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# The effect on performances of B20 biodiesel blend with ZnO nanoparticle

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**Abstract**
The Use of fossil fuel gives world a large opportunity to use the energy in various fields and helped many countries to develop. But today world is facing bigger challenges as Greenhouse gases emission which is causing the world new problems such as Ozone reduction in atmosphere and climate change. Hence to reduce the dependence on Fossil fuel is the biggest solution right now and as a replacement of fuel energy of diesel the use of biodiesel is now a great option. It is not only renewable, made from relatively cheap materials and waste materials and also biodegradable which make it lower toxic to environment and economically viable. Since biodiesel is a good example of replacement of conventional diesel it has some challenges as poor engine efficiency when it is used in the engines. But by adding additives, efficiency of biodiesel can be improved. Since there are many element and there components can be used as a additives here in this research study ZnO nanoparticle used as a additive which is blended with biodiesel and various techniques for making ZnO nanoparticles, Its bending with biodiesel and physiochemical feature. Further the combustion behavior, emission and performance characteristics of the blended Bio fuel.

**Keywords:** Ozone reduction, physiochemical, components

## Introduction
In today world with the development of the world increases the more use of energy is required to fuel this growth and to fulfill this growth, one of the most important energy sources is fossil fuel. Fossil fuel is required for ignition in engines, electricity generations, transportation etc. hence the demand of fossil fuel is increasing day by day.
This increasing demand for fossil fuel has generated a motivation for scientists and researchers to invent a new energy source which can fulfill its excess need. Fossil fuel is that it emits high amount of greenhouse gases and other harmfull gases which can be harmful for environment and also for living beings. In general, diesel ignition emits many harmful gases such as unburnt hydrocarbons (HC), nitrogen oxides (NOx), particulate matter (PM), and high amount of smoke. This high emission is responsible for many problems in the environment such as acid rain and its harmful effect on humans and plants [1].
Hence to solve the problem of pollution caused by the fossile fuel and reduce the emission one of best alternative solution for the energy needs which is closer for diesel engine is 'biodiesel'. The biodiesel has less amount of emission and renewable source of energy.
The most biodiesel are generally generated from the waste organic material such as agricultural waste, food waste, forest waste, algie etc. Once of the alternative resource to make biodiesel is Neem oil.
Neem is name of tree that is grows in various parts of India. It is evergreen tree which is 12 to 17 meter tall height and has grith up to 1.8 to 2.5 meters. The Neem tree seeds have 30-40% oil in it which makes it a good source for biodiesel production. It has high viscosity, density, flash point and molecular weight. 5,6(Bio)
Neem has mainly of large amount of triterpenoid compound and triglycerides. It also caontains saturated fatty acids.
In this experiment the aim is to explore and check the various properties of neem oil biodiesel and check the impact on the emission and performance features of diesel engine which is fueled by fuel additives ZnO nanoparticles. The emission and performance tests are taken for formation at different load and fix engine speed condition.

## Preparations

### Preparation for biodiesel

In this present study the production of biodiesel consist of reaction in which ester is reacting with ester to form another ester and alcohol. Here Neem oil is ester which consists triglyceride. To prepare biodiesel from the Neem oil there are four methods

1. Trans esterification
2. Thermal cracking of vegetable oil
3. Micro emulsion in diesel fuels
4. Direct use or blending in diesel fuel

Out of these four methods, Transesterification is the most popular to use in vegetable oil.

In this method the raw neem oil (ester) is mixed with 15% of methanol and 5% of NaOH catalyst by mass basis at 55-65C temperature to production of methyl ether.

Biodiesel can be made in two step process, Firstly, to reach equilibrium condition at 55-65 c temperature Secondly, After reaction mixture of biodiesel and glycerin poured to resting it in separating funnel. In this way the biodiesel which has lower density and viscosity than glycerin floats top of glycerin and the heavy density glycerin rested in bottom of funnel and then separated. This diesel has lower density and higher kinetic viscosity.

### Additives

Additives are use to increase the performance and reduce the emission of blend of biodiesel in fuel. With the properties of additives the efficiency of biodiesel blend increases.

