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Performance and Emission Characteristics of CI Engine using Diesel and Biodiesel (Pongamia) Blends with Aluminum Oxide Nanoparticles as Additive

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ABSTRACT:

In this paper, aluminum oxide nanoparticles as added with pongamaia biodiesel. Experimental study is focussed the performance and emission characteristics of a compression ignition diesel engine using biodiesel and biodiesel mixed with aluminum oxide nanoparticles as an additive in different proportions. The aluminum oxide nanoparticles promote complete combustion in the diesel engine. The experiments were conducted using biodiesel (B100) with aluminum oxide nanoparticles additive in proportions of BN100, BN200, BN300, BN400 and BN500 ppm at different brake power. Results were analyzed and compared with diesel, biodiesel, biodiesel with addition of aluminum oxide nanoparticles. Gas analyzer was used to measure the various gas pollutants. The test results showed that the addition of aluminum oxide nanoparticles with biodiesel has improved complete combustion of the fuel leading to better performance and reduced exhaust emissions like CO, HC, smoke and NO_x when compared to diesel fuel.

KEYWORDS:

Biodiesel; Aluminum oxide nanoparticle; Performance; Emissions; Diesel engine

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NOMENCLATURE:

BSFC	Brake specific fuel consumption
BP	Brake power
ME	Mechanical efficiency
BTE	Brake thermal efficiency
CO	Carbon monoxide
HC	Hydrocarbon
NO_x	Oxides of nitrogen
PPM	Parts per million
PME	Pongamia methyl ester
ALONP	Aluminum oxide nanoparticles
BN100	Biodiesel (PME) + Aluminum Oxide nanoparticles of 100ppm
BN200	Biodiesel (PME) + Aluminum Oxide nanoparticles of 200ppm
BN300	Biodiesel (PME) + Aluminum Oxide nanoparticles of 300ppm
BN400	Biodiesel (PME) + Aluminum Oxide nanoparticles of 400ppm
BN500	Biodiesel (PME) + Aluminum Oxide nanoparticles of 500ppm

1. Introduction

Diesel engines are mostly used for economical and better operation prospectives. Demand of petroleum fuels is depleting due to population growth and enormous energy usages. Need for research in to alternative fuels and world energy requirement will be fulfiled by biodiesel. Balat et al [1] studied biodiesels as alternative substitute for diesel fuel. Serio et al [2] found that biodiesels are sulphur free and eco-friendly fuels. Threats by emissions in the norms of regulations are given by government to protect environment. Biodiesel is blended with nanoparticles to improve the engine efficiency and reduced emissions such as HC, CO, NO_x and smoke. Shahabuddin et al [3] studied that various process of combustion affects the efficiency of engine. Jones et al [4] found that metal oxide additives can be used in fuels without any modification of diesel engine.

Taghipoor et al [5] studied the use of nanoparticles catalyst increases the efficiency and lowered the gas emissions such as particulate matter and NO_x. Raja et al [6] studied that the biodiesel with addition of nanoparticles increases atomization and efficiency and thereby reduces the ignition delay period, viscosity and NO_x emissions. Saravanan et al [7] found that nanoparticles additive has improved the performance and combustion of the engine. Dinesh Kumar et al [8] studied that biodiesel with addition of fuel additive improved the combustion characteristics, performance, fuel properties and also reduced the emission characteristics. Singh et al [9] studied that the addition of nanopaticles with biodiesel promotes higher evaporation, flame temperature and reduced ignition delay period and emissions. Vishwajit et al [10] concluded that higher enhancement of the brake thermal efficiency, reduction in the harmful pollutants, more surface area of reaction and higher thermal conductivity can be achieved by using nanoparticles additives with biodiesel.

2. Materials and methods

2.1. Preparation of biodiesel

Biodiesel preparation consists of removal of fatty acids through transesterification process. During biodiesel processing, the effect of triglycerides of pongamia oil by using methanol with the help of a catalysts lead to transesterification. for the. Magnetic stirrer, thermo-meter, and beaker were used for transesterification process. Raw material is pongamia oil, methanol and potassium hydroxide. Pongamia seed oil was measured to a capacity of 1000ml filled into the beaker. It was stirred at 1000rpm and heated up at 60°C to the oil. 250ml of methanol and 5g of potassium hydroxide was dissolved by stirring. Hot oil was taken in the bottle for 24 hours to settle down methyl ester at the top and glycerin at the bottom. Double the volume of distilled water at 80°C was added with PME. This procedure was repeated until the ester layer was cleared.

