

Testing of Diesel Engine with Composite Nanomaterial as Fuel Additive

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ABSTRACT: Innovative techniques are underway to utilize various additives with the diesel and biodiesel fuels to improve the working attributes of internal combustion engines. Many researchers have proposed various methods on adopting different types of additives to enhance the working attributes of diesel engines to cope up with increasing price of mineral fuels, eventual depletion of fossil reserves and global warming. The purpose of current research work is to study performance of Palm and Castor biodiesel with perovskite type composite nanomaterial as an additive. The result shows significant increase in performance with use of composite nanomaterial as an additive with B80 Palm biodiesel as compare to biodiesel with and without nanomaterial.

KEYWORDS- Palm biodiesel, Castor biodiesel, perovskite composite nanomaterial, etc

I. INTRODUCTION

Diesel engine is one of the most efficient and reliable energy conversion devices available till date. During the beginning of 20th century, the plenty of low cost diesel have engrossed people to run diesel engines with diesel. However, after more than a century, the scenario has just been reversed. The frantic use of diesel has now led to a situation where the global fossil diesel storage may last merely for a few decades. As a result, the price of diesel has reached to a momentous height. This is coupled with the serious environmental pollution created by its burning. These facts have stimulated researchers around the globe to search for suitable, sustainable, renewable, and cheap alternative to diesel fuel.

Biodiesel is an oxygenated diesel engine fuel that can be obtained from vegetable oils or animal fats by conversion of the triglyceride esters via transesterification. It has similar properties to those of fossil diesel [1][2][12][16]. Biodiesel is an alternative diesel fuel derived from the transesterification of vegetable oils with simple alcohols to give the corresponding mono alkyl esters. It has been reported by the results of many studies that biodiesel can be used in diesel engines with little or no modifications, and with almost the same performance. Besides it reduces various diesel engine emissions. The results vary according to the base vegetable oil or animal fats, the process of biodiesel production as well as biodiesel fuel properties [3][4][5][6][17]. The study reveals that use of nanomaterials as an fuel additive enhances combustion property of CI engine in particular and performance in general [14][15][18]. The Palm and Castor biodiesel properties are shown in Table 1 and Table 2.

Table 1. Properties of Palm biodiesel

Viscosity at 40 °C	4.1 mm ² /s
Density at @15°C	0.875 g/cm ³
Specific gravity @15°C	0.875
Flash Point	175°C
Pour Point	-12°C
Cetane number	52
Calorific Value	36790 kJ/kg
Visual appearance	Dark Brown liquid

Table 2. Properties of Castor biodiesel

Viscosity at 40°C	15.98 mm ² /s
Density at room temp.	888 kg/ m ³
Calorific Value	37900.8 kJ/kg
Specific gravity at room temp.	0.888 kg/lit
Flash Point	190.7°C
Pour Point	-45°C
Cetane number	50
Visual appearance	Viscous pale yellow

In the present study the biodiesel derived from palm, castor oil and combination of palm and castor oil with additives of perovskite type composite nanomaterial (BNN) are used to find out the performance parameter of diesel engine [7][8][9][10][11].

II. EXPERIMENTAL SETUP

The experimental setup consist of a single cylinder, vertical, 4-stroke cycle, single acting, totally enclosed, water-cooled, high speed compression ignition engine. As shown if figure no. 1, engine was coupled to an Eddy Current Dyanamometer through universal coupling. The engine and the dynamometer were mounted on a common bed made from Iron C-Channel which was bolted to the cement foundation. One of the basic operations in testing of any engine is loading the engine by means of dynamometer. In case of eddy current dynamometer, the loading is electrical i.e., by means of excitation current to the dynamometer oil. Therefore basic but important factors involved in engine loading is complete reliability and stable operation of engine at different loads and speed points on torque/speed characteristics.

