-lash point by PMCC method	52°C
Fire point by PMCC method	67°C
Cloud point	-5°C
Pour point	-12°C
Moisture content	0.010%
Calorific value	10143.916 Cal/g

Table 4.4 Properties of RB100

Parameters	Results
Acid Value	1.3 mg NaOH/g of oil
Density	0.822 g/cc
Kinematic Viscosity @40°C	0.84 cSt
Copper Strip Corrosion @ 60°C for 3hrs	1a
Flash point by PMCC method	221°C
Fire point by PMCC method	234°C
Cloud point	2°C
Pour point	-10C
Moisture content	0.013%

Calorific value	8642.63 Cal/g
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Table 4.5 Properties of RB20

Parameters	Results
Acid Value	0.42 mg NaOH/g of oil
Density	0.8524g/cc
Kinematic Viscosity @40°C	1.69 cSt
Copper Strip Corrosion @ 60°C for 3hrs	1a
Flash point by PMCC method	153°C
Fire point by PMCC method	161°C
Cloud point	20°C
Pour point	13°C
Moisture content	0.06%
Calorific value	9842.6Cal/g

Table 4.6 Transesterification of Rice bran oil

Parameters	Results
Free fatty acid	0.50%
Catalyst (NaOH) quantity	5 grams
Oil to methanol molar ratio	1.6
Temperature	60°C
Reaction time	90 minutes
Yield	93.4%



Fig 4.14: Smoke meter and Gas Analyzer

The fig 4.14 shows a gas analyzer and a smoke meter. The diesel exhaust smoke meters are also known as opacity meters which identify and measure the amount of light blocked in a sample of smoke given out by diesel engines. The smoke meter displays the smoke density giving the rate of the efficiency of the combustion. The smoke meter consists of an optical unit mounted inside a measuring head which also has a separate electrical control unit. The gas analyzers are of the principle that the absorption of light by the gas under test. The analyzer only needs to shine a beam of light via the unheated chamber then it is measured to understand how much, the specific wavelength was observed by the sample. The analyzer consists of an optical filter that cancels out all light leaving the wavelength that the selected gas molecule can observe. Other gas molecules will not absorb light at this particular wavelength, and they don't even affect the amount of light reaching the detector.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION

The experimental investigations were conducted on the blends with and without adding alumina nano additives and results are analyzed. For the purpose of better comparison, the pure diesel results are also compared at the similar conditions. The results obtained from the engine testing are analyzed and presented through graphs. The performance, combustion and emission of all the three blends with and without adding alumina nano additives are discussed and obtained from engine testing.

The performance parameters consists of Brake thermal efficiency, Specific fuel consumption, Exhaust gas temperature and volumetric efficiency. The combustion parameters include cylinder pressure, change in pressure with change in heat and net heat release rate for all three blends. The emission characteristics include Carbon monoxide, Carbon dioxide, Hydro carbon, Oxides of nitrogen and smoke parameters of all three blends of all three blends with and without addition of alumina nano additives and compared with the diesel results and presented in the graphs.

5.2 PERFORMANCE CHARACTERISTICS

Brake thermal efficiency, specific fuel consumption, and volumetric efficiency and exhaust gas temperature which are all the performance characteristics of the blended fuel are explained in this section.

5.2.1 Brake Thermal Efficiency

Brake Thermal Efficiency is defined as break power of a heat engine as a function of the thermal inputs from the fuel. It is used to evaluate how well an engine converts the heat from a fuel to mechanical energy. It is mainly affected by fuel properties such density and heating values.

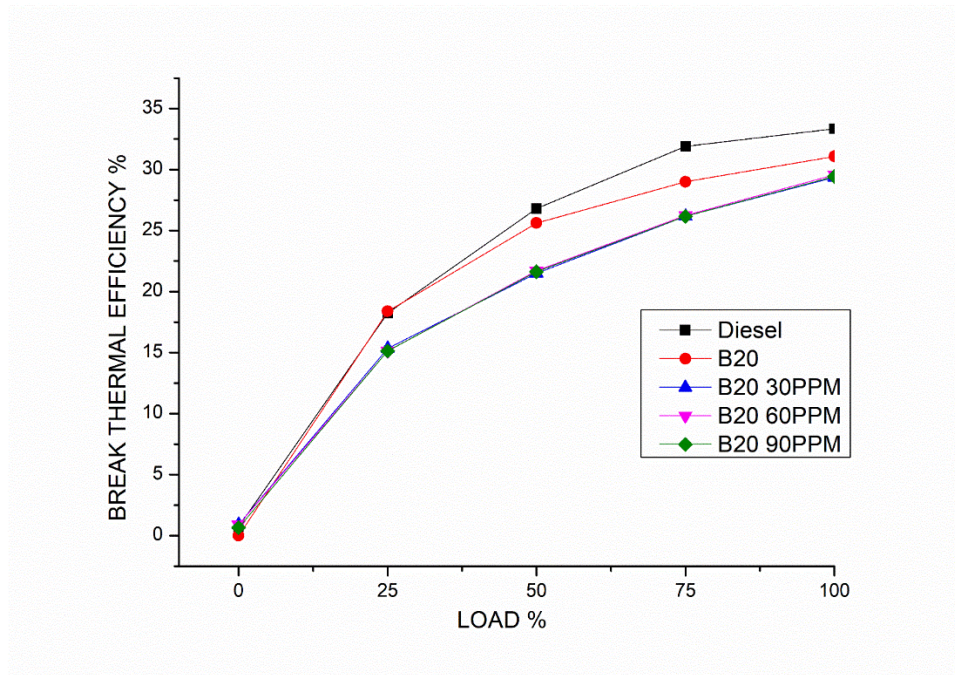


Fig 5.1: Brake thermal efficiency.

It is observed from the graph that variation in brake thermal efficiency against different loads. The graph is drawn between different loads in x-axis and Brake Thermal Efficiency in y-axis. It clearly shows from the above graph that the diesel has highest brake thermal efficiency and it is followed by B20, B20 30PPM, B20 60PPM, B20 90PPM. But it is finally observed that B20 30PPM, B20 60PPM, B20 90PPM has the same brake thermal efficiency. This is due to the increased density and viscosity and reduced calorific value, which prohibits proper atomization and thereby poor combustion. The results show that the efficiency of B20 30PPM, B20 60PPM, B20 90PPM is lesser than diesel. So, the diesel has highest brake thermal efficiency throughout the load.