Since biodiesel has certain disadvantages such as higher emission and lower boiling temperature, use of additives reduces the organic and inorganic disadvantages of the biodiesel. Many researchers and scientists found in their research that the use of metal oxide nanoparticle additives increases the performance and reduce the emission in the biodiesel blend.

### Blend preparation

The fuel (diesel) was collected from petrol pump in Jhansi and has mixed to create different blend proportions witrh the produces need biodiesel and nano particle.

**Table 1:** The properties of the nano particle is given in the table

| S. No. | Parameters | ZnO Particles |
|---|---|---|
| 1 | Average Particle size | 67 nm |
| 2 | Formula | ZnO |
| 3 | Formula Weight | 81.39 g/mol |
| 4 | Specific Surface Area | 16 $m^2/g$ |
| 5 | Appearance | White |
| 6 | Form | Powder |
| 7 | Mass Fraction | 81.39 g/mol |
| 8 | Melting Point | 2350 $^0C$ |
| 9 | Boiling Point | 3450 $^0C$ |
| 10 | Solubility in Water | Insoluble |

Since this study is about knowing the properties of B20 biodiesel blend in diesel with ZnO nanoparticle additives, the Blend is made from in 5%, 10% and 20% of biodiesel and 95%, 90% and 80% diesel proportion.

**Table 2:** Diesel and biodiesel blend.

| | Formulation | | | |
|---|---|---|---|---|
| | B5 | B10 | B15 | B20 |
| Diesel % | 95 | 90 | 80 | 75 |
| Biodiesel % | 5 | 10 | 20 | 25 |

Afterwords, ZnO nanoparticle is added in 25ppm, 50ppm, 100ppm and 200ppm in blend of diesel and biodiesel

**Table 3:** B20 and ZnO nanoparticle blend

| | Formulation | | | |
|---|---|---|---|---|
| | 25ZnO | 50ZnO | 100ZnO | 200ZnO |
| ZnO ppm | 25 | 50 | 100 | 200 |

### Experimental setup

In this study, a four stroke variable compression disel cylinder water cooled motor is used. Detailed specification of the engine is given in table. This setup is built to verify the efficiency of engine in various variable compression ignition. In this configuration the measurement instruments involved to measure the pressure of combustion and angle of crank. This setup also enables to study various characteristics such as braking power, friction power, volumetric efficiency, stipulated power, IMEP, BMEP, thermal brake efficiency, mechanical efficiency, heat efficiency, specific energy usage, temperature equilibrium and A/F ratio.

**Table 4:** Table specification of engine

| Make and model | Kirloskar, TV1 |
|---|---|
| Type of engine | four stroke variable compression diesel engine |
| No. of cylinders | Single cylinder |
| Cooling media | Water cooled |
| Rated capacity | 3.5KW at 1500 rpm |
| Cylinder diameter | 87.5mm |
| Stroke length | 110mm |
| Connecting rod length | 234mm |
| Compression ratio | 12:1 to 18:1 |
| Dynamometer | Eddy current dynamometer |

### Adjuster

This component is used for changing the compression ratio by adjustingto desired mark using spanner. Thos is in-built valve mechanism.

### Exhaust gas emission analysis

This is instrument which is used in exhaust of an engine. In diesel engine the mostly pollutants are either oxides or nitrogen. AVL 4000 light Di-Gas Analyzer is used for measuring the UBHC, CO and CO2. Analyzing the exhaust gases will assist to analyze the efficiency of the engine and its associated problem.

### Result and discussion

The engine runs continuously with the diesel blend (diesel + Neem oil biodiesel + ZnO nano particle at different proportion of 25, 50, 100, 200ppm proportion). The whole experiment was performed in the single cylinder CI diesel engine, which is unchanged at 1500 rpm, loads of 1kg, 2kg and 3kg and compression ratio of 17.5:1.

**Properties of different formation**

**Density**

Density denotes how much space a object occupies in 3 dimensions. It is defines as the ratio of weight to volume or can be said weight per unit volume.

