

Investigation of Pongamia Pinnata with Nano Additives on Performance Characteristics of Diesel Engine

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Abstract

Worldwide researches are being done to find an alternate fuel as fossil fuels are depleted at a faster rate. Bio diesel is a substitute to diesel in diesel engine and blending of nano additives with them would enhance performance of an IC engine. There exists a lot of opportunity for future enhancement in the performance and emission control, compared to further modifications in engine and exhaust system. This paper analysis the possibility of using biodiesel as an emulsion fuel by blending them with cerium oxide (CeO_2) and aluminium oxide (Al_2O_3) nano particles. Relative study on properties of diesel and biodiesel fuels with/without existence of water and nanoparticle additives have been made. Experimental testing was done on an IC engine by using diesel and biodiesel fuels with/without presence of water and nanoparticle additives. It was seen that blending nanoparticles with these type of emulsion fuel would improve performance of an IC engine.

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INTRODUCTION

Diesel is used for systems like automobiles, power plants, agriculture engines and also generators which increase the demand for diesel. Due to increased usage, diesel is being depleted rapidly. Biodiesel is considered as a possible replacement to diesel because they are derived from natural resources. Sunflower, rape seed, cotton and soya bean are various sources of biofuels. Biofuels could also help to conserve environment as they are derived from natural sources. At present, nanoparticles owing to their enhanced properties are used in various systems. The blending of diesel and biodiesel increases the emissions from the engine at various experimentally tested conditions. The peak pressure is higher. Pollutant release drops. Carbon nano tubes were used along with fuel blends as an additive [1]. Water in diesel mixture was prepared with varying

proportions of water in diesel. Surfactants were used to blend water with diesel. Emulsifiers help in stabilizing the mixture [2]. To control the air pollution and the engine exhaust, diesel-water emulsion is used as a fuel, oxygen line is connect with the inlet and incoming air is augmented with twenty seven percentage oxygen and water-fuel emulsion of 10%. This not only controls the emission but also reduces ignition delay and overcomes power loss. Reduce in NOX, HC emission. Oxygen is sent with incoming air so that brake thermal efficiency increased and also NOX level is increased [3]. Inclusion of hydrogen boosted pulsation engine. Pongamia and oils were blended with main diesel in varying volume proportions [4]. Cymbopogonflexuosus is used as a biofuel and cerium oxide is used as nanoparticles, and synthesized by method of sol-gel combustion. 20% of biofuel is mixed with diesel and nanoparticles of

different ratio as 10, 20, 30 ppm, load condition with a persistent speed of 1500 rpm. Smoke and NOX emitted reduced. The results exhibited high thermal stability and brake thermal efficiency due to oxygen buffer [5]. Silver nanoparticles were being used along with fuel. Density and kinematic viscosity of emulsion increases. Accumulation of nano particles with diesel cum biofuel, enhanced engine output. CO and UHC emission decreased, but NOX emission decreased [6]. Water and alcohol can used to enrich an engine with oxygen which thereby augments features of engine. They improve fuel atomization [7]. It was seen that inclusion of nano particles upgraded the characteristics and blending also had significant influence on properties of fuel [8-11]. The impact of cooking oil which is wasted from domestic resources and its influence on engine have been investigated [12]. Palm oil diesel is used as lubricant under half throttle condition with an engine speed 2500 rpm which was continued throughout the period of twenty hours. Satisfactory result was gained with ordinary diesel, palm oil and emulsion of 10% water, this combination gives promising resisting wear, then the ordinary diesel fuel [13]. Back pressure effects on features of an engine has been experimentally studied [14]. Preheated palm oil with a temperature of 90 degree Celsius was used as fuel in DI variable compression engine. Augmentation in performance features was perceived [15]. A technical review has been made on treated vegetable oil in detail [16]. Influence of nanoparticles with Calophyllum biodiesel is investigated. Varying proportions of nanoparticles are added to the mixture. Nanoparticles improves engine performance and combustion owing to their catalytic effect [17]. Significance of nanoadditives on a compression ignition engine have been discussed [18, 19]. In this paper, cerium oxide and aluminium oxide nano particles were blended in varying proportions with pongamia pinnata biodiesel. The influence of this emulsion fuel on an engine has been experimentally studied. The impact of nano particles in emulsion fuel has also been examined in this paper.

