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Performance of Di Diesel Engine With JATROPHA Biodiesel and Aluminum Oxide 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 Jatropha biodiesel will be more advantageous for our farmers. The Jatropha 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% Jatropha (B20). The combustion of the engine depends on the flow capability of the fuel. With the higher viscosity, Jatropha 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 Aluminum Oxide Nano particles as additive on the performance and emission characteristics of Jatropha biodiesel blend(B20). It is blended with Aluminum Oxide Nano particle in mass fraction of 50 PPM,100 PPM and 150PPM.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. Aluminum 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*- Aluminum oxide, Jatropha Biodiesel blend, Nano additives.**

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 Jatropha biodiesel is most suitable alternate fuel with its properties in diesel engines. Many researches had tried on Jatropha 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 Jatropha, the flow capacity of Jatropha 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 types of nanoparticles. It is also reported that adding aluminum oxide nano particles to Jatropha bio diesel could enhance the ignition properties of biodiesel due to the heatbuildup within the fuel of reactive nature of aluminum Oxidenanoparticles. 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 nano additives in diesel engines with biodiesels. Some of them are presented below. M. Mohan Rao et., [1] Investigated the effect of Zinc oxide as a fuel additive in various proportions on diesel engine performance fuelled with Palmolion Stearin Wax biodieseland concluded that the engine performance and emissions are better compare to diesel. Further the effect of Rhodium oxide as a fuel additive with Pongamia oil and Pongamia pinnata biodiesels was investigated by S.Manibharathiet., [2] and concluded that the brake thermal efficiency is increased marginally compared to diesel, due to the better combustion in the combustion chamber. Experimental investigations on DI diesel engine with aluminum oxide nano additive with Zizipus jujube methyl ester biodiesel in various mass fractions of biodiesel blends was performed by C. Syed Aalamet. [3] and concluded that the emissions were drastically reduced with the high flow characteristics and inherent oxygen content of nano additive.

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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 flue gas analyzer system and smoke meter is used. Using Aluminum oxide nanoparticle additive withJatropha 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 Jatropha pure and B20 (20% Jatropha biodiesel 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,1500 RPM
Bore & Stroke	80mm x 110mm
Compression Ratio	16.5:1
Dynamometer	Belt brake
Emissions	AVL Gas analyzer

Table 2. Properties of Diesel and Jatropha biodiesel

S. No	**Properties**	**B20**	**Jatropha**	**Diesel**
1	Density (Kg/m^3)	856	880	850
2	Viscosity (Mm^2/s)	3.0	4.80	2.6
3	Flash Point(°C)	73.4	127	60
4	Fire Point(°C)	77.4	131	64
5	Calorific Value(MJ/Kg)	41.5	39.2	43

Table 3Properties of Aluminum Oxide nano additive

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

The experiments are conducted for different loads at constant injection pressure.

The performance and emission parameters of B20(80% diesel+20% Jatropha biodiesel) blended with the nano particles in the mass fraction of 50PPM,100PPM and 150PPM are compared with the B20 blend performance parameters. The Jatropha 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 Aluminum oxide nano particles with average size of 30nm are taken from Indian chemicals private limited, Chennai, India. The Jatropha oil is blended with diesel in a Magnetic stirrer.

Figure 1. Magnetic stirrer

The mixing of Aluminum oxide nano particle with Jatropha 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.

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Figure 2. Ultrasonicator for blending

IV. RESULTS AND DISCUSSIONS

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

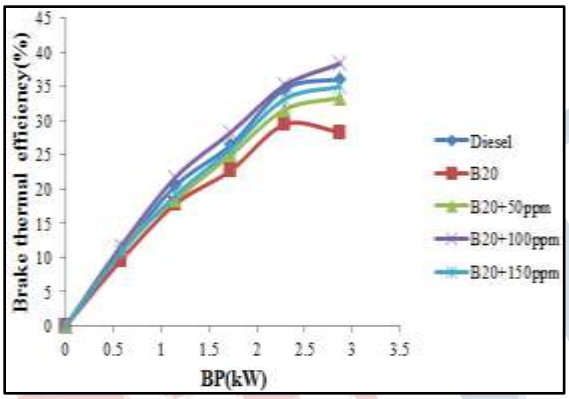

Figure 3. Variation of Brake thermal efficiency with B.P

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 is decreased compare to 100 PPM blend of nano additive.

