

Effect of Al_2O_3 Nano Fuel Additive on Performance and Emission Characteristics of the Dairy Scum Biodiesel Blend Fuelled Diesel Engine

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Abstract—The Diesel engine is one of efficient engines among all internal combustion engines. Conventional fossil fuels cause more pollution and fossil fuels are in depleting stage this leads to search for environmentally friendly and renewable alternative source of fuels. Biodiesel is one of the alternative sources for fossil fuels, Biodiesel can be used in Internal combustion engine without modification and biodiesel contains virtually no Sulphur or aromatics and use of biodiesel in a conventional Diesel engine results substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter but main drawbacks of biodiesel are high density, less heating value, high fuel consumption and high oxides of nitrogen emission compare to diesel fuel. To overcome this draw back various types of additives are used with biodiesel. Due to their special properties of additives like higher thermal conductivity, chemical properties promote better combustion this causes reduction emissions and improve the performance of Compression ignition engine.

In the experimental work carried out performance and emission tests of Al_2O_3 Nano particles additives of different proportion (50ppm, 100ppm and 150ppm) with optimized Dairy scum Biodiesel blend (B20). From experimental investigation it has observed that the addition of Al_2O_3 Nano additive with Dairy scum Biodiesel B20 enhance performance and combustion parameters compare to B20 blend and reduces HC, CO emissions with Marginal Increases in NO_x .

Index Terms— Biodiesel, Additives, Performance, Combustion, Emissions.

I. INTRODUCTION

Efficient use of natural and local resources is the fundamental requirements for the country to become self sustainable and independent which leads to economic growth of the country. Fossil fuel are in depleting stage for next generation many researchers have concentrated on developing new agro and renewable based alternative fuels, which will provide sustainable solution for the energy demands.

Fossil fuels are containing more hydrocarbons, which can be burned and used as a source for heat energy. Fossil fuels are found in the Earth crust, globally more carbon emissions contributor are the fossil fuels by human activates. The various literatures reviews shows a reduction in exhaust emissions with the inclusion of

oxygenating additives in the diesel and bio diesel blends due to their enhanced properties like combustion characteristics, lower aromatic compounds.

The world demand of energy is rapidly increasing. We are using fossil fuels mainly in transportation sector and industries. In the present modern life style energy consumption is keep on increasing as machines are the part of our life style and needs, One of the main energy sources is coal and oil power plants contribute more than renewable energy sources and rate of production is expected to peak in the upcoming years. Biodiesel is a biodegradable, clean burning easy combustible fuel derived fuel from natural and waste resources waste oils like Dairy scum, jatropa vegetable oils and animal fats. These fuels are meet standards specifications these fuels can be blended with fossil fuel as additive these are recommended by environmental agency. Biodiesel can be used in any internal combustion engines in either its pure form, which is referred to neat biodiesel, or it can blended in any concentration with regular petroleum fuels.

II. LITERATURE REVIEW

Various Investigations done on the diesel and biodiesel characteristics by adding the biodiesel with various additives. Nanoparticles of Metal oxide are enhance the engine efficiency and burning characteristics and reduce the outlet emissions of the diesel engine. It is show that the additives like aluminium oxide Nano particles be the most promising additive for biodiesel blends. However, still more investigations are in going on to reduce the possible unburnt nanoparticles in the exhaust of the engine in order to safe guard the surrounding environment [1]. Nanoparticles, catalysts can mix with the fuels to improve their performance and exhaust emission characteristics as per the research works [2]. The inclusion of alumina nanoparticles to blend reduced the ignition delay period and accelerated the combustion process, it led to a reduction in magnitude of maximum heat release rate [6]. Aluminium particles are best nano metal oxide additives for enhance the thermal performance, combustion characteristics and decreasing the emission of a diesel engine. The aluminium particles can be used as additive to further improve the existing properties of Honge Oil Methyl Easter (B20) fuel [7]. In addition carbon nano tube additives to diesel found more assured, because seems to produce high benefits like promoting thermal efficiency and decrease in emissions [8]. analysis nanotube of carbon with diesel shows carbon nanotubes have potential to be further researched as an additive for diesel due to significant combustion improvement and increase in emissions of NOx. [5]. Nanoparticles blended to diesel increase the negligible density and viscosity, the significant thermal conductivity increases. The mixture was stable for more than 2 months without need to remix. [10].