2.2. Preparation of biodiesel with addition of nanoparticles

Biodiesel with addition of aluminum oxide nanoparticles at different proportions of 100ppm, 200ppm, 300ppm, 400ppm and 500ppm are properly mixed by using an ultrasonicator. Properties of diesel and biodiesel are given in Table 1.

Table 1: Properties of diesel and biodiesel

Property	Diesel	PME
Kinematic viscosity @ 40°C in Cst	2.51	4.7
Density (kg/m3) @ 15(°C)	834	885
Cetane number	50	55
Flash point (°C)	50	179
Specific gravity @ 27 (°C)	0.840	0.875

3. Experimental set up and test procedure

The experiment was conducted on four strokes, air cooled diesel engine. Details of the engine specification are given in Table 2. The AVL smoke meter 415 was used to measure the smoke density. AVL - DIGAS 444 five-gas analyzer was used to measure the rest of the pollutants such as NO_x, HC and CO emissions. The experimental setup is shown in Fig. 1.

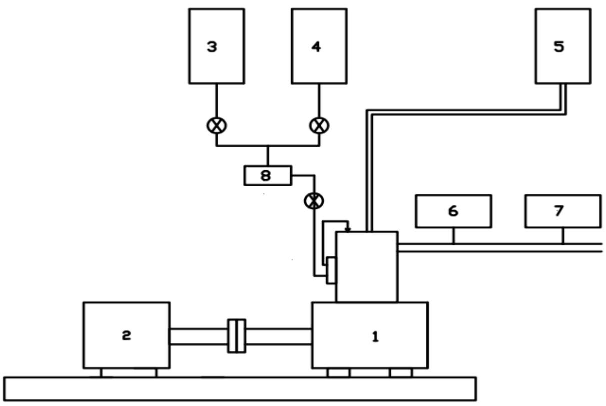

Fig. 1: Experimental setup

1. Engine; 2. Electrical dynamometer; 3. Diesel fuel tank; 4. Biodiesel fuel tank; 5. Manometer; 6. Gas analyzer; 7. Smoke meter; 8. Fuel control valve

Table 2: Vertical air cooled, 4 stroke, single cylinder diesel engine specification

Parameter	Value
Bore diameter, Stroke	87.5 mm, 110 mm
Compression ratio	17.5:1
Maximum power, Speed	4.4 kW, 1500 rpm
Dynamometer	Swing field electrical type
Injection timing	23° (before TDC)
Injection pressure	200 bar

4. Results and discussion

4.1. Engine performance

Fig. 2 shows the variation of brake power with respect o the specific fuel consumption (SFC) for biodiesel and biodiesel with aluminum oxide nanoparticles. Fuel consumption was reduced by increasing the aluminum oxide dosing levels. SFC for biodiesel is more than the diesel. Biodiesel with additive proportions of 100ppm to 500ppm aluminum oxide nanoparticles improved the SFC reduction considerably. The addition of aluminum oxide fuel resulted in reduction of SFC at maximum brake power. Fig. 3 shows the brake thermal efficiency (BTE) with respect to the brake power for diesel, biodiesel and biodiesel with aluminum oxide. BTE was slightly decreased for B100 when compared to the diesel fuel. Increasing the dosing level of nanoparticles with biodiesel from 100ppm to 500ppm increased the BTE.