5.2.2 Specific Fuel Consumption

It is amount of fuel consumed by a vehicle for each unit of power output. Specific fuel consumption of an engine is the rate of fuel burnt to produce a unit of thrust. Lower the specific fuel consumption it will give higher mileage. The fuel property like heating value will vary the amount of specific fuel consumption value

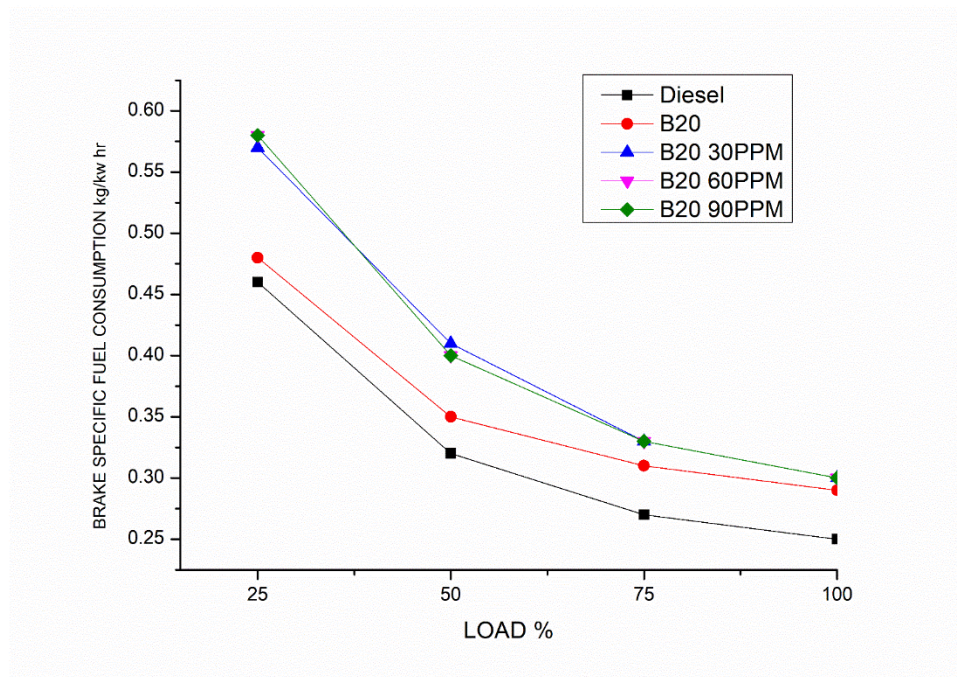


Fig 5.2: Specific fuel consumption

With reference to the above graph, it shows the changes in specific fuel consumption against various loads. The graph is drawn between different loads in x-axis and specific fuel consumption in y-axis. It decreases with increase in loads. At 25% load B20 60PPM and B20 90PPM has more specific fuel consumption than others. As the load increases it decreases with specific fuel consumption. However, while increasing the biodiesel blend to 100%, there was a fall in efficiency even with the addition of nano particles. This is due to the increased of density and viscosity and reduced calorific value, which prohibits from proper atomization and thereby poor combustion. Finally at 100% load B20 30PPM, B20 60PPM and B20 90PPM shows the highest specific fuel consumption and they are similar to each other. But 100% load diesel shows the least specific fuel consumption

5.2.3 Volumetric Efficiency

Volumetric efficiency is the ratio of volume of air sucked by the engine to volume swept by the piston. Piston moves towards bottom dead center in expansion stroke but the volume it sucks from outside is not the same it has swept while expanding.

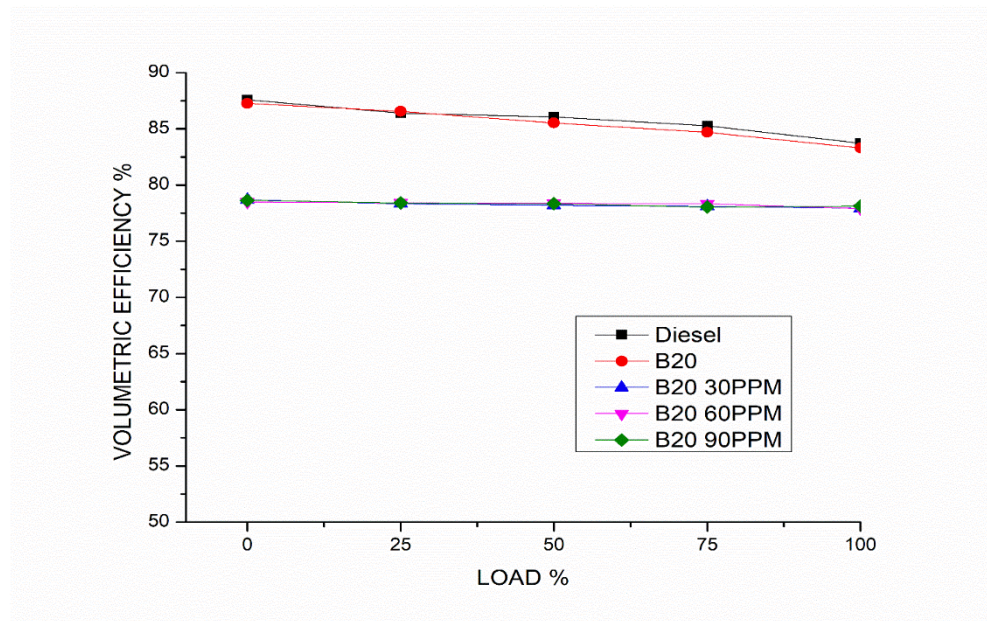


Fig 5.3: Volumetric efficiency.

The above graph shows the variations in volumetric efficiency at different loads. The graph is drawn between different loads in x-axis and volumetric efficiency in y-axis. From the graph it shows that Diesel and B20 has the same volumetric efficiency. But B20 with B20 30PPM, B20 60 PPM and B20 90PPM has the same volumetric efficiency. Even from lower loads to higher loads.

5.2.4 Exhaust Gas Temperature

Exhaust Gas Temperature is a measurement of exhaust gas temperature. It measures gas at the manifold of the engine. For proper functioning of catalytic converter in an internal combustion engine, exhaust gas temperature (EGT) is needed. The Exhaust Gas Temperature varies from about 200 degrees Celsius to 500 degrees Celsius.