Comparative study on engine performance with diesel and biodiesel blends have been made in this paper.

EXPERIMENTAL WORK

Water – pongamia pinnata emulsion fuel (EF) is prepared by using magnetic hot plate stirrer as shown in Figure 1. Water and biodiesel are generally immiscible. They are mixed by means of surfactants, which are used to mix immiscible liquids. Surfactant span 80 plus tween 80 were used for blending water through biodiesel. Surfactants used here act as emulsifiers. So as to get a stable mixture value should lie in between 7-11. To get this hydrophilic–lipophilic balance value, mixing of 2 surfactants tween 80 cum span 80 was done to get 8 balance value. The mixture of surfactant is 2% by volume. This is mixed with biodiesel (88% volume) and 10% water (10% volume) and is agitated in magnetic stirrer which is shown in Figure 1.

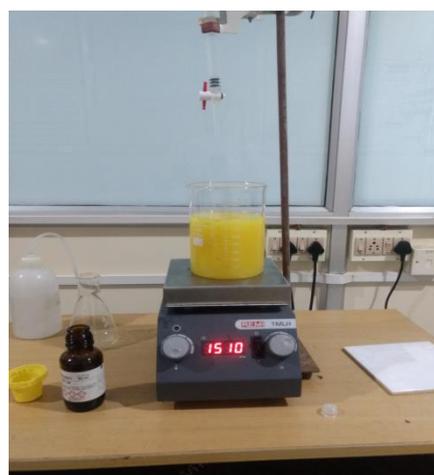


Figure 1. Hot Plate Magnetic stirrer

Table 1 presents the composition of pongamia pinnata biofuel.

Component	Composition (%)
Carbon	70.44
Hydrogen	12.08
Oxygen	17.45
Nitrogen	0.011

Table 2. pProperties of Aluminium oxide & Cerium oxide

Property	Aluminium oxide	Cerium oxide
Chemical formula	Al ₂ O ₃	CeO ₂
Appearance	Crystal white	Pale yellow
Boiling point	660.37 °C	2400 °C
Melting point	2467 °C	3500 °C
Nano size	50 nm	20 nm

Nano particles are weighed by using infra-red electrical balance. Ultrasonicator and magnetic stirrer are used for preparing required H₂O – biodiesel emulsion fuel (EF) with nano particles (say 50,100 and 150 ppm). Cerium oxide and aluminium oxide nano particles are dispersed in mixture by means of an ultrasonicator as shown in Figure 2. After dispersion of nano particles by using ultrasonicator, then the mixture is agitated by means of mechanical stirrer which results in water – biodiesel emulsion fuel (EF) with nano particles (say 50,100 and 150 ppm). Three samples of water – biodiesel emulsion fuel (EF) with nano particles (say 50,100 and 150 ppm) were prepared by the above procedure. The composition of five samples with which the engine is tested is shown in Table 3.



Figure 2. Ultrasonicator

Table 3. Composition of samples

Sample Number	Sample Composition
Sample 1	pongamia pinnata bio diesel

Sample 2	Emulsion fuel (88% volume biodiesel + 2% surfactant + 10% water)(EF)
Sample 3	Emulsion fuel 50A(88% volume biodiesel + 2% surfactant + 10% water+50 ppm nanoparticle)(EF50A)
Sample 4	Emulsion fuel 100A(88% volume biodiesel + 2% surfactant + 10% water+100 ppm nanoparticle)(EF100A)
Sample 5	Emulsion fuel 150A(88% volume biodiesel + 2% surfactant + 10% water+150 ppm nanoparticle)(EF150A)

These samples along with diesel is experimentally tested on an engine which is presented in Figure 3. Table 4 displays the details of engine. The experimental test is performed under varying load conditions.



