PERFORMANCE OF DI DIESEL ENGINE WITH DATURA BIODIESEL AND ZnO NANO ADDITIVE

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Abstract- The depleting of fossil fuels has simulated the worldwide search for the alternate fuels. As our country is an agricultural based one and large amount of land is available, production of Datura biodiesel will be more advantageous for our farmers. The Datura biodiesel is a perfect replacement to diesel because this is derived from indigenous sources and is renewable. But due to its high viscosity and lower calorific value it cannot be directly used in the diesel engine without major modifications to the engine. Hence in the present work it is planned accordingly to use the combination of diesel and biodiesel in the ratio of 80% diesel and 20% Datura (B20). The combustion of the engine depends on the flow capability of the fuel. With the higher viscosity, datura oil fluidity will be less and this can be improved with the addition of nano additives. Further the investigation is planned to study the effect of Zinc Oxide Nano particles as additive on the performance and emission characteristics of datura biodiesel blend (B20). It is blended with Zinc Oxide Nano particle in mass fraction of 50 ppm, 100 ppm and 150 ppm. The whole investigation is carried out in a constant speed vertical cylinder water cooled DI Diesel Engine. The performance parameters are analyzed and the results are presented. Zinc oxide nano particles act as an oxygen buffer which improves the combustion results in increase the Brake thermal efficiency and reduction in the Exhaust emissions.

***Keywords*-Datura Biodiesel blend, Nano additives, Zinc oxide.**

I-INTRODUCTION

Diesel engines are considered to be used as a work horse for the industry due to their high torque output, durability, exceptional fuel economy and ability to provide power under a wide range of conditions. The consumption and demand of petroleum products are increasing day to day with increase of vehicles and urbanization, along with that the emissions are also enormously increased. Hence the researchers and the industries are concentrating on alternative fuels. These should be renewable, easily available, low cost and eco-friendly. Various types of biodiesels like sun flower oil, Jatropha, Pongamia etc., are available which are produced in India by our farmers. Among all the fuels Datura biodiesel is most suitable alternate fuel with its properties in diesel engines. Many researches had tried on Datura as a replacement for diesel and confirmed that with minor changes in engine, the efficiency of diesel engine can be improved marginally. But due to the higher viscosity of Datura, the flow capacity of is less which is the major drawback for increasing the efficiency of engine. But with the addition of metal and metal oxide nano particles to bio fuels the flow characteristics will improve and the engine performance enhances as well as reduces the harmful gases in the engine exhaust. To overcome this flow problem, in the present work it is planned to work with blending process and with various proportions of nanoparticles. It is also reported that adding of zinc oxide nano particles to Datura bio diesel could enhance the ignition properties of biodiesel due to the heat buildup with in the fuel of reactive nature of Zinc Oxide nanoparticles. Size of Nano particles may also affect the parameters like combustion process, ignition delay and burning rates of fuel.

II-LITRATURE REVIEW

Considerable amount of research work has been done on various types of biodiesels on diesel engine. Some of them are presented below.

Krishnaiah.T et al [1] have studied the CORN blended with diesel bio fuel extremely in a four-stroke direct injection single cylinder diesel engine. From the experimental investigation ,the following conclusions are drawn:
Most Important characteristics of Corn and its blends with diesel fuel were similar to those of diesel fuel when compare with each other.
The CORN content blends with 5 and 20 %,(B5, B20) has improved BTE of the diesel engine and slightly increased BSFC. The maximum BTE increased to 27.58% with B20. Furthermore, B5 and B20 improved exhaust emissions.The highest CORN content blend (B25) resulted in significant improvements in emissions, but they did have better performance characteristics than diesel fuel. Nonetheless, small modifications may provide significant improvements in the performance of B25.

Gopinath .V et al [2] have investigates the emission characteristics of single cylinder diesel engine using biodiesel blends and compares that with diesel fuel. In this experiment, an attempt has been made to investigate four types of fuels are considered 100% Diesel, 90% Diesel+10% Corn oil Methyl Ester, 80% Diesel+20% Corn oil Methyl Ester, 70% Diesel+30% Corn oil Methyl Ester and 60% Diesel+40% Corn oil Methyl Ester. The diesel engine is run on these blends at different load conditions and emission parameters like NOx, Carbon dioxide and Unburned Hydrocarbon are measured. From the results obtained on the

test, the engine emission parameters such as Carbon dioxide, NOx and Unburned Hydrocarbon for biodiesel blends are low as compared to diesel fuel. And also the proportion of corn oil methyl ester increases, the engine emissions are decreased. Hence 60% Diesel Diesel+40% Corn oil Methyl Ester can be used as fuel in IC engine without any engine modification. However the performance of the IC engine fuelled with 60% Diesel+40% Corn oil Methyl Ester was less as compared to diesel fuel. Based on the references the performance of engine fuelled with 80% Diesel+20% Biodiesel comparable to diesel fuel. Hence 80% Diesel+20% Corn oil Methyl Ester is the optimum blend for engine emission as well as performance of the engine.