III. MATERIALS AND METHODS

In the experimental research work Performance and Emission test carried out in computerised Four stroke single cylinder water cooled diesel engine, specification of engine as mentioned in Table.2 Emissions are measured by gas analyser specification tabulated in Table.3, using Al_2O_3 Nanoparticles as additives at a different proportion (50ppm, 100ppm and 150ppm) with optimized Biodiesel blend of Dairy scum (B20), performances like fuel consumption(FC), Thermal efficiency and Emissions were analysed at a constant speed of 1500 rpm and obtained results are compared with the diesel fuel.

TABLE I. PROPERTIES OF ALUMINIUM OXIDE PARTICLE

Particle Purity	99%
particle Average size	20-30nm
particle Color	White
Crystallographic structure of particle	Spherical
Melting point of particle	2040°C
Boiling point of particle	2977°C
Density of particle at 20 ⁰ C	3.9 g/cm ³
Molarmass of particle	101.96g/mol
Molecular Weight of particle	101.96

A. Dairy scum Biodiesel

The dairy scum is collected from the dairy milk waste products such as ghee and butter, the scum containing water impurities, it is heated at 55 to 60°C for moisture content removal. It will allow settle down unwanted solid wastes for that suspended particles can be removed. Then oil will separated at the top and oil filtered. By transesterification process biodiesel was produced by various stages of processing with mixture of methanol and

NaOH as Catalyst then oil, methanol and glycerin mixture, Separated scum methyl ester, by Washing of Bio Diesel and after Drying of Bio Diesel can be used in internal combustion engines.



Figure 1: Dairy scum waste and dairy scum oil

B. Aluminium oxide nanoparticle

Aluminium (Al_2O_3) Nano particles are used in different applications because of its beneficial enhanced properties, Addition of nanoparticles in fuels called as Nano fuels these can improve combustion in internal combustion engines and reduce emissions during combustion. Nano particles measure 1 to 100 nm size in diameter. Nano additives are added to biodiesel and diesel to enhance the fuel properties. Aluminium (Al_2O_3) Nano particles enhanced Biodiesel blend properties due to thermo properties of Nano particles, also reduces harmful emissions due to improve in combustion properties and reduce delay period etc.

B. Preparation of blends and Experimentation

For the experimentation purpose Diesel, optimised dairy scum biodiesel B20 blend with Aluminium oxide nanoparticle of various proportions like 50ppm, 100ppm and 150ppm by ultrasonicator apparatus (Figure 2) for the duration of 30 minutes prepare homogeneous mixture of fuel blends.

Analyzer measures CO, HC, CO₂ & NO_x. Analyzers of gas working on the principle of light absorption by the gas under test. Absorption analyzers need shine a light beam through a sample chamber and measure specific wavelengths absorbed by the sample. The light absorption amount is proportional to the concentration of the component in fluid which absorbed light.



Figure 2: Ultrasonicator



Figure 3: Computerised IC engine Test rig

IV. RESULTS AND DISCUSSION

Experiments are conducted to find the properties of blends as per standards and results are tabulated in table 4. Results show that fuel properties are improved with addition of aluminium oxide nanoparticles, calorific value of fuel increases with increase in nanoparticle proportions, flash and fire point also increases with Nano additives.

TABLE II. ENGINE PARAMETERS

Parameters of Engine	Engine Specification
Diesel Engine	single cylinder Four stroke
	Kirloskar
No. of cylinders	1- Cylinder
Horse power of engine	5HP
Speed	1500 rpm
Bore(D)	80 mm
Stroke length(L)	110 mm
Compression ratio(R_c)	17.5
Start of engine	Manual
Working cycles	four stroke
Cooling system	Water cooled system
Ignition system	Compression ignition system
Dynamometers	Eddy Current dynamometer

TABLE III. SPECIFICATIONS OF GAS ANALYZER

Emission	Range of Measuring
CO-	0.00% - 9.99%
HC-	0ppm - 9999ppm
CO ₂ -	0.0 - 20.0%
O ₂ -	0.0 - 25.0%
NO _x -	0ppm - 9999ppm