**Table 5:** Density of the samples are in the table –

| S.N. | Sample name | Density |
|---|---|---|
| 1 | Diesel | 830 |
| 2 | 20B | 843 |
| 3 | 20B50ZnO | 840 |
| 4 | 20B100ZnO | 837 |
| 5 | 20B150ZnO | 834 |
| 6 | 20B200ZnO | 832 |

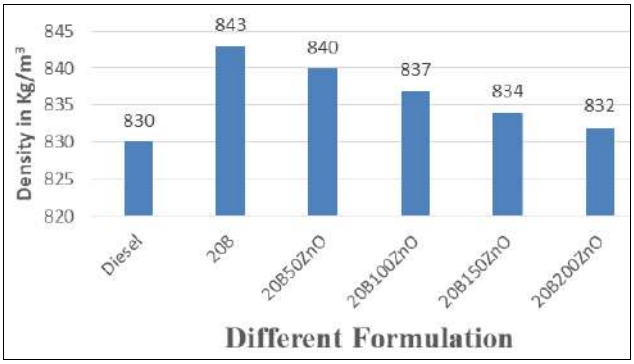


**Fig 1:** Density at 15 °C

**Calorific value**

It is measurement of value of quantity of energy that a substance accumulates, produces and releases through a kilogram of particular burning.

**Table 6:** Calorific value of the samples are in the table-

| S.N. | Sample name | Calorific value ((kj/kg)) |
|---|---|---|
| 1 | Diesel | 42186 |
| 2 | 20B | 41989 |
| 3 | 20B50ZnO | 42117 |
| 4 | 20B100ZnO | 42288 |
| 5 | 20B150ZnO | 43001 |
| 6 | 20B200ZnO | 44190 |

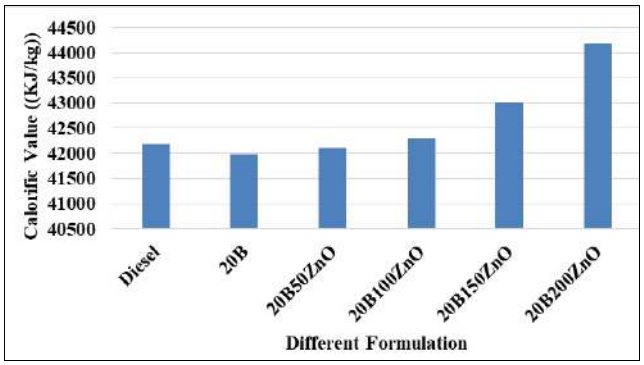


**Fig 2:** Calorific Value (KJ/kg)

**Ash Content**

The ash content is a measure of inorganic impurities in the fuel that stays at particular elevated temperature after the oil has been combusted in air.

**Table 7:** Shows the Sample name and its result

| S.N. | Sample name | Result (%) |
|---|---|---|
| 1 | Diesel | 0.01 |
| 2 | 20B | 0.009 |
| 3 | 20B50ZnO | 0.008 |
| 4 | 20B100ZnO | 0.007 |
| 5 | 20B150ZnO | 0.007 |
| 6 | 20B200ZnO | 0.006 |

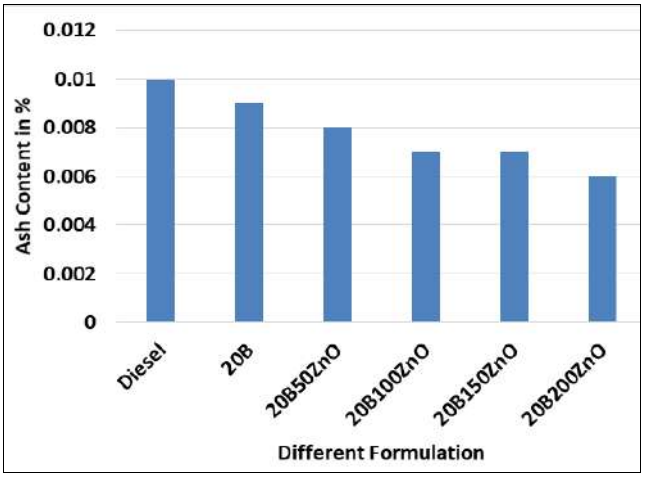


**Fig 3:** Ash Content in %

**Performance analysis**

**1. Brake Thermal efficiency**

Brake Thermal Efficiency is defined as break power of a heat engine as a function of the thermal input from the fuel. It is used to evaluate how well an engine converts the heat from a fuel to mechanical energy. It can be promised on brake endurance or strength indicated.