Figure 3. Diesel engine

Table 4. Engine Specification

Engine	Single Cylinder 4 Stroke CI Engine
Engine Make	KIRLOSKAR
Power (BP)	3.7kW (5 BHP)
Speed (N)	1500 rpm
Bore (B)	80 mm
Stroke (SL)	110 mm
Cooling Type	Water Cooled
Fuel	Diesel
Circumference of Brake Drum (Cb)	0.785 m
Coefficient of Discharge	0.65
Lubrication	Splash

RESULTS & DISCUSSIONS

The deviation of fuel consumption in accordance to load can be understood from Figure 4. From Figure 4, it can be inferred as diesel has minimum fuel consumption. Biodiesel, EF100A and EF150A have fuel consumption little superior than diesel because their heating value is lower compared with diesel. It was seen that emulsion fuel (EF) has the least calorific value due to which it has the highest fuel consumption. It was also inferred that with the rise in nanoparticle concentration, calorific value increases and so fuel consumption drops.

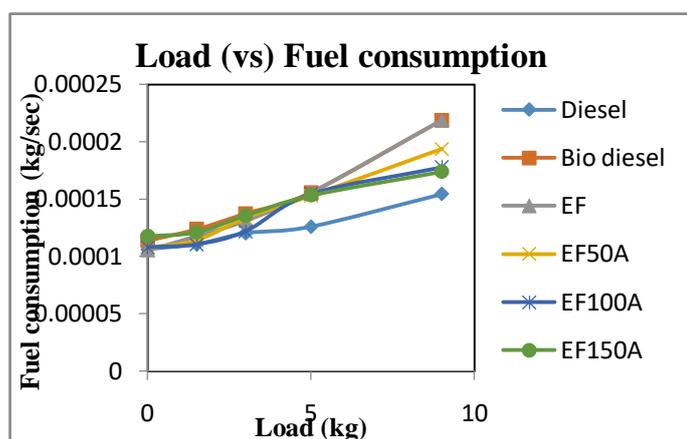


Figure 4. Variation in consumption of fuel pertaining to load

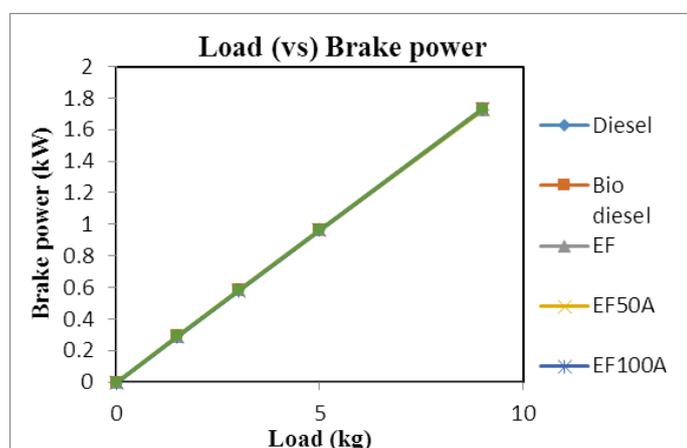


Figure 5. Variation in Brake power pertaining to load

The deviation of brake power respect to load is shown in Figure 5. From Figure 5, it was inferred that brake power remained almost same for all

samples. The process of emulsification and adding nanoparticles does not affect the brake output power of the engine.

