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FINDING THE PERFORMANCE AND EMISSION CHARACTERISTICS OF A NANOPARTICLES ADDED CASTOR OIL BIODIESEL BLENDS IN A CI ENGINE

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Abstract: Compression Ignition (CI) engine operates in lean air fuel mixture in most of the running conditions. In our work castor oil based biodiesel extracted from the plants of *Ricinuscommunis* testing in a four stroke constant speed running CI engine. The extracted non-edible oil was then transformed to into biodiesel for testing in the engine and the same was mixed with 100ppm of Cerium Oxide (CeO_2) nano particles. Then the prepared castor oil biodiesel (CBD) was diversified with the diesel in numerous ratio (5:95, 10:90 & 15:85).These three biodiesel blends were then tried in a constant speed CI engine to associate its enactment and discharge characteristics with that of diesel. The engine was tested in a different Brake power (1.15, 1.71, 2.29 & 2.75 kW) for all the three mixtures and the diesel fuel. The numerous emissions of the engine like Carbon monoxide (CO) and Hydro Carbon (HC) and Oxides of Nitrogen and smoke emissions released at this engine load for all the test fuels were measured and discussed here.

Keywords: Biodiesel, Additive, Castor oil, Performance characters, Nano particles.

1. Introduction

Fuel in the energy production industry is experiencing and new dead natural material which may be used as fuel or for business industry. It has become common among coal power facilities, which shift from coal to fuel in order to change to renewable energy production without wasting being generating plant and structure. Mass most frequently relates to plants or plant-based materials that are not utilized for food or food, and are specifically named lignocellulosic fuel. As an energy source, fuel can either be used immediately via burning to create energy, or indirectly after converting it to different kinds of biofuel. The alternative fuel, most broadly determined, is any fuel except the conventional selections, petrol and diesel, used to create energy or force. The emissions effect and energy production offered by alternative fuels changes, dependent on the fuel source. Examples of alternative fuels include biodiesel, alcohol, energy, propane, compressed natural fuel, and gas. Biodiesel is the clean burn, renewable alternative energy that will developed starting a large variety of plant oils and organic fats. Biodiesel holds no oil, then be able to be combined at any point with crude diesel to produce the biodiesel mix. It may be applied at compression-ignition (diesel) machines with slight or no changes. Automobiles are one of the major utilizer of crude oil based products for transportation purpose [1]. Also CI engines are considered as suitable for using an alternative fuel as it required less or no modification at all [2]. The extracted vegetable oil contains fatty acid of methyl or ethyl esters [3]. Around 95% of the biodiesel used were basically derived from edible oils like soyabeen, sunflower, rapeseed and palm[4]. As most of the vegetable oils are triglycerides and rich in oxygen they are used for the production of the biodiesel, In that palm oil shows the maximum yielding of about 2000 liter per acre [5]. The presence of high percentage of monounsaturated fatty acid and less polyunsaturated fatty acid is required in the plant oil for the making of biodiesel [6]. It is observed that the habit of CBD fallouts in the lessening of harmful exhaust emissions, the performance characteristics also very impressive matched to that of the diesel fuelled device [7] & [8]. The glycerol in the vegetable oil must be removed in order to practice it as a biodiesel and the procedure carried out is known as trans-esterification [9]. Because of the absence of aromatic compounds and the availability of the oil seeds in the environment, biofuels are getting attention as an alternate source of fuel [10].In this experimental research, castor grease was used as a biofuel as the annual potential is about 227 to 531 liters per acre [5]. Castor oil is the raw plant oil created by squeezing the germs of the Ricinus communis, a.k.a. The Castor oil complex. This Castor petroleum complex is indigenous to the sea, to eastern Africa, and to India. Castor oil is the very heavy and sticky oil. It has a tasteless, oily taste, and no specific smell. Typically, Castor oil is the thin yellow colour, though the form of Castor oil called Jamaican colored Castor oil, which is created by a other method than common Castor oil, is dark brown in color. Castor petroleum has served several purposes throughout past. It was applied both for cosmetics and as the lighting petroleum in old Egypt. The important purgative called Castor Oil is the limited petroleum received from the seeds of the Castor Oil complex. Besides being employed

medicinally, this petroleum is also used for lubricating purposes, burning and for leather sauce. The Chinese are told to take some manner of depriving it of its healthful properties so as to make it appropriate for cooking purposes. Castor oil was created by pushing the seeds of the Castor complex, Castor oil is the good component that has a variety of anti-inflammatory and pain-relieving properties. When applied in cloth toiletries, fabrics like Jamaican Black Castor Oil both remove impurities and modify the skin, resulting in more efficient and more eco-friendly result. The fatty acids existing in the castor oil should be removed with the help of transesterification process[11]. Castor oil biodiesel was blended with the diesel in various proportions namely 5% CBD and 95% diesel (CBD5), 10% CBD and 90% diesel (CBD10), 15% of CBD and 85% of diesel (CBD15) and 0%CBD and 100% diesel (CBD0) and it was tested in a one cylinder constant speed CI engine [12] to find its performance &characteristics. The HC, Smoke, CO and NO_X are the major emissions of diesel engines [13]. Also there is urgency in our country to followstrict emission norms;CBD can be a possible solution [14].