v

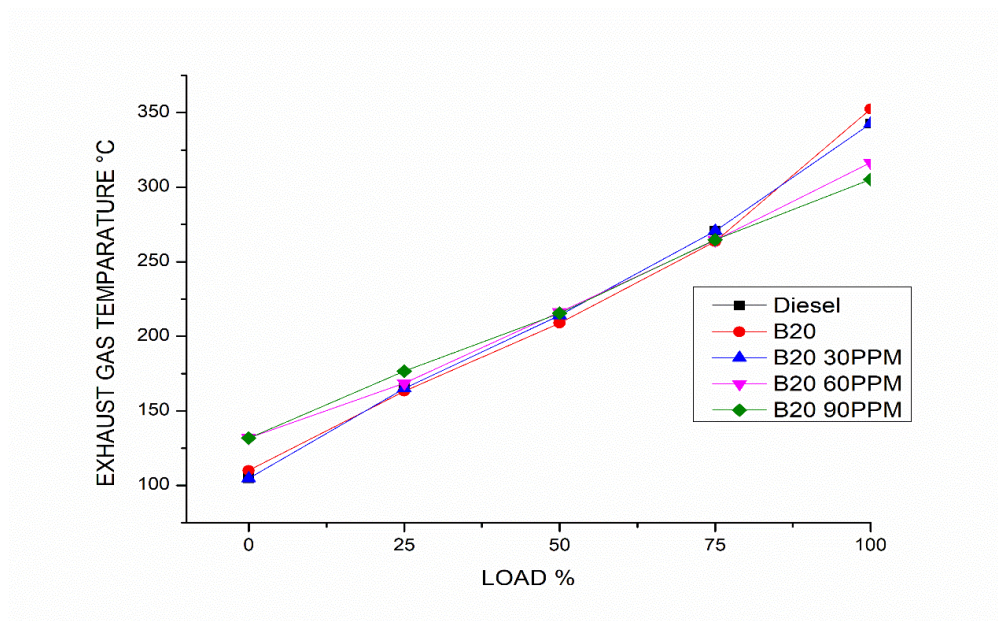


Fig 5.4:Exhaust Gas Temperature

The below graph shows the exhaust gas temperature at various loads. The graph is drawn between different loads in x-axis and exhaust gas temperature in y-axis. The Exhaust gas temperature is increasing with increase in loads. B20 has more Exhaust Gas Temperature at 100 load whereas B20 with B20 90PPM has lowest Exhaust Gas Temperature at 100% load. But at 0% load it has the highest Exhaust Gas Temperature

5.3.1 Cylinder Pressure

The combustion parameter, cylinder pressure results obtained from the engine test are analyzed and discussed in the fig5.5 to fig5.9. The graph is drawn between the crank angle in x-axis and cylinder pressure in y-axis for all different loads varying like 0%load, 25%load, 50%load, 75%load and 100%load. So totally 5graphs are drawn for each load simultaneously. Cylindrical pressure is high for diesel and high performance fuel without adding Nano additives. While the alumina Nano additives are added to the high performance blend the cylinder pressure is reducing slightly with less difference at initial loads and can be seen in fig5.5. As the load % increases the diesels pressure is decreasing and the high performance fuel has high cylindrical pressure for maximum loads and the blends with adding alumina Nano additives will decreasing the cylinder pressure even at maximum loads has obtained from fig 5.5

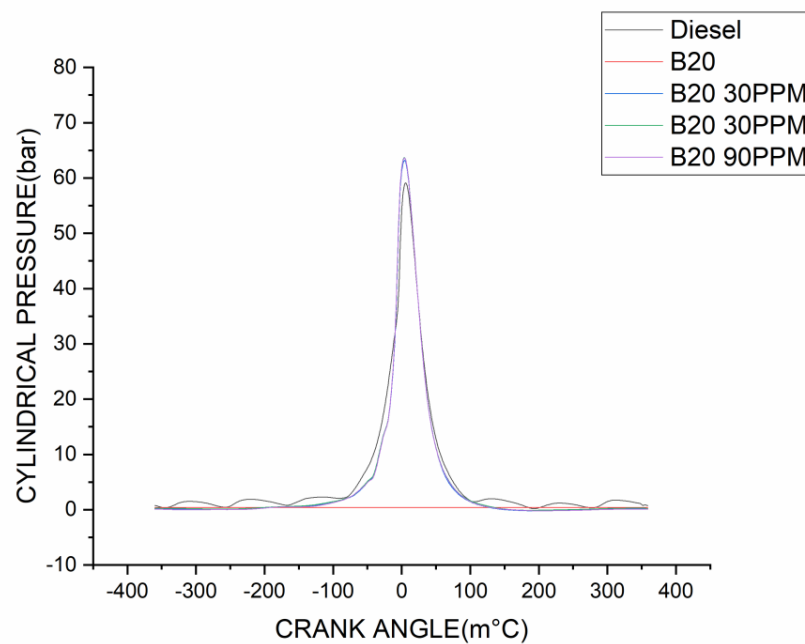


Fig 5.5: Cylinder Pressure At 0% Load

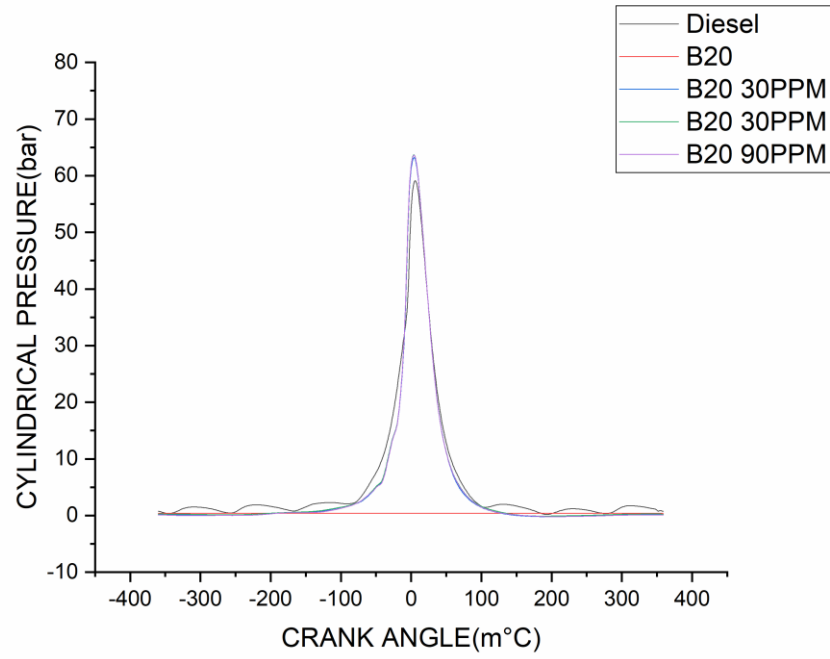


Fig 5.6: Cylinder Pressure At 25% Load

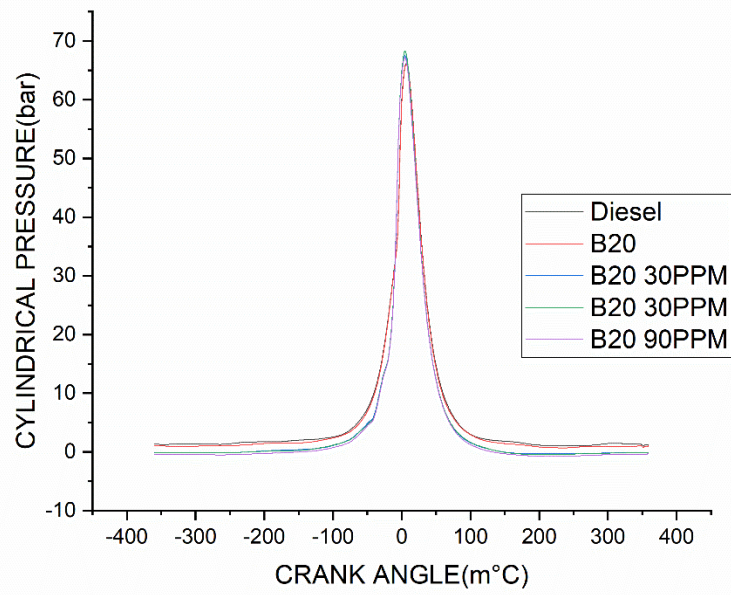


Fig 5.7: Cylinder Pressure At 50% Load.