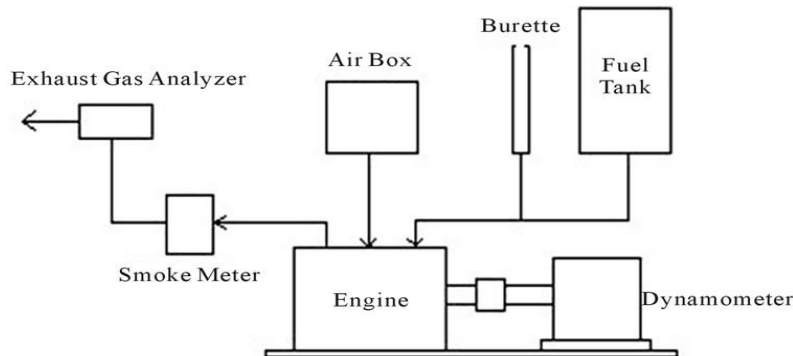


Fig. 1. Schematic Diagram of Experimental Setup

III. EXPERIMENTATION

Experimentation is carried out in two parts. i.e. synthesis of perovskite type composite nanomaterial and Experimentation on CI engine. Firstly, Composite nanomaterial of perovskite type is synthesized by conventional solid state method [7]. Then it is mixed with the blend as per 2 gram per liter. XRD and SEM of the BNN material was carried out. XRD shows sharp single peaks. This indicates the single phase nature of the sample with cubic structure [10]. Secondly, before experimentation, DOE (Design of experiment) was carried out by Taguchi method and accordingly the biodiesel and its blends were selected [13]. Bio-diesel (B100) and its blends B20, B40, B60, B80 & additive were used to test the engine at different engine loads (25%, 50%, 75%, 100% and 115% of the load corresponding to the load at maximum power at an average engine speed of 1500 rpm). At each load, the engine was stabilized for 10 minutes and then measurement parameters were recorded. The pressure of diesel injector was maintained 195 bar. The engine was loaded using the Eddy current dynamometer. The engine speed in rpm was sensed using a sensor pre-installed in the dynamometer and was recorded from the display on the control panel of the dynamometer. On every loading the performance parameters were measured.

IV. RESULT AND DISCUSSION

After obtaining the observations and results of different parameters using castor and palm oil biodiesel as fuel and perovskite composite nanomaterial(BNN) as an fuel additive, the various graphs were obtained to compare performance characteristics of the engine as shown in figure no. 2, figure no. 3 and figure no. 4.