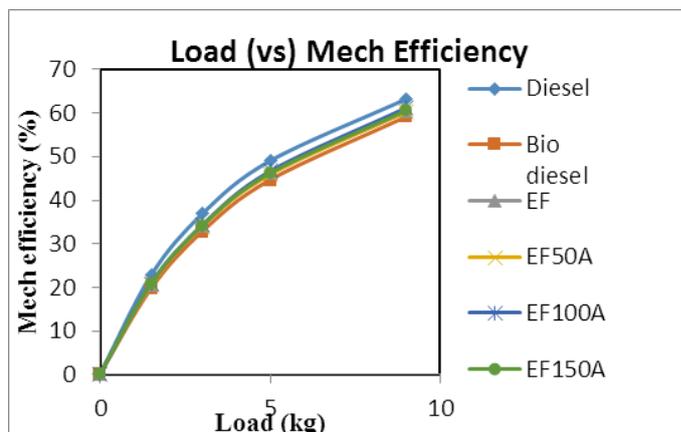


Figure 6. Variation in mechanical efficiency respect to load

The difference of mechanical efficiency accordance to load is shown in Figure 6. From Figure 6, it is viewed that mechanical efficiency of main diesel fuel is superior compared to all samples due to low viscosity. Biodiesel owing to higher viscosity has the least mechanical efficiency of all samples. The mechanical efficiency of EF150A is next to that of diesel. It was studied that with the rise in the proportion of nanoparticles, mechanical efficiency increases. Also emulsification reduces viscosity, which in turn improves mechanical efficiency.

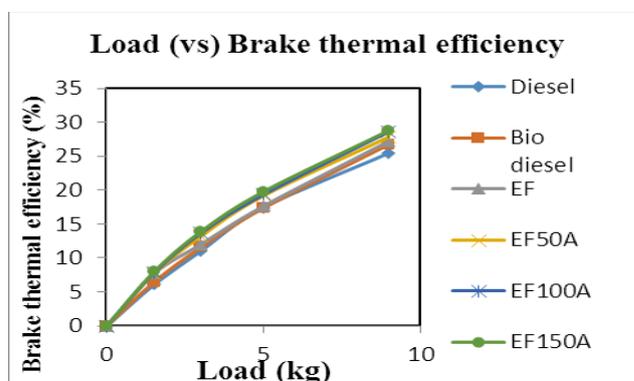


Figure 7. Variation of brake thermal efficiency respect to load

The deviation of brake thermal efficiency pertaining to load is shown in Figure 7. From Figure 7, it is understood that thermal efficiency is maximum for

EF150A. Samples which does not contain nano particles have less brake thermal efficiency. Diesel and biodiesel samples were found to have lower brake thermal efficiency. The presence of nano particles increases the rate of combustion due to phenomenon of micro explosion which is in accordance with literature [7]. Due to this phenomenon, with the growth in nano particles, thermal efficiency increases.

The deviation of mean effective pressure with accordance to load can be seen in Figure 8. It is perceived that there is no substantial variation in mean effective pressure for all samples. Addition of nano particles does not substantially influence brake mean effective pressure. The difference of indicated mean effective pressure pertaining to load can be seen in Figure 9. It is understood that diesel has the minimum indicated mean effective pressure and biodiesel has the maximum indicated mean effective pressure. This is due to the reason that diesel has minimum frictional loss due to less viscosity whereas biodiesel has maximum frictional loss due to high viscosity. It can also be witnessed that with the rise in the concentration of nano particles, indicated mean effective pressure increases. This is owed to reason that with the increase in the concentration of nano particles frictional loss drops due to rise in viscosity.