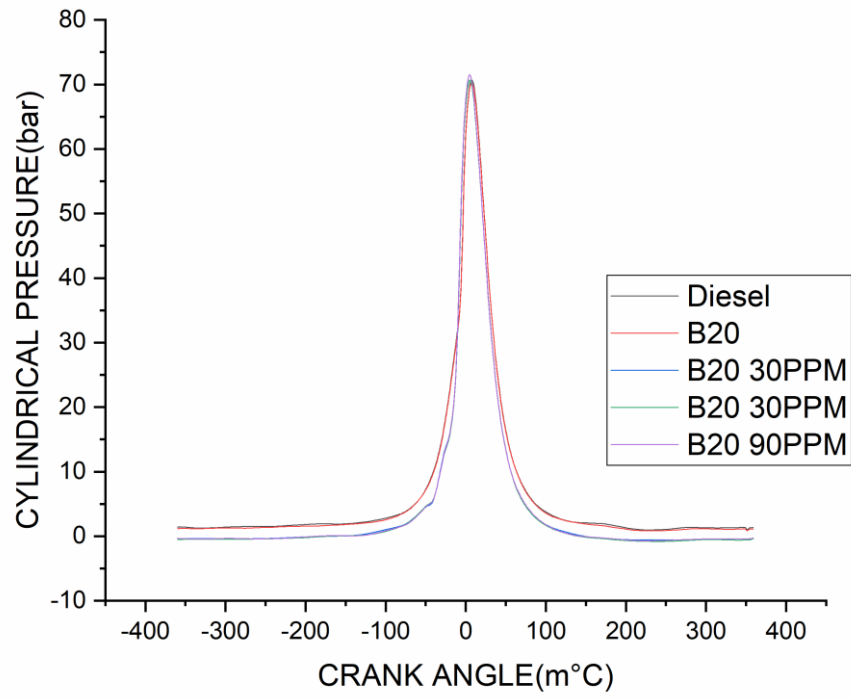


Fig 5.8: Cylinder Pressure At 75% Load.

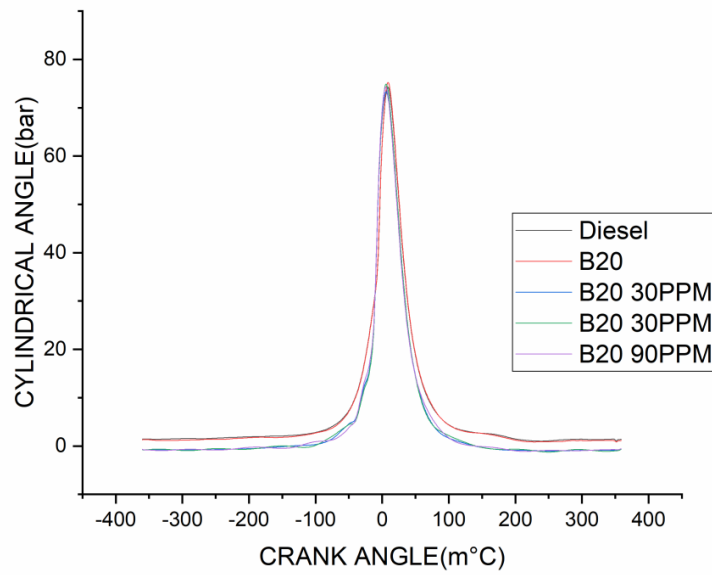


Fig 5.9: Cylinder Pressure At 100% Load.

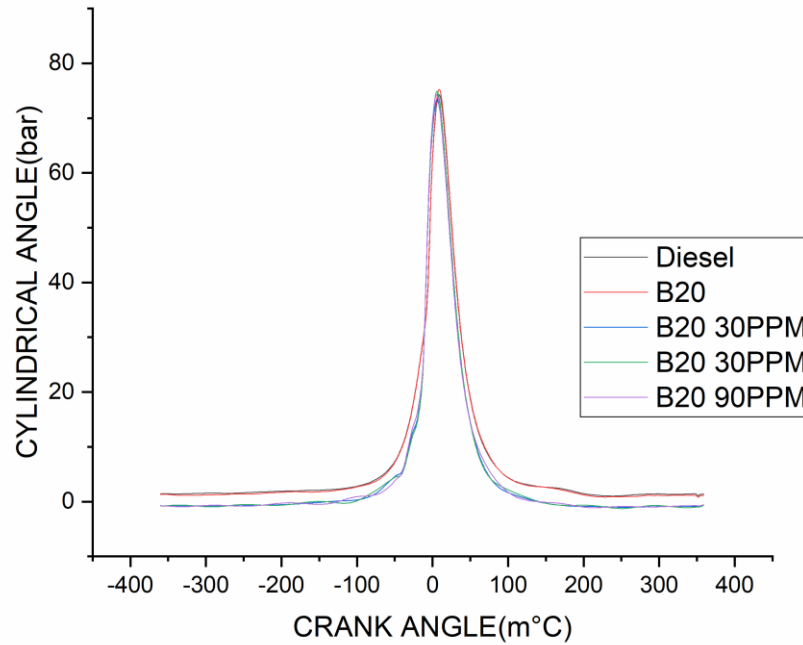


Fig 5.9: Cylinder Pressure At 100% Load.

The above graphs of combustion characteristics show the cylindrical pressure of the engine at various percentages of Combustion. From fig 1.1, fig 1.2, fig 1.3, fig 1.4, fig 1.5, we can clearly say that the cylinder pressure for all PPM has increased when tested at 0% load. The cylinder pressure of all the other PPM conditions remains same for every load. Also we can study that the cylindrical pressure values for 100% combustion is higher than others.

5.3.2 Net Heat Release Rate

In an CRDI engine, the combustion of the fuel and air inside the cylinder of the engine takes place due to movement of the piston. The heat produced in the cylinder during this combustion is the heat release rate. The heat also can be used to improve the working medium internal energy by heating it and can be useful for doing work in the shaft. Due to the cooling water through the cylindrical walls and cylinder head some heat can be lost.