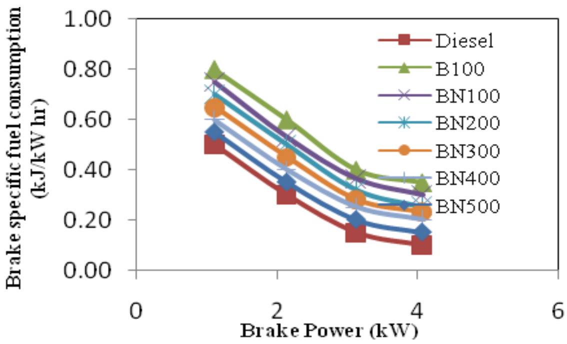

Fig. 2: Specific fuel consumption vs. Brake power

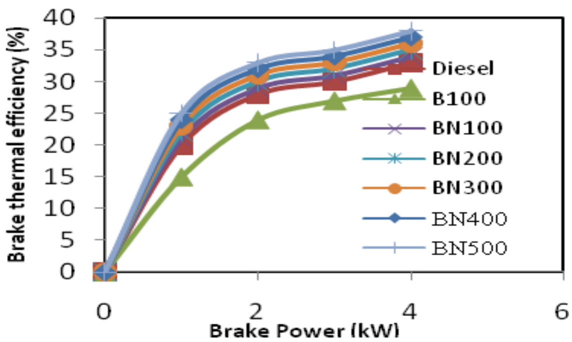

Fig. 3: Brake thermal efficiency vs. Brake power

3.2. Emission parameters

Fig. 4 shows that the biodiesel with addition of nanoparticles increased the level of oxygen. Oxygen substance of fuel is the most important cause for decreased HC emissions due to the complete combustion. HC emissions were reduced in the biodiesel with addition of nanoparticles. If the brake power is increased, HC emissions were increased. Fig. 5 shows

CO emissions against brake power for diesel, biodiesel and biodiesel with nanoparticles. Nanoparticles addition to biodiesel reduced CO emissions for 100ppm to 500ppm mixtures at maximum brake power. Reduction of CO emissions due to shorter ignition delay and better air fuel mixing of the combustion chamber results in reduced CO emissions. Fig. 6 shows the variation of smoke with respect to brake power for biodiesel and biodiesel with addition of nanoparticles. The results shown that smoke decreases with addition of nanoparticles from 100ppm to 500ppm at maximum brake power which is due to the complete combustion in the combustion chamber.

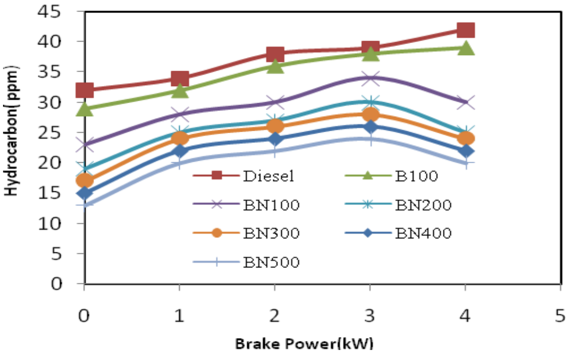

Fig. 4: Hydrocarbon emission vs. Brake power

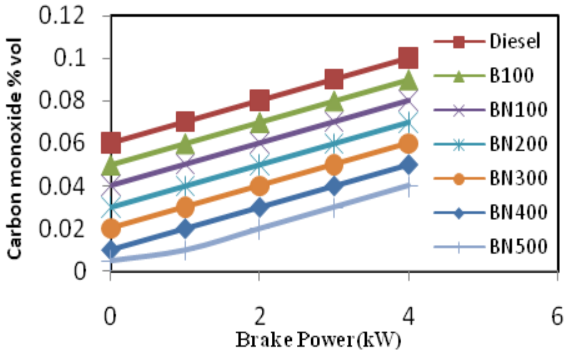

Fig. 5: Carbon monoxide emission vs. Brake power

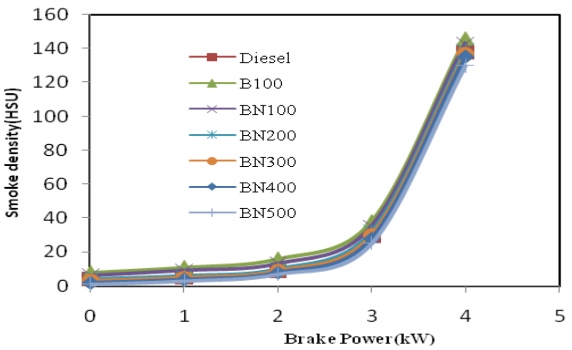

Fig. 6: Smoke density vs. Brake power

Fig. 7 shows the variation of NO_x with respect to the brake power for diesel, biodiesel and biodiesel with addition of nanoparticles. Increased brake power rises temperature in the combustion chamber and NO_x emission also increases. NO_x is more in the biodiesel when compared with mixing of nanoparticles in the biodiesel. NO_x emission was decreased due to 100ppm to 500ppm of nanoparticles mixing with the biodiesel at maximum brake power.