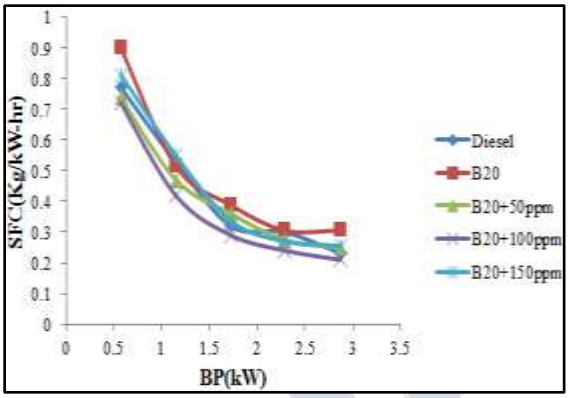

Figure 4. Variation of Specific fuel consumption with B.P

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. Sothe 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.

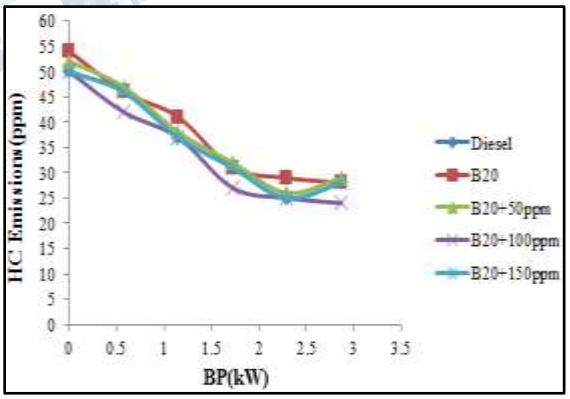

Figure 5. Variation of HC Emissions with B.P

The HC emissions are decreased by 16%at B20+100PPM compare to diesel and by 11%compare to B20+150PPM blend of biodiesel. At B20+100PPM the complete combustion takes place due to sufficient oxygen present in combustion chamber by means of nano additive. so

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the hydrocarbon emissions are decreased. But at B20+150PPM due to incomplete combustion in chamber compare to 100PPM blend the hydrocarbon emissions are increases.

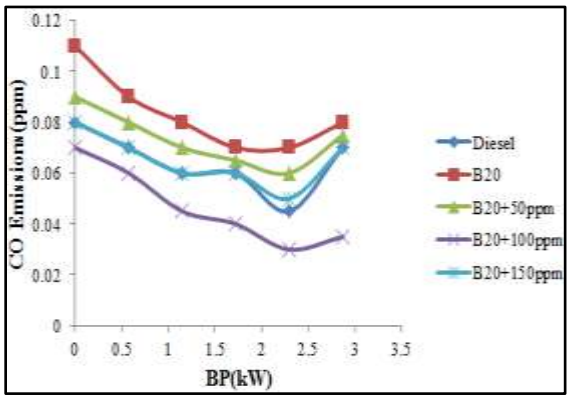

Figure 6. Variation of CO Emissions with B.P

The CO emissions are decreased by 13%at B20+100PPM compare to diesel and it is decreased by 8% at 150PPMblend of biodiesel. At B20+100PPM 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.

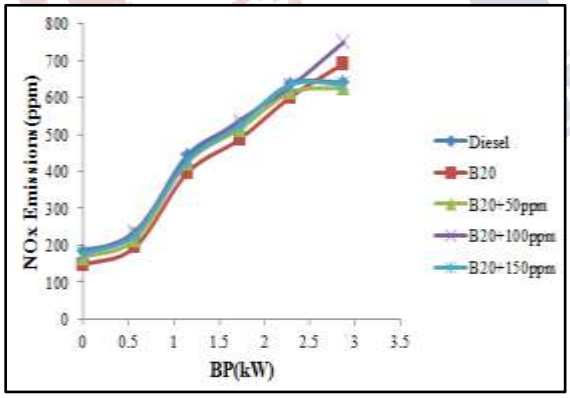

Figure 7. Variation of NO_x Emissions with B.P

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 depend up on the temperature in combustion chamber. So at 100 PPM blend of biodiesel the NO_x are increased compare to diesel and with B20+150 PPM blend of biodiesel

V. CONCLUSION

The performance and emission characteristics of diesel and varies blends of biodiesel are investigated in a diesel engine with Aluminum oxide nano additive.The blend B20+100PPM shows better performance. The conclusion 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+150PPM 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. The 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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