U. Santhan Kumar[3] have been examined the use of diesel-corn oil mixtures in diesel four-stroke engine. From the experimental results, the following conclusions are drawn:

The specific fuel consumption of the 0.31kg/kw-hr was observed with the blend B15 the SFC is lower for above blend than that of other blends and pure diesel. In the combustion analysis, the maximum cylinder pressure observed as 69 bar for B60 blends than all the other blends at maximum brake power of the engine. The heat release rate is also higher for B30 blend than pure diesel and all the other blends. The CO2 percentage increased with increase of loads. The minimum value occurred at B45&B60 The hydro carbons are also lower for all the blends compared with diesel.

D. K. Ramesha et al [4]. have presents the results of investigation carried out in studying the properties and behavior of methyl esters of corn seed oil, fish oil and its blends with diesel fuel in a C I Engine. Engine tests have been carried out to determine the performance, emission and combustion characteristics of the above mentioned fuels. The tests have been carried out in a 4-stroke, computerized, single cylinder, constant speed, direct injection diesel engine at different loads. The loads were varied from 0% to 100% of the maximum load in steps of 25%. The Methyl Ester blends of 10%, 20% and 30% by volume with diesel were used. The engine test parameters were recorded with the help of engine analysis software and were studied with the help of graphs. The results showed that the properties of the above mentioned oils are comparable with conventional diesel. The 20% blend performed well in running a diesel engine at a constant speed of 1500 rpm. It substantially reduced the emissions with acceptable efficiency. Hence the oils can be used as suitable additives for diesel in compression ignition engine.

Hemanandh Janarthanam1, Narayanan KV[5] have been study the Emissions and performance of refined vegetable oils from Kirloskar Direct Injection 4-stroke Diesel engine, single cylinder air-cooled, 4.4 kW, compression ratio 17.5:1 and at constant speed of 1500 rpm,. The Injection pressure, blend percentage, and various loading were used as input parameters. Emissions and Performance like NOx, CO, HC, CO2, and Break specific fuel consumption, Brake thermal efficiency were considered as output parameters. Methyl Esters of refined vegetable oils was transesterified with sodium meth oxide as catalyst before blending with diesel. A 3- hole nozzle was used to inject the fuel. The biodiesel and diesel properties are compared with ASTM and BIS standards. The Emission results were studied using AVL gas analyzer. In this study the experimental data showed that the break thermal efficiency of the Refined Palmolein of the biodiesel was marginally higher than diesel fuel. It was also observed that CO, HC, CO2 & NOx are less in Refined Palmolein than Refined Corn and Refined Sunflower oil. Also specific fuel consumption of the refined Palmolein oil biodiesel is reduced by 28.57% compared to pure diesel fuel.

Er. Sumit Vohra Ahuja1,Er.Subhash2 et. al. [6] made an analysis of performance and emission characteristics of an internal combustion engine operated with various biodiesel fuels and also a comparative study with petroleum diesel. With both biodiesels due to their lower energy along with increasing blend percentage engine performance was reduced and also increase in fuel consumption was noticed. Some emissions like NOx, CO were found to be decreasing while other emissions like HC showed quite opposite trend. Finally it was noticed that each biodiesel had its own scale of effect on engine performance and emissions.

Mohan Kumar et. al[7] on analysis concluded that a minimum drop thermal efficiency , little higher specific fuel consumption was noticed by using sunflower seed oil esters as fuel in diesel engine when compared to diesel fuel. This can be attributed to the low calorific value of sunflower oil ester.

A. Rajalingam1 et al [8]. The vegetable oil/animal fat has a high energy density to meet the energy compensation, but its properties are not favorable for better atomization so can be converted in to biodiesel. Generally four methods are used to produce biodiesel from vegetable oils and animal fat. The biodiesel production methods such as direct use and blending, transesterification process, pyrolysis and micro emulsion.