5.3.2.1 Effect of Blends

The results of the net heat release rate which is a combustion characteristic are shown in the fig 5.10 to 5.14. The graphs drawn between the crank angle in the x-axis and heat release rate in y-axis for all the different loads like 0%load, 25% load, 50%load, 75%load and 100%load. As we analyze the graphs we get to know that the heat release rate for all the angles are almost same and are in the manner of uneven trend. As the crank angle keep on increasing the heat release rate for all the blends keep reducing in an uneven trend that if one is increasing in at one angle then it is decreasing at other load. So the results from the fig 5.10 to 5.14 can say that the heat release rate is similar for all blends and they are following an uneven trend.

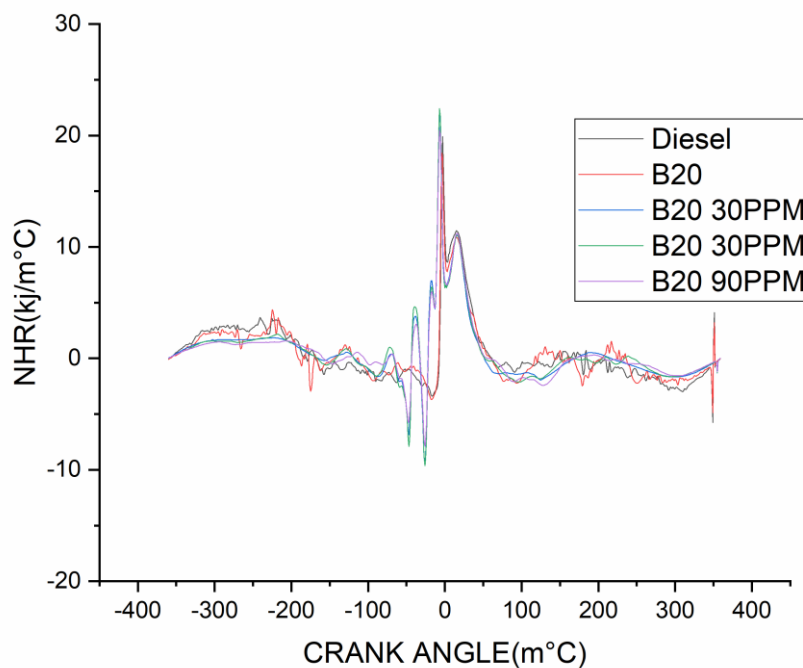


Fig 5.10: Net HR At 0% Load.

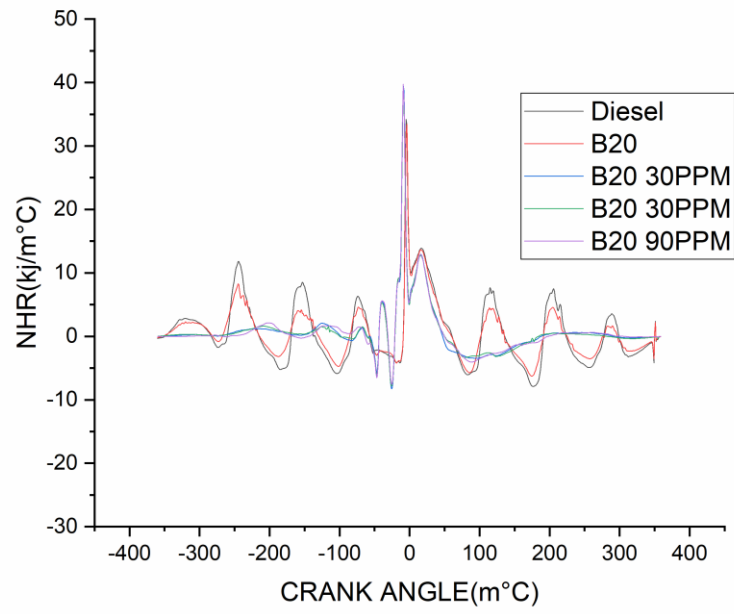


Fig 5.11: Net HR At 25% Load.

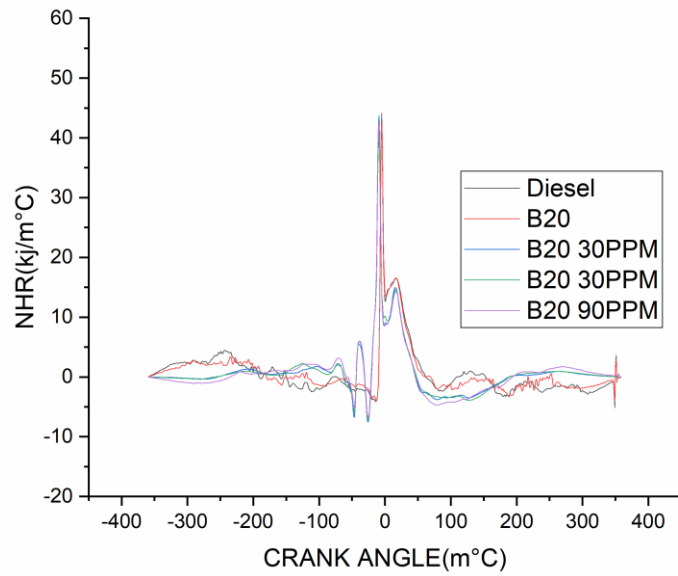


Fig 5.12: Net HR At 50% Load

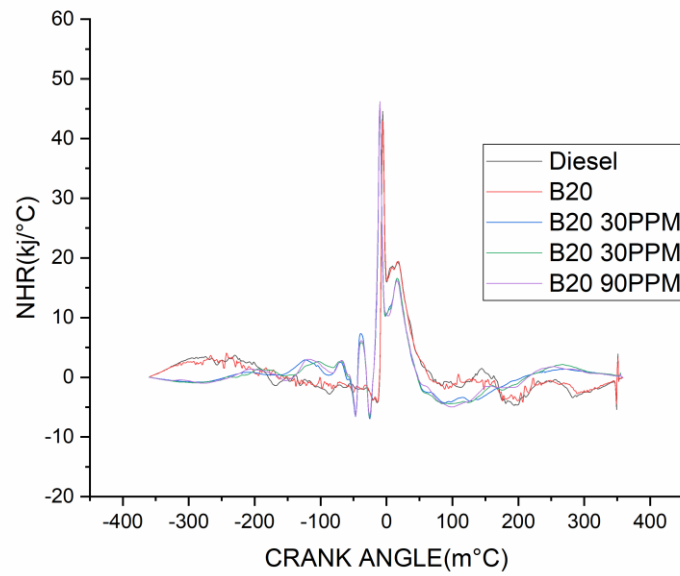


Fig 5.13: Net HR At 75% Load.