TABLE IV. PROPERTIES OF BLENDS

Fuel	Diesel	B20	B20 + 50ppm	B20 + 100ppm	B20 + 150ppm
Density (kg/m ³)	830	840	841	841	842
Kinematic Viscosity (Cst)	2.9	2.98	2.98	2.98	2.99
Calorific Value (MJ/kg)	43	40.89	41.02	41.50	42.45
Flash Point (°C)	50	60	58	56	55
Fire Point (°C)	55	65	62	60	58

A. Performance and Emission Parameters

Figure.3 shows Maximum Break Thermal Efficiency is obtained in the Diesel engine and B20+150ppm Al₂O₃ shows almost near efficiency to the diesel. Biodiesel shows less efficiency compared to the other blends. Biodiesel shows 19.62% and B20+150ppm Al₂O₃ shows 21.69% comparatively 10.41% of Break thermal efficiency is Increased and compared with Diesel 4.36% of Break thermal efficiency is Increased.

Figure.4 shows Maximum Break specific fuel consumption is obtained in the Diesel engine, and B20+150ppm Al₂O₃ shows more fuel consumption to the diesel. Biodiesel shows less efficiency compared to the other blends. Biodiesel shows 0.99% and B20+150ppm Al₂O₃ shows 0.90% comparatively 9.09% of Break specific fuel consumption Increased and compared with Diesel fuel 15% of Break specific fuel consumption decreased.

Figure.5 shows Carbon monoxide Emission of various blends, B20+150ppm Aluminum oxide Nano particle blend shows lesser emissions among all the blends. and Diesel shows more emission. Diesel and Biodiesel shows 13.33% more carbon monoxide emission compared to B20+150ppm Aluminum oxide Nano particle blend.

Figure.6 shows Hydro carbon Emission of various blends, B20+150ppm Aluminum oxide Nano particle blend shows fewer emissions among all the blends. and Diesel shows 16.25% more Hydro carbon and Biodiesel shows 26.37% more Hydro carbon emission compared to B20+150ppm Aluminum oxide Nano particle blend Figure.7 shows Nitrogen oxide is obtained in the Diesel engine and B20+150ppm Al₂O₃ shows almost more emission to the diesel. Biodiesel shows less emission compared to the other blends. Biodiesel shows 573ppm and B20+150ppm Al₂O₃ shows 628ppm comparatively 8.75% of Nitrogen oxide emission is Increased and compared to diesel 6.68% of Nitrogen oxide is Increased.