E.Muthamizhselvan et al [9] Reported on "prediction and reduction of NOx Emission Using bio fuel in multi cylinder diesel engine by injecting ammonia with SCR" injection of aqueous solutions of ammonia in the tail pipe of a diesel engine for the decrease of oxides of nitrogen (NOx) has been carried out in a four stroke multi cylinder,water cooled, constant speed diesel engine, four observation has been made for the exhaust emission NOx analysis of concentration of ammonia solution B25,B50,B75 and B100 by weight with different pressure of ammonia solution as reductant by fitting Marine ferromanganese nodule as SCR catalyst.

III-EXPERIMENTAL WORK

For the present experimental work a constant speed, single cylinder, four stroke, vertical, water cooled, high speed diesel engine equipped with AVL five gas analyzer system is used. The Experiment set up is as shown in figure.1

Figure 1. Photographic view of Experimental setup

Using Zinc oxide nanoparticle additive with Datura biodiesel blends as a fuel the performance and emission characteristics were obtained for various loads at constant speed of 1520 rpm at a constant injection timing of 23.4° bTDC (before Top Dead Centre).The engine has a belt brake dynamometer to measure its output. A constant load test is conducted and the results were recorded under steady state conditions. The properties of pure diesel, Datura and B20 (20% Datura oil and 80% diesel) are measured with standard equipment. The specifications of the engine and properties of fuel is mentioned in the following tables.

Table 1. Technical Specifications of the Engine

Make	Kirloskar
Type	4-stroke,1-cylinder diesel engine (water cooled)
Rated power output	5HP,1520 RPM
Bore & Stroke	80mm x 110mm
Compression Ratio	16.5:1
Dynamometer	Belt brake
Emissions	AVL Gas analyzer

Table 2. Properties of Diesel and Datura biodiesel

S.No	Properties	Diesel	Datura	B20
1	Density (Kg/m^3)	850	880	856
2	Viscosity (Mm^2/s)	2.6	4.80	3.04
3	Flash Point (ºC)	60	127	73.4
4	Fire Point (ºC)	64	131	77.4
5	Calorific Value (MJ/Kg)	43	39.23	41.44

Table 3 Properties of zinc Oxide nano additive

S. No.	Properties	Zinc oxide
1	Density (Kg/m^3)	3900
2	Molecular Weight (g/mole)	101.96
3	Appearance	White solid
4	Flash Point (ºC)	1500

The performance and emission parameters of B20 **(**80% diesel+20% Datura biodiesel) blended with the nano particles in the mass fraction of 50 ppm, 100 ppm and 150 ppm are compared with the B20 blend performance parameters. The Datura biodiesel was supplied by Jatropha oil seed development & Research Hyderabad, India. The Diesel fuel was purchased from The Bharat Petroleum pump outlet, Tirupati, A.P, India. The Zinc oxide nano particles with average size of 30nm are taken from Indian chemicals private limited, Chennai, India. The Datura oil is blended with diesel in a Magnetic stirrer.

Figure 2. Photographic view of Magnetic stirrer

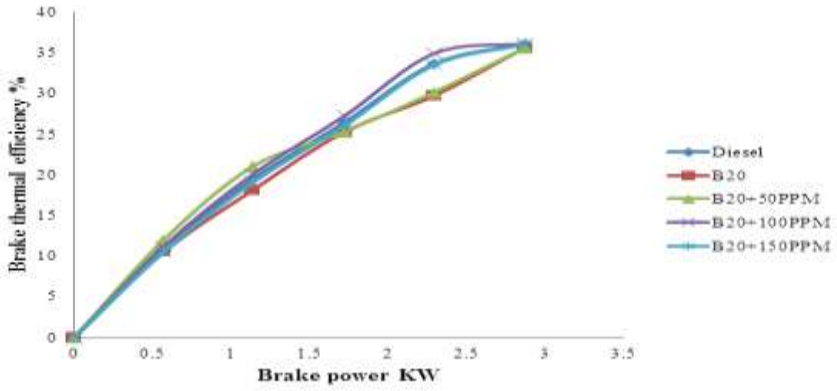
The mixing of Zinc oxide nano particle with Datura biodiesel was blended in an ultrasonicator at a frequency of 40 kHz and 120W for 60 minutes. The ultrasonicator technique is an act of applying ultrasound energy to agitate particles in a sample. The same procedure is applied for blend of biodiesel with mass fractions of 50 ppm,100 ppm and 150 ppm of nanoparticles.