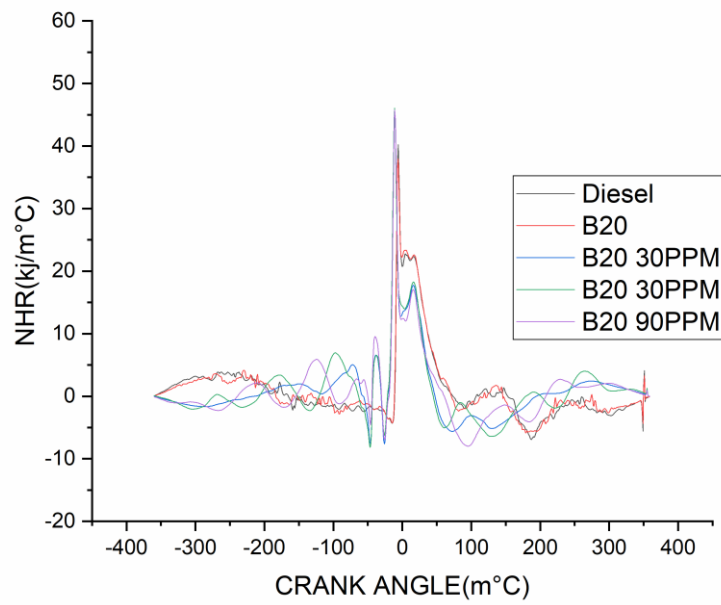


Fig 5.14: Net HR At 100% Load.

The above graphs show the net heat release of the engine during the combustion process at various loads. From the fig 2.1, fig 2.2, fig 2.3, fig 2.4, fig 2.5 when tested with 0% load RB20 60PPM condition has higher net heat release compared to other conditions. At 25 % load the net heat release is almost similar to the 0% load. At 50% load, RB20 30PPM has the higher net release compared to all the other conditions. Also the net heat release of RB20 is slightly higher than the Diesel. At 75% and 100 % load the RB20 90PPM irrespective of hot or cold conditions tends to be higher than the RB20 30PPM and RB20 90PPM. The net heat release of RB20 30PPM fuel is also slightly higher than the Diesel.

5.3 EMISSION CHARACTERISTICS

Emission characteristics like CO emissions, CO₂ emissions, NO_x emissions, HC emissions and also smoke emissions results are studied and discussed in this section by drawing the graphs for all the emission levels at different loads.

5.3.1 CO Emissions

Carbon monoxide (CO) - A product of incomplete combustion, inhaled carbon monoxide reduces the blood's ability to carry oxygen; overexposure (carbon monoxide poisoning) may be fatal. (Carbon monoxide persistently binds to hemoglobin, the oxygen-carrying chemical in red blood cells, where oxygen (O₂) would temporarily bind. The bonding of CO excludes O₂ and also reduces the ability of the hemoglobin to release already-bound oxygen, on both counts rendering the red blood cells ineffective. Recovery is by the slow release of bound CO and the body's production of new hemoglobin—a healing process—so full recovery from moderate to severe [but nonfatal] CO poisoning takes hours or days. Removing a person from a CO-poisoned atmosphere to fresh air stops the injury but does not yield prompt recovery, unlike the case where a person is removed from an asphyxiating atmosphere

Carbon monoxide (CO) which is colorless, odorless, tasteless and toxic air pollutant which pollutes the environment. The carbon containing fuels like gasoline, natural gas, coal and wood are burnt incompletely then the emissions like carbon monoxide are released through the exhaust gases.

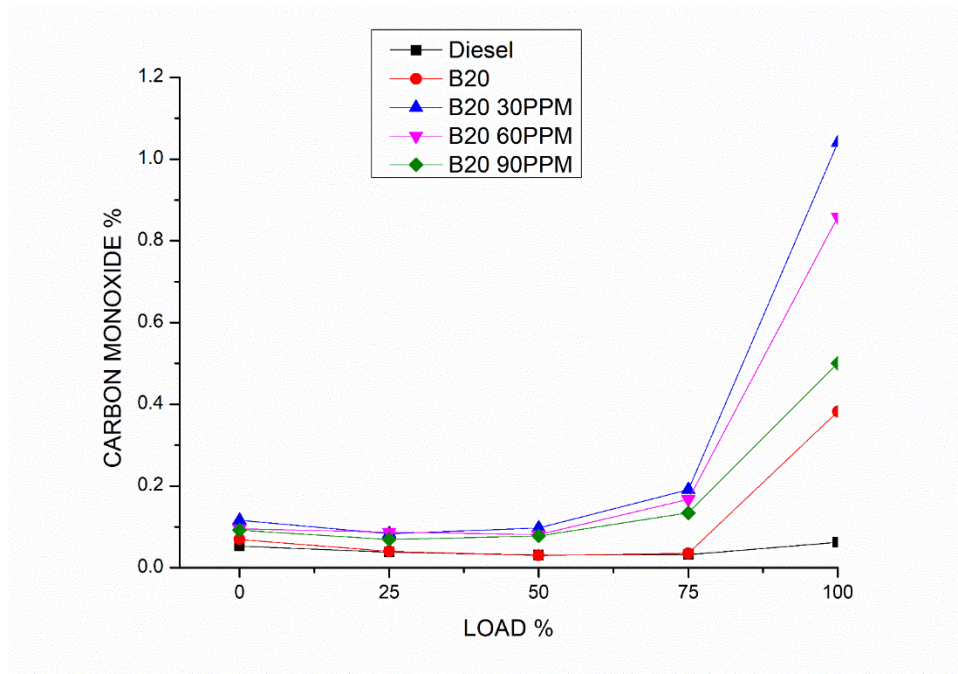


Fig 5.20: CO Emissions.

The above graph shows the Carbon monoxide emissions at various loads. The graph is drawn between the different loads in x-axis and the CO emissions in the y-axis. At 0% load diesel shows the least CO emission. CO emission increases with increase loads. As the load increase the B20 30PPM gives the maximum CO emission. But at higher loads diesel gives the minimum CO emission.

5.3.2 CO₂ Emissions

Carbon dioxide is the gas that can emit from the engine due to the combustion of fossil fuels like coal, oil and natural gas. Carbon dioxide will show the impact on the health of humans by replacing the oxygen in the atmosphere. As the carbon dioxide emission levels are increasing day by day the earth is becoming hotter and the changes in the climate will take place and this leads to global warming also.