BTE = Brake power) / (mass of fluid * calorific value)

BP = Brake work done/S $=F_h*2\pi r_b*N/60$

Here,

$F_b$ = Load on engine

$R_b$ = Brake radius

N = Speed of engine in rpm

**Table 8:** Shows the sample name and load (kg)

| Sample Name | Load (Kg) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Diesel | 17.54 | 27.54 | 30.01 |
| 20B | 13.58 | 22.52 | 24.83 |
| 20B50ZnO | 16.58 | 25.83 | 27.64 |
| 20B100ZnO | 17.85 | 26.32 | 28.56 |
| 20B150ZnO | 18.35 | 26.94 | 29.14 |
| 20B200ZnO | 19.01 | 27.78 | 32.23 |

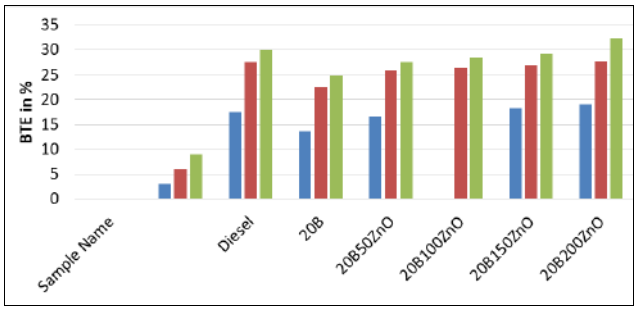


**Fig 4:** load in KG

**2. Brake specific fuel consumption**

Brake-specific fuel consumption is a parameter that reflects the efficiency of a combustion engine which burns fuel and produces rotational power.

BSFC = BP/ (FC*CV)

BF = Brake power in KW

FC = Total fuel consumption in Liter / given time

CV = Calorific Value of Fuel

**Table 9:** Shows the Sample Name and its Load (Kg)

| Sample Name | Load (Kg) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Diesel | 0.7 | 0.9 | 0.8 |
| 20B | 0.51 | 0.65 | 0.67 |
| 20B50ZnO | 0.45 | 0.45 | 0.55 |
| 20B100ZnO | 0.33 | 0.35 | 0.42 |
| 20B150ZnO | 0.28 | 0.24 | 0.31 |
| 20B200ZnO | 0.23 | 0.2 | 0.24 |

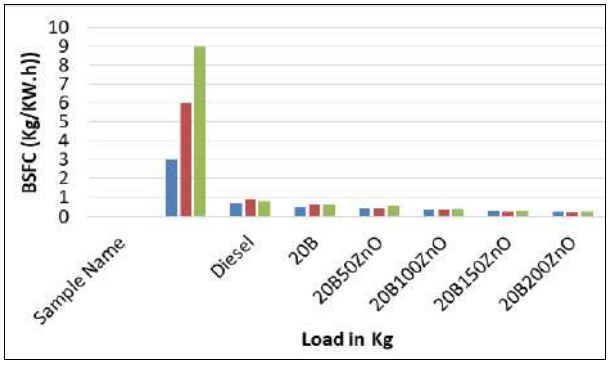


**Fig 5:** Shows sample name load in Kg BSFC (Kg/KW.h)

**Exhaust gas emission analysis**

**1. Unburnt hydrocarbon emission**

Hydrocarbons are present in fuels and are primery source of energy. Any vehicle that works on diesel/petrol emits hydrocarbons which shows its incomplete combustion. It also is major factor for pollution in air and heavely dangerous for human health.