Figure 3. Photogrphic view of Ultrasonicator

IV-RESULTS AND DISCUSSIONS

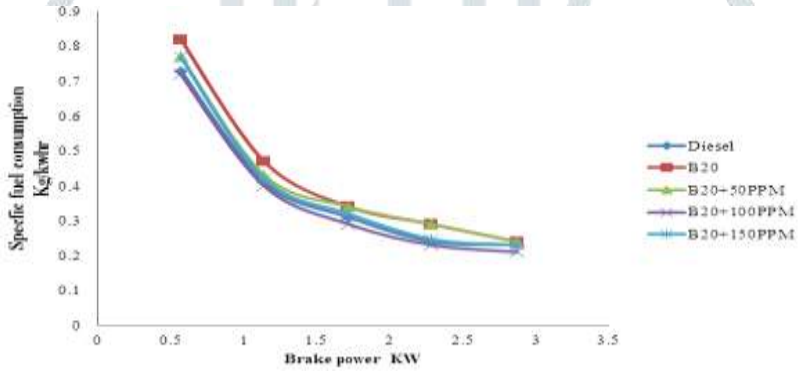
The following results are obtained after testing the B20 blend at rated load.

Graph 1 shows the variation in brake thermal efficiency with brake power for diesel, B20 and B20+50 ppm,B20+100 ppm and B20+150 ppm of nano fluid additive



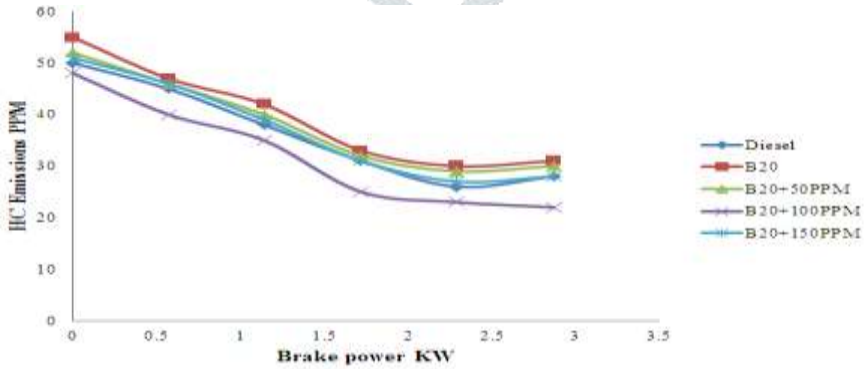
Graph.1. Variation of Brake thermal efficiency with B.P

The Brake thermal efficiency of B20+100ppm nano additive is increased by 1.14% and 3.29% compare to diesel and the biodiesel blend with 150 ppm respectively. At 100 ppm nanoparticles blend the flow characteristics are improved and further it enhances the combustion with the inherent oxygen in the nanoparticles. But at 150 ppm nano additive blend with the availability of more oxygen in combustion chamber the air fuel ratio becomes lean mixture and further leads to the improper combustion.so the brake thermal efficiency of 150 ppm is decreased compare to 100 ppm blend of nano additive.



Graph.2. Variation of Specific fuel consumption with B.P

Graph 2 shows the variation of specific fuel consumption with brake power for diesel, B20 and with B20 when added with additives. The Specific fuel consumption is decreased by 2.29%at B20+100ppm compare to diesel and it is decreased by 5.9%compare to 150ppm blends of biodiesel. At B20+100ppm we are getting the maximum brake thermal efficiency due to complete combustion. So the specific fuel consumption is decreased, due to inversely proportion relation between them. But at B20+150ppm due to improper combustion the brake thermal efficiency is decreased. So the specific fuel consumption is increased compare to 100ppm blend.

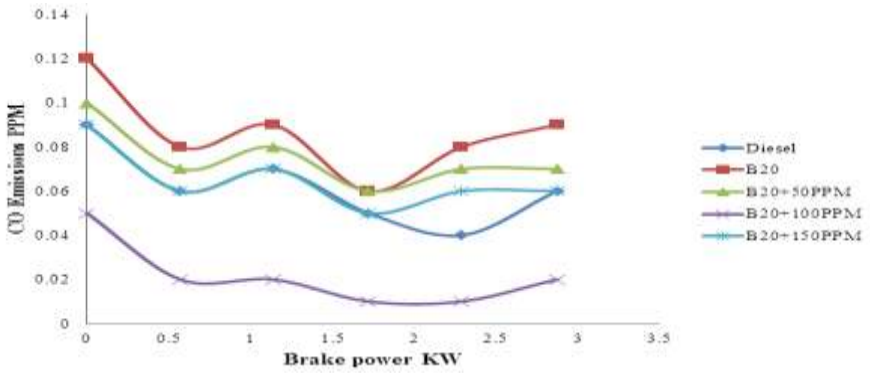


Graph.3. Variation of HC Emissions with B.P

Graph 5 shows the variation of the HC emissions with brake power for diesel, B20 and B20 with nano fluid additive with different proportions.