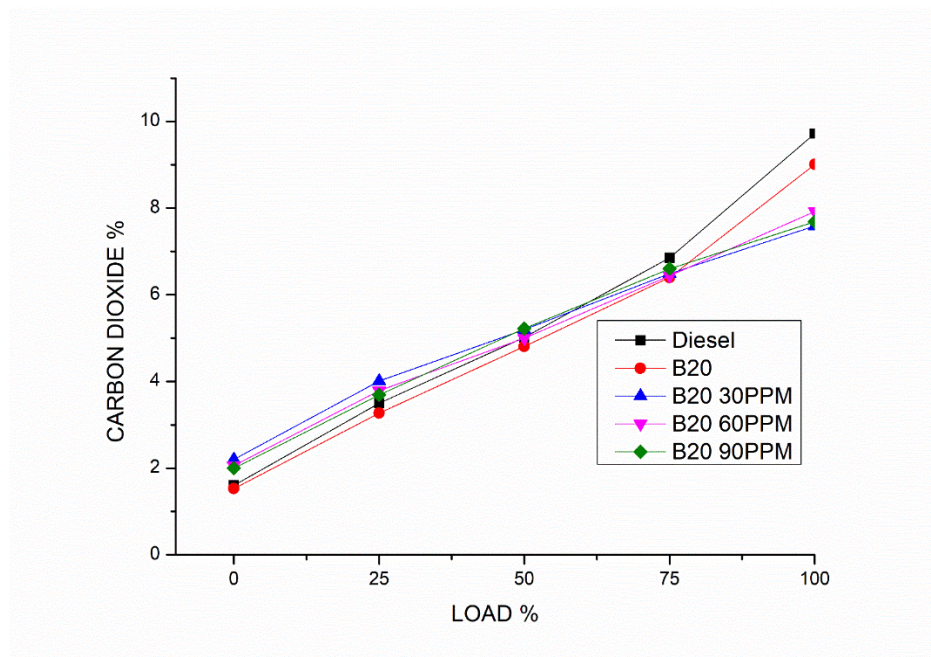


Fig 5.21: CO₂ Emissions.

The above graph fig shows the Carbon monoxide emissions at various loads. The graph is drawn between the different loads in x-axis and the CO₂ emissions in the y-axis. The emission characteristic of carbon dioxide results are studied and discussed from obtaining the values from engine test. B20 has the lower CO₂ emission in lower loads. Diesel has the highest CO₂ emission with high loads. It is followed by other fuels. Whereas B20 30PPM has less emission at maximum loads.

5.3.3 HC Emissions

Hydrocarbons are raw fuel, also called as Gasoline. The poor ignition of the fuel will release the high amount of hydrocarbons into the atmosphere. The formation of the hydrocarbons is due to the very rich and lean mixtures during combustion. Over mixing of the air-fuel mixture beyond the lean flammability limits will also lead to the emission of hydrocarbon gas to the atmosphere and this leads to the pollution in the atmosphere.

5.3.3.1 Effect of Blends

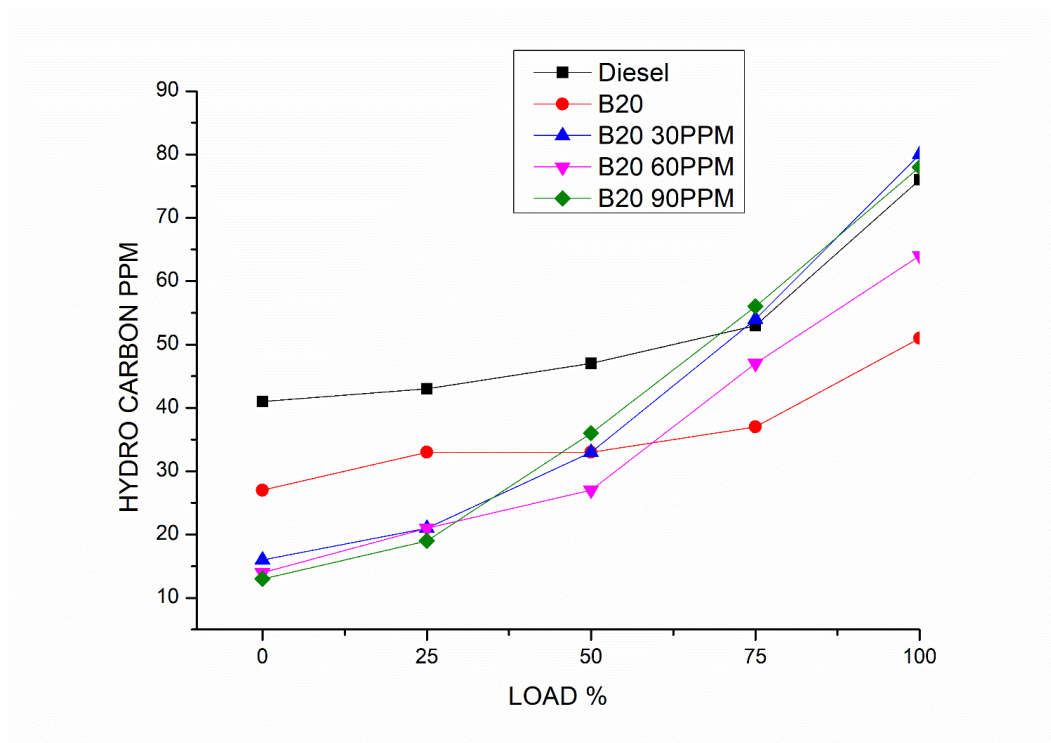


Fig 5.22: HC Emissions.

The above graph shows the Hydrocarbon emissions at various loads. The graph is drawn between the different loads in x-axis and the HC emissions in the y-axis. HC emission increases with increasing load. At 0% load diesel has highest value but at 100% load B20 30PPM has highest HC emission. B20 90PPM became minimum HC emission value at 0 and 25% load

5.3.4 NO_x Emissions

The oxides of nitrogen like nitrogen dioxide and nitrogen oxide are together referred as the NO_x emissions. High NO_x emissions can emit when the engines air-fuel mixture is very clean. The leak in the fuel system, problem with the vehicles oxygen sensor can leads to the release of the oxides of nitrogen emissions into the atmosphere. The oxides of nitrogen (NO_x) will react with water and can form an Acid rain which causes the disaster to the atmosphere and it will effects the human health mostly.