**Table 10:** Shows the sample name

| S.N. | Sample Name | Load (Kg) | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| 1 | Diesel | 27.85 | 26.47 | 24.74 |
| 2 | 20B | 26.43 | 25.21 | 23.12 |
| 3 | 20B50ZnO | 18.45 | 17.43 | 16.78 |
| 4 | 20B100ZnO | 17.35 | 16.23 | 14.35 |
| 5 | 20B150ZnO | 14.65 | 15.08 | 13.12 |
| 6 | 20B200ZnO | 12.58 | 12.12 | 10.99 |

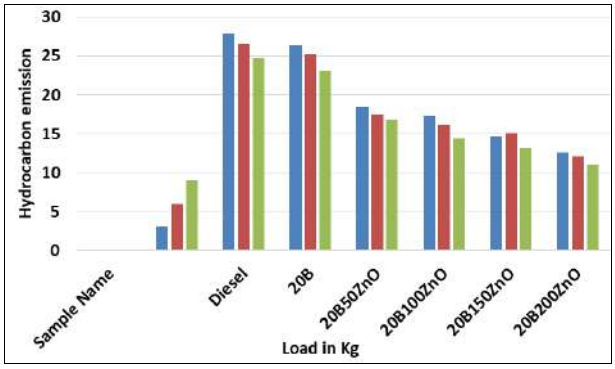


**Fig 6:** Shows sample name and load in Kg hydrocation emission

**2. Carbon Mono Oxide Emission**

Carbon mono oxide is one of the minor greenhouse emission gases. Its present in the environmentt is minimal but its affect are linked to climate change and global worming.

**Table 11:** Shows the sample name and load kg

| S.N. | Sample Name | Load (Kg) | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| 1 | Diesel | 12.32 | 10.86 | 10.58 |
| 2 | 20B | 9.95 | 9.08 | 8.93 |
| 3 | 20B50ZnO | 7.9 | 7.04 | 6.71 |
| 4 | 20B100ZnO | 7.71 | 6.99 | 6.39 |
| 5 | 20B150ZnO | 7.37 | 6.87 | 6.13 |
| 6 | 20B200ZnO | 6.62 | 5.88 | 5.69 |

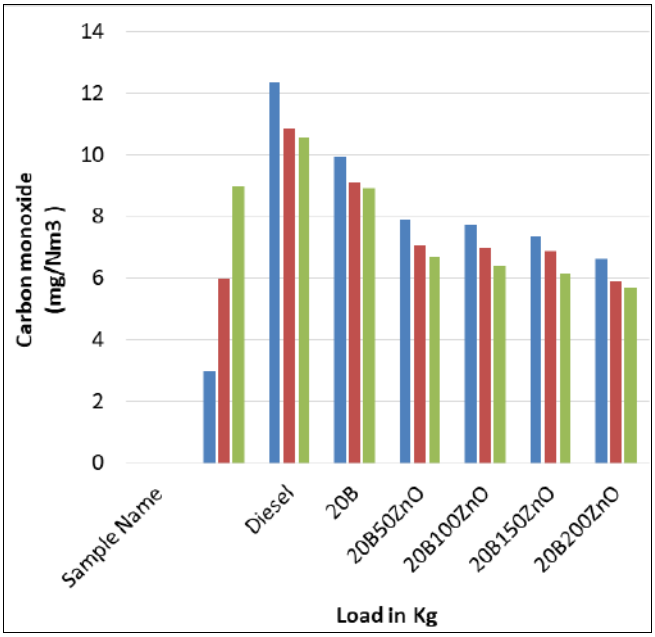


**Fig 7:** Shows load in kg Carbon monoxide

**Conclusion**

In this experiment, different formulation of biodiesel blends are made up with Neem biodiesel, ZnO nanoparticle and diesel. Neem oil biodiesel is made up with transesterification process and its blends as a different samples are tested in single cylinder 4-stroke CI engine. After the experiment the test results are follows –

1. The BTE of the blend is higher than neat diesel. The maximum BTE is observed for B20 with ZnO, 200 ppm is 32.23% for 3kg load where as for neat diesel it is 30.01%.
2. The BSFC of blend is lower than neat diesel. In blend B25 with ZnO (200ppm) has lowst bsfc obtain as 0.24% where as in diesel it is 0.8% at 3kg load.
3. Unburnt HC emission of blend is lower than neat diesel. In blemd B25 with ZnO(200ppm) has lowest emission as 10.99% Compared to neat diesel at 3kg load.
4. The CO emission is of blend lower than the neat diesel. It has lower CO emission in B20 with nano particle ZnO(200ppm) blend as 5.69% to neat diesel at 3kg load.

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