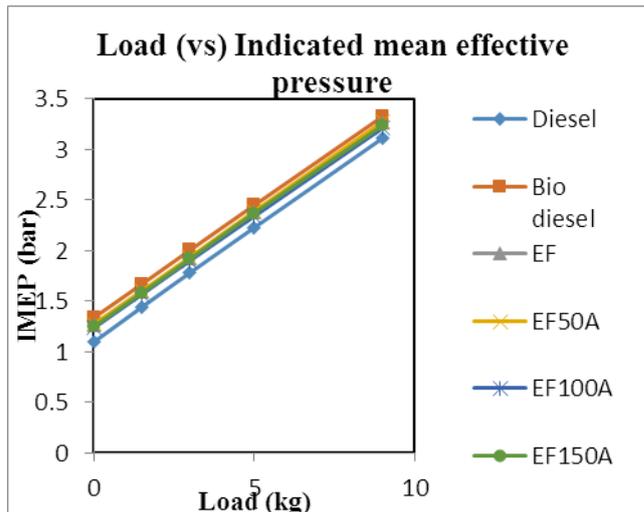


Figure 9. Variation of indicated mean effective pressure pertaining to load

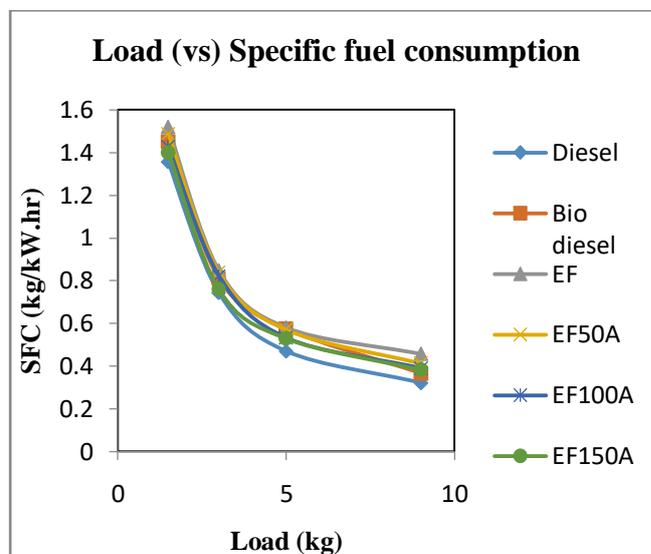


Figure 10. Variation of specific fuel consumption pertaining to load

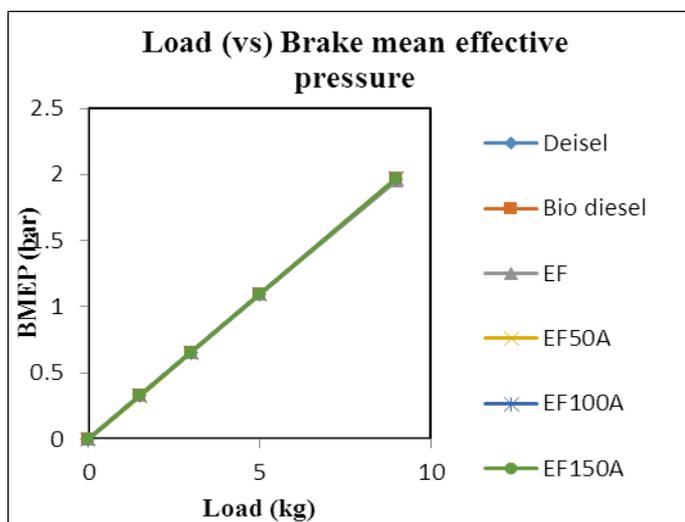


Figure 8. Variation of brake mean effective pressure respect to load

The deviation of specific fuel consumption in accordance to load is shown in Figure 10. It is perceived that diesel has the least unit fuel consumption because it has chief heating value of all samples. Emulsion fuel has greater unit fuel consumption because it has least heating value. It is also viewed that with the inclusion of nanoparticles, unit fuel consumption drops owing to the augmentation in heating value.

CONCLUSION

The effect of pongamia pinnata with nano particles on performance of a diesel engine has been experimentally inspected. The engine is tested with diesel, biodiesel, emulsion fuel and emulsion fuel with nanoparticles. From this, the subsequent conclusions can be made,

a) It was viewed that emulsion fuel (EF) has the least calorific value due to which it has the maximum fuel consumption. It was also inferred that with the upsurge in nanoparticle concentration, calorific value rises and so fuel consumption decreases.

b) Biodiesel due to higher viscosity has the least mechanical efficiency of all samples. It is perceived that with the upsurge in the percentage of nanoparticles, mechanical efficiency increases. Also emulsification reduces viscosity, which in turn improves mechanical efficiency.

c) The samples which does not contain nano particles have less brake thermal efficiency. Micro explosion phenomenon rises with the upsurge in concentration of nano particle which in turn enhances brake thermal efficiency. Also rise in concentration of nanoparticles reduces fuel consumption owing to the upsurge in heating value.

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