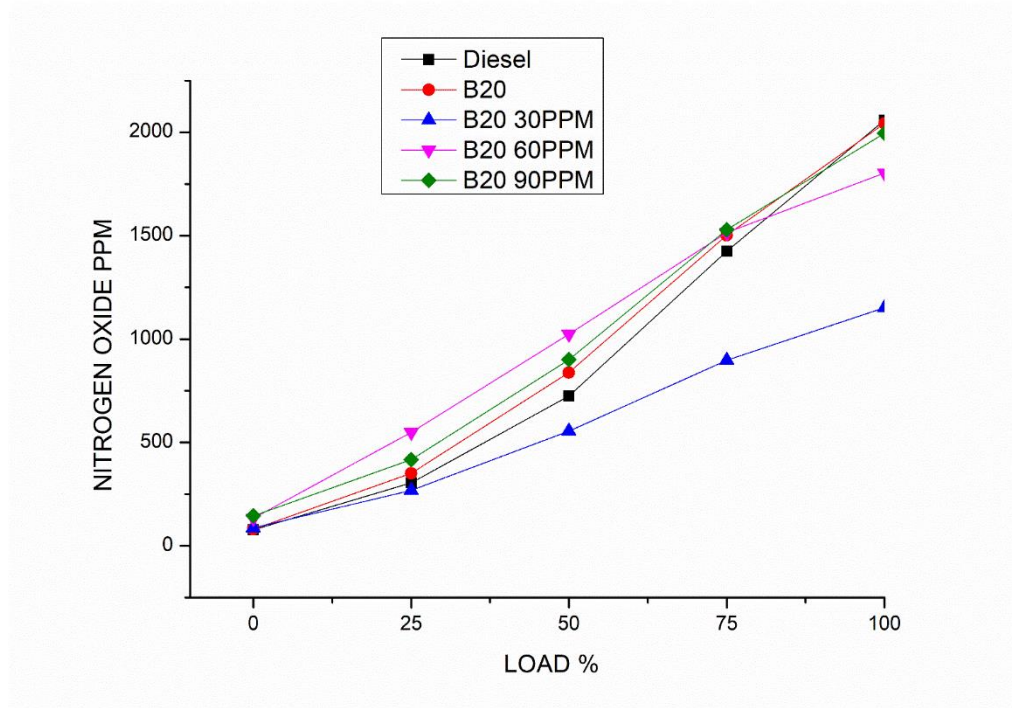


FIG 5.23: NO_x Emissions.

The above graph shows the Nitrogen Oxides emissions at various loads. The graph is drawn between the different loads in x-axis and the NO_x emissions in the y-axis. At 0% load pure diesel and B20 30PPM has minimum NO_x value, whereas B20 60PPM has maximum value at 0% load. At maximum load (100%) diesel contains maximum amount of NO_x. Where diesel has more amount of emission when we increase loads. B20 30ppm has a minimum amount of NO_x at lower and in higher load

5.3.5 Smoke opacity

The type of emission particles which will produce due to the deposition of fuel on the walls of the cylinder. Opacity is the degree to which smoke block lights and helps in the measuring of the smoke which comes out from the internal combustion engine due to the fuel left on the cylinder walls. The excessive smoke will emit out if the engines are malfunctioned or maintained poorly. This emissions which comes out and went into the atmosphere will make health effects to the humans and also atmosphere.

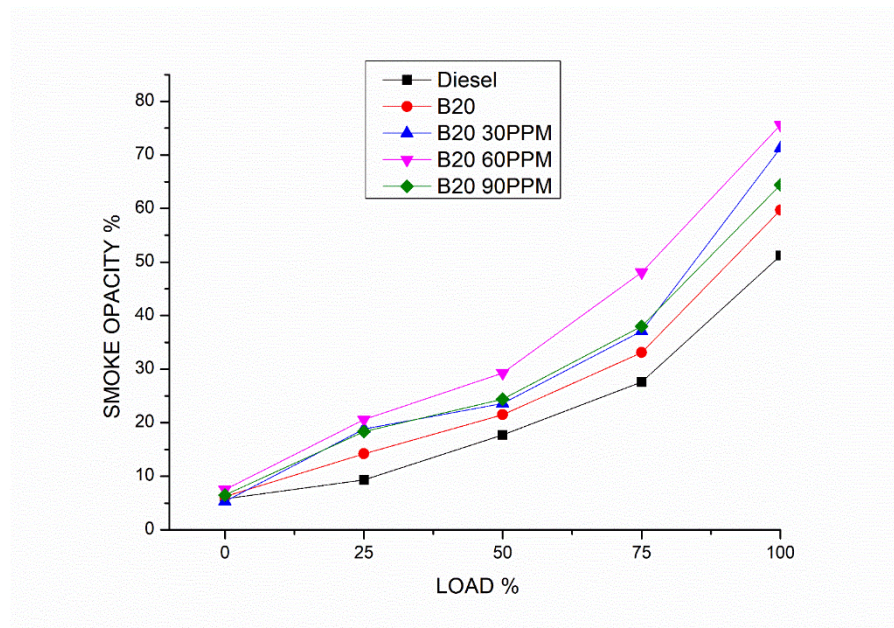


Fig 5.24: Smoke Emissions

Smoke opacity at maximum load whereas diesel has minimum amount of Smoke. The above graph shows the Smoke opacity at various loads. The graph is drawn between the different loads in x-axis and the Smoke opacity in the y-axis. At 0% load pure form of diesel tends to have minimum Smoke opacity. And it is followed by B20, B2030PPM, B20 60PPM and B20 90PPM. Finally B20 60PPM has a maximum smoke emission.

CHAPTER 6

SUMMARY AND CONCLUSIONS

Based on the research performed on Alumina Nano additives that are added in high performance fuel blends which are tested in Compression Ignition engine and the results obtained were analyzed and the following conclusions were made based on Performance, Combustion and emission .The emission characteristics such as CO, HC, NO_x, Smoke, CO₂ emissions are polluting the environment by the release of harmful gases into the atmosphere in order to reduce these emissions alumina nano particles are mixed to the high performance fuel blend and following points have concluded from the engine results.

- The performance characteristics show that diesel has more thermal efficiency, compared to biodiesel blends. The values of brake thermal efficiency will be increased if the content of biodiesel is more in blends.
- The specific fuel consumption for biodiesel blends are normal and almost same to the straight diesel
- The exhaust gas temperature for the diesel is less and blends of the biodiesel have the same trend.
- For the volumetric efficiency the diesel has higher rate and the biodiesel blends have the uneven trend in volumetric efficiency
- The CO emission for the straight diesel and the normal blend of biodiesel are high, whereas for samples having alumina Nano additives gives lesser CO emissions.
- In hydro carbon emissions the diesel gives lesser emissions compared to the biodiesel blends, the normal fuel blend gives more hydrocarbon emissions.
- For the NO_x emissions the high-performance fuel blend having alumina nano additives in proportion of 100ppm is giving less NO_x emissions when compared to the Diesel.

- The smoke emissions for the diesel are high and the biodiesel blends of having alumina nano additives 50ppm, 100ppm are giving less smoke emissions.
- Finally, by addition of the alumina nano additives to the high performance fuel blend gives the better emission characteristics while compare to the pure diesel and high performance fuel blend.
- Although the performance characteristics the addition of alumina nano additives are reducing the efficiencies and increasing the exhaust temperature but the high performance fuel blend gives better performance compare to pure diesel and the blends with alumina nano additives.

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