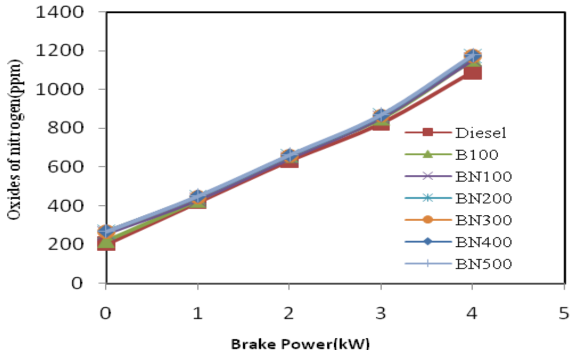

Fig. 7: NOx emission vs. Brake power

5. Conclusion

In this experimental study the effects of aluminum oxide nanoparticles additive mixing in the pongamia biodiesel on the diesel engine performance and emission were studied. The SFC for the biodiesel was higher than neat diesel at the entire brake power and it was decreased with an increase in the nanoparticles dosing level of aluminum oxide nanoparticles. The BTE of biodiesel was less than neat diesel at all the brake power and improved by using aluminum oxide additives with biodiesel. The CO and HC emissions were reduced by the use of aluminum oxide nanoparticles when compared with neat diesel. The quantity of smoke emission is higher for biodiesel than the neat diesel. The addition of aluminum oxide nanoparticles, the smoke density of emission was further reduced compared to biodiesel. The NO_x emission is lesser for the neat diesel than the biodiesel. The NO_x emission was increased with increasing brake power. Biodiesel with addition nanoparticles reduced the NO_x emission when compared with biodiesel fuel.

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REFERENCES:

[1] M. Balat and H. Balat. 2010. Progress in biodiesel processing, *Applied Energy*, 87, 1815-1835. https://doi.org/10.1016/j.apenergy.2010.01.012.

[2] M.D. Serio, R. Tesser, L. Pengmei and E. Santacesaria. 2008. Heterogeneous catalysts for biodiesel production, *Energy & Fuels*, 22, 207-217. https://doi.org /10.1021/ef 700250g.

[3] Shahabuddin, A.M. Liaquat, H.H. Masjuki, M.A. Kalam and M. Mofijur. 2013. Ignition delay, combustion and emission characteristics of diesel engine fuelled with biodiesel, *Renewable and sustainable Energy Reviews*, 21, 623-632. https://doi.org/10.1016/j.rser.2013.01.019.

[4] M. Jones, H.L. Calvin, A. Afjeh and G.P. Peterson. 2011. Experimental study of combustion characteristics of nano scale metal and nano metal oxide additives in biofuels (ethanol), *Nano Scale Research Letters*, 6:246. https://doi .org/10.1186/1556-276X-6-246.

[5] A.A.T. Bafghi, H. Bakhoda and F.K. Chegeni. 2015. Effects of Cerium oxide nanoparticles addition in diesel

and diesel-biodiesel blends on the performance characteristics of a CI engine, *Int. J. Mech., Aerospace, Industrial, Mechatronics and Mfg. Engg.*, 9(8), 1415-1420.

[6] R.B. Raja and K. Rameshbabu. 2015. Theoretical and experimental validation of performance and emissions characteristics of nanoparticles blended diesel engine, *Int. J. Research in Aero. and Mech. Engg.*, 3(5), 18-31.

[7] C.G. Saravanan and C.S. Aalam. 2015. Effects of nano metals oxide blended mahua biodiesel on CRDI diesel engine, *Ain Shams Engg. J.*, 1-8. https://doi.org/10.1016/j.asej.2015.09.013.

[8] L.S. Dineshkumar, P.R. Pravin and K.P. Nikul. 2012. Performance and emission by effect of fuel additives for CI engine fuelled with blend of biodiesel and diesel - A review study, *J. Engg. Research and Studies,* 3(4), 1-4.

[9] G. Singh and S. Sharma. 2015. Performance, combustion and emission characteristics of compression ignition engine using nano-fuel: A review, *Int. J. Engg. Sci. and Research Tech.*, 4(6), 1034-1039.

[10] A. Vishwajit, B.C. Bhagwat and N.R. Banapurmath. 2015. Graphene nanoparticles-biodiesel blended diesel engine, *Int. J. Engg. Research and Tech.*, 4(2), 75-78.