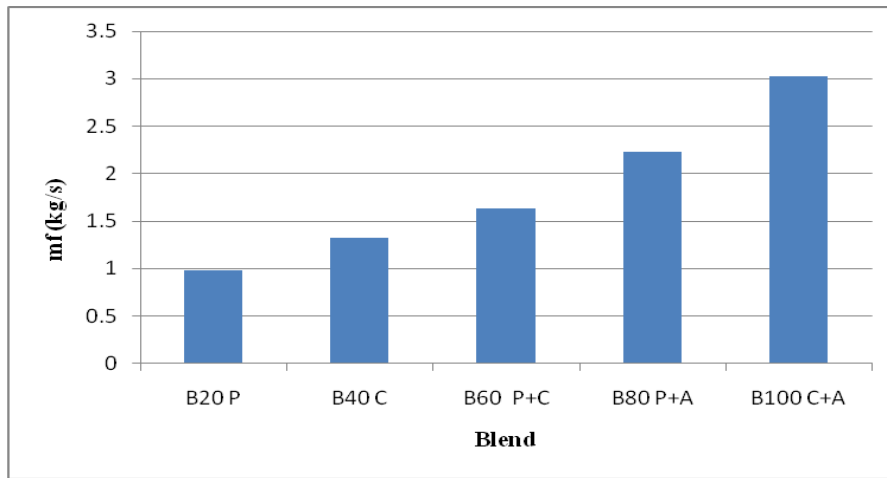


Fig. 2. Fuel consumption vs Biodiesel blend

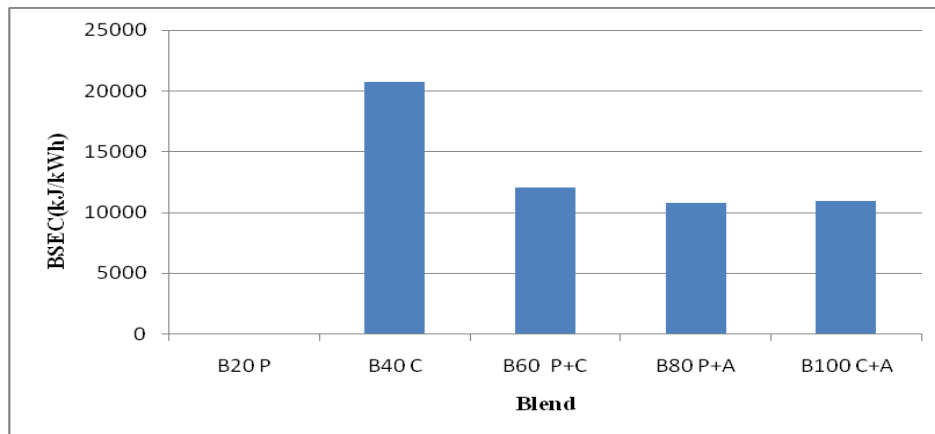


Fig. 3. BSEC vs Biodiesel blend

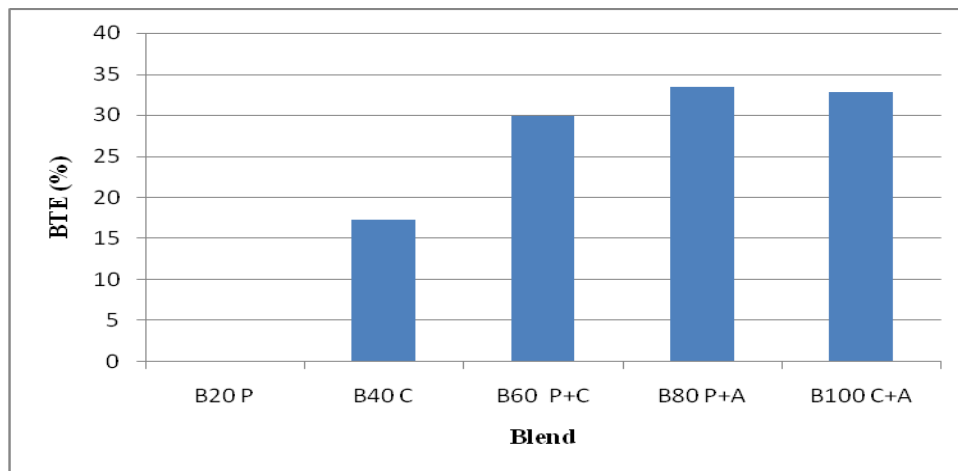


Fig. 4. BTE vs Biodiesel blend

FUEL CONSUMPTION:

Though from figure no. 2 it is predicted that the fuel consumption is increasing with increasing various biodiesel blends. This increase in fuel consumption is due to increase in load applied i.e. from 0 Nm to 24 Nm respectively according to DOE. But the fuel consumption of B80 (P+BNN) is less when compared with other biodiesel with and without additives at same input torque.

BRAKE SPECIFIC Energy CONSUMPTION:

BSEC is a measure of combustion efficiency. BSEC with respect to different blends of Biodiesel are shown in figure no. 3. The B20 (P) shows zero BSEC since it is at 0Nm Torque. The graph predicts that though Blend B80 (P+BNN) is used at higher torque, the BSEC is less for B80 (P+BNN) as compared to other blends with and without additive. This is because low density of Palm biodiesel.

BRAKE THERMAL EFFICIENCY:

The variations of brake thermal efficiency with different blends of biodiesel and additive are represented in figure no. 4. The graph predicts variation of BTE with respect to various blends of Palm with additive. It is found that as blend ratio increases, brake thermal efficiency increases up to B80 later on it decreases at B100. The more BTE encountered at blend B80. Viscosity of Palm is less as well as BNN material is more dense so proper mixing of fuel i.e. optimization takes place and complete combustion occurs.

V. CONCLUSION

The testing of diesel engine using various biodiesel with and without additives reveal that B80 blend of palm biodiesel with BNN as an additive shows an optimized trend of performance enhancement. The use of palm oil creates a need to increase palm oil sources. Being bio-degradable, non-toxic, eco-friendly, sulphur free & renewable alternative fuel, biodiesel helps in arresting global warming. One of the positive efforts towards the problem of energy deficit and energy demand is use of renewable energy source like Biodiesel with nanomaterial as a fuel additive. Which is effective because of enhancement of surface area to volume ratio. Also nanomaterial helps for complete combustion. Hence use of nanomaterial as an additive in diesel engine is a need of era.

ABBREVIATION

BNN – Barium Nickel Niobium oxide
B20(P) – Palm Biodiesel 20% + Diesel 80%
B40(C) – Castor Biodiesel 40% + Diesel 60%
B60(P+C) – Palm Biodiesel 60% + Castor Biodiesel 40%
B80(P+A) – Palm Biodiesel 80% + Diesel 20% + BNN nanomaterial additive
B100(C+A) – Castor Biodiesel 100% + BNN nanomaterial additive
BTE – Brake thermal efficiency (%)
BSEC – Brake Specific Energy Consumption (kJ/kWh)
 m_f – Fuel consumption (kg/s)

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