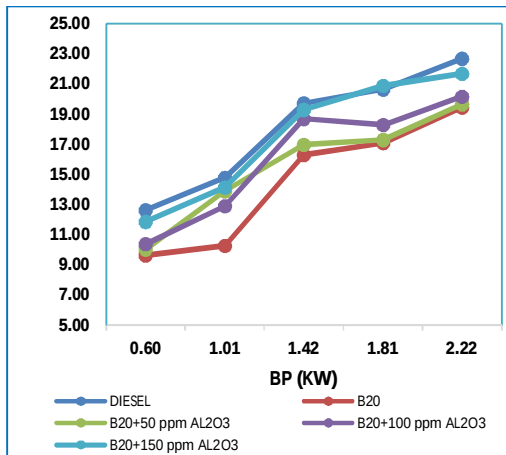


Figure 3: BTE-Brake Thermal Efficiency

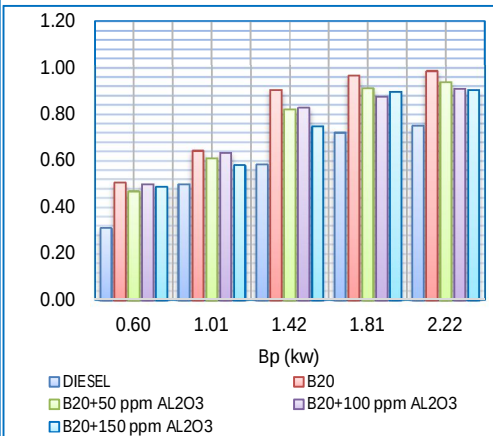


Figure 4: BSFC- Brake specific fuel consumption

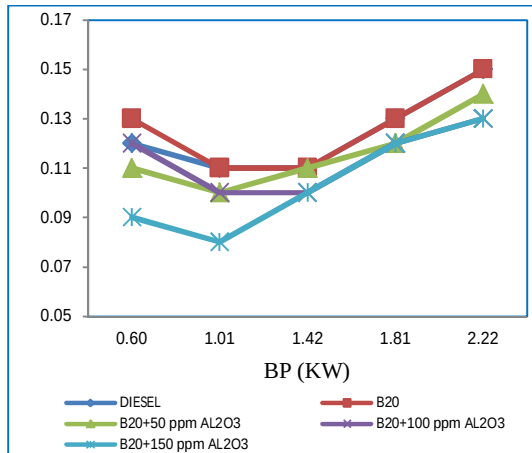


Figure 5: CO-Carbon monoxide Emission

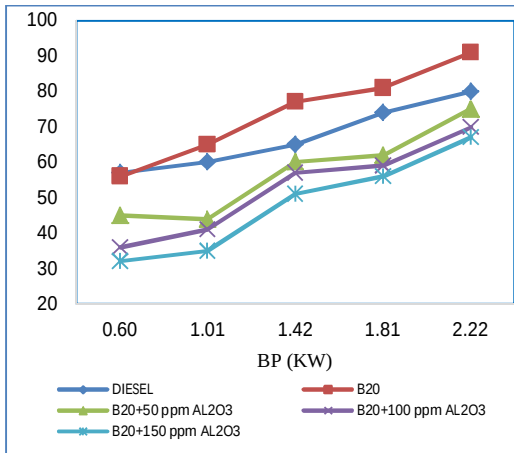


Figure 6: HC-Hydrocarbon Emission

In Fig.8 it can be observed that Maximum Pressure obtained In Diesel and as Nano particle added Pressure Increased compared to Dairy scum Bio diesel. At B20+150ppm Al_2O_3 shows nearer Pressure compare to Diesel.

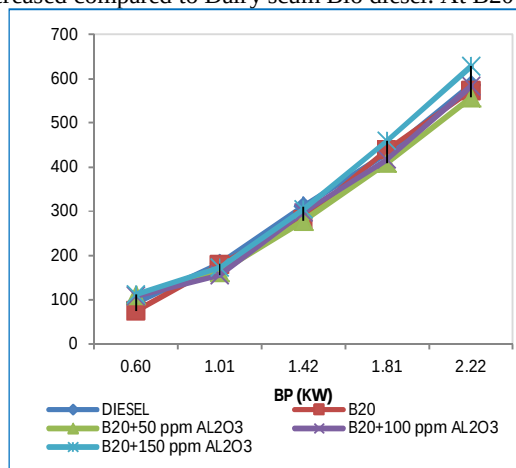


Figure 7: Nitrogen oxide with BP

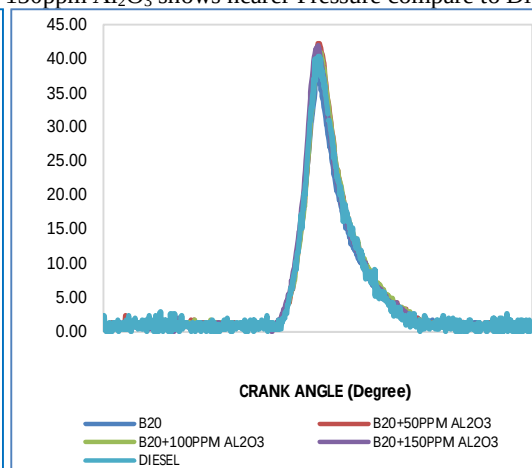


Figure 8: pressure with crank angle

V. CONCLUSIONS

The effects of Al_2O_3 Nano additive of fuel in diesel and dairy scum biodiesel blends on diesel engine performance, combustion parameters and exhaust emission characteristics were investigated in computerized Diesel engine test rig. On the experimental Based investigation of blends following outcome are drawn.

- The Brake thermal efficiency of Diesel engine increases with increase in concentration of nanoparticle in Diesel and Biodiesel blends,
- Fuel consumption decrease with addition of the nanoparticles of Aluminium oxide in diesel and bio diesel blends.
- Hc and Co emissions were less compare to neat diesel in all blends and Biodiesel.
- Marginal increase in Nitrogen oxide emission was observed in experimental results.

From above experimental investigation it can be conclude that Aluminium nanoparticle dispersed biodiesel enhances the performance and reduces the emission, B20+150ppm Aluminium nanoparticle blend exhibits better performance among all blends. Additives are plays major role to overcome the drawbacks of biodiesel.

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