The HC emissions are formed due to improper combustion. The HC emissions are decreased by 16%for B20+100ppm and by 11%compare to B20+150ppm blend of biodiesel and diesel respectively. At B20+100ppm the complete combustion takes place

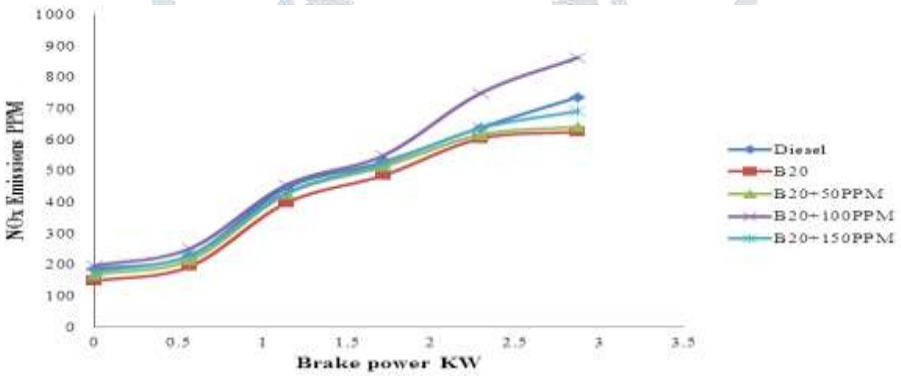
due to sufficient oxygen present in combustion chamber by means of nano additive. So the hydrocarbon emissions are decreased. But at B20+150ppm due to incomplete combustion in chamber compare to 100ppm blend the hydrocarbon emissions are increases.



Graph.4. Variation of CO Emissions with B.P

Graph 6 shows the variation of the CO emissions with brake power for diesel, B20 and B20 with nano fluid additive with different proportions.

The formations of CO emissions are due to lack of oxygen for combustion in the chamber. In the present work the CO emissions are decreased by 13%at B20+100 ppm compare to diesel and it is decreased by 8% at 150 ppm blend of biodiesel. At B20+100 ppm the air fuel mixture is equal to the stoichiometry air fuel ratio, the complete combustion takes place in the combustion chamber. So the CO emissions are decreased compare to diesel and 150 ppm blend of nano additive.



Graph.5. Variation of NO_x Emissions with B.P

Graph 5 shows the variation of the NO_x emissions with brake power for diesel, B20 and B20 with nano fluid additive with different proportions. The NO_x are formed due to higher temperatures in chamber, at lower temperature the NO_x are inactive. In present work the NO_x emissions are increased by 1.3%at B20+100ppm compare to diesel and it is increased by 3% at B20+150ppm blend of biodiesel. At 100ppm blend of biodiesel we got the maximum brake thermal efficiency. So the temperature in the combustion chamber is also maximum. The NO_x are depending up on the temperature in combustion chamber. So at that blend of biodiesel the NO_x are increased compare to diesel and other blends of biodiesel.

V-CONCLUSION

The performance and emission characteristics of diesel and varies blends of biodiesel are investigated in a diesel engine with Zinc oxide nano additive. The blend B20+100ppm show better performance. The conclusions are as follows.

1. The Brake thermal efficiency is increased by 1.14% and 3.29% compare to diesel and the biodiesel blend with 150 ppm respectively.
2. The Specific fuel consumption is decreased by 2.29%compare to diesel and also it is decreased by 5.9%compare at 150ppm blends of biodiesel.
3. The HC emissions are decreased by 16%compare to diesel and also it is decreased by 11%compare at B20+150 ppm blend of biodiesel.
4. The CO emissions are decreased by 13%compare to diesel and also it is decreased by 8% at 150ppmblend of biodiesel.
5. NO_x emissions are increased by 1.3%compare to diesel and also it is increased by 3% at B20+150ppm blend of biodiesel.

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