2. Preperation of Biodiesel

Transesterification is the process that will help to remove the unwanted fats from the biodiesel. Traditional knowledge to create biodiesel primarily contains of two distinct ways: Lipids abstraction trailed by trancesterification. The substitute to this traditional knowledge is that in situ transesterification (or through transesterification) now which the lipids abstraction and transesterification agreed out at one block was broadly examination. So, at situ transesterification, which is now met with material solution at the manner of substances to biodiesel, shows hope of both simplifying and reducing the price of making biodiesel from microalgae biomass. Biodiesel is usually created by the transesterification of the produce oil or animal fat feedstock, and additional non-edible natural materials , e.g., frying petroleum, etc. There exist various methods for carrying out the transesterification activity including the general batch procedure, heterogeneous catalysts, supercritical procedures, ultrasonic methods, and even microwave methods[15].

Table.1.Properties of Castor oil Biodiesel

S.No	Properties	Castor Oil	Diesel
1	Kinematic Viscosity	6.6 mm^2/s	3 mm^2/s
2	Flash point	105˚C	63.6˚C
3	Fire point	125˚C	91˚C
4	Pour point	-12 ˚C	-6 ˚C
5	Density	0.895 g/ml	0.831 g/ml

In this process, methanol is mixed with sodium hydroxide and the treated methanol is added with the castor oil and continuously stirred at 55˚Cfor an hour. Then the mixture is transported to a separation chimney to settle down the fatty acids in the form of glycerol at bottom [16]. This bottom glycerol is removed and the top biodiesel is washed with deionized water to remove the extra soap content or glycerol and the final product is taken for testing [18]. Then the Biodiesel is blended with 100ppm of CeO_2nanoparticles with the help of an ultrasonicator. The castor oil is tested to find its various properties and the results obtained were given in the table 1.Then the biodiesel was varied with diesel oil in the proportion 5% (CBD5%), 10% (CBD10%) & 15% (CBD15%).

3. Experimental Method

The engine or machine is a device designed to convert one kind of energy into a mechanical life. Energy engines consume the fuel to produce energy which is so used to do business. Internal combustion engines are heating engines that burn fuel in the combustion chamber to extract the chemical energy present in it. In this experiment, the engine used for the testing of the diesel and other castor oil blends is a constant speed engine that will run without any kind of variation in its speed nevertheless of the weight input. Image of the engine utilized for this experimental research was shown in figure.1.

Figure.1.Test Engine

Some basic description of the engine charity for the trying of CBD blends and sole diesel was set in table.2. run in CBD5, CBD10 & CBD15 for various load conditions (3.5, 5.5, 7.5 & 9.5kg).

Table.2 IC Engine set up specification

1	Operated by	Diesel Fuel

2	Cylinder and operation	Single cylinder, 4 stroke, constant speed (1500rpm)
3	Max Power generated	3.50kW @1500rpm
4	Dynamometer used	Eddy Current Dynamometer
5	Swept volume of the cylinder	661.45cc

The diesel engine was allowed to run only in CBD0 to check its performance and later it was allowed to Then the performance and characters and the amount of smoke emission released for the various operating conditions were recorded by using a Smoke meter. The 5 gas analyser was secondhand to extent the hurtful discharges like HC, CO & NO_X.

4. RESULTS AND DISCUSSIONS

4.1. BP Vs Brake Thermal Efficiency

Figure.2 represents the brake thermal efficiency at various engine load. From the fig.2, we can conclude that the BTE of the CBD mixtures were lesser than the diesel fuel. Also the BTE of the fuel was decreased with the increase in the blend of the castor biodiesel in the sole diesel fuel [19].

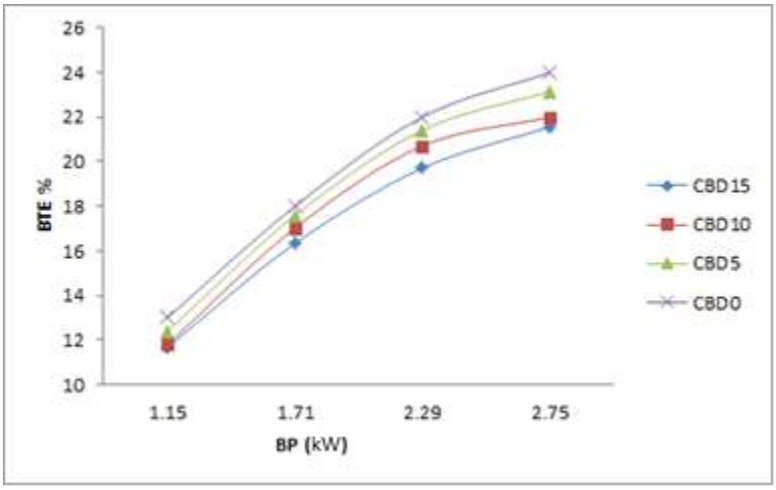

Figure.2. BP in kW vs BTE in %

The reason for this decrement is due to the reduction of the sum of energy produced during burning. As the amount of energy present in the fuel gets reduced with the rise in the blend proportion, the BTE reduced. At 1.17 BP of the engine load the BTE of CBD5, CBD10 and CBD 15 is found to be 2.65%, 5.29% and 10.44% less than that of the diesel fuel. This shows that the CBD mixed fuel has the lesser BTE equated to that of the diesel in all the engine load.

4.2. Brake power Vs SFC

The fuel efficiency of the automobile relates distance travelled by the vehicle and the quantity of fuel consumed. Demand may be expressed in terms of amount of fuel to go the space, or the distance travelled per unit amount of fuel consumed. Since fuel consumption of vehicles is a important factor in pollution, and since import of motor fuel may be a huge part of the country's international business, some countries impose requirements for fuel economy. Other methods are used to calculate the real performance of this vehicle. The viscosity of the CBD mixed fuel will be developed than that of the diesel fuel; the higher viscosity results in the increase of SFC and atomization of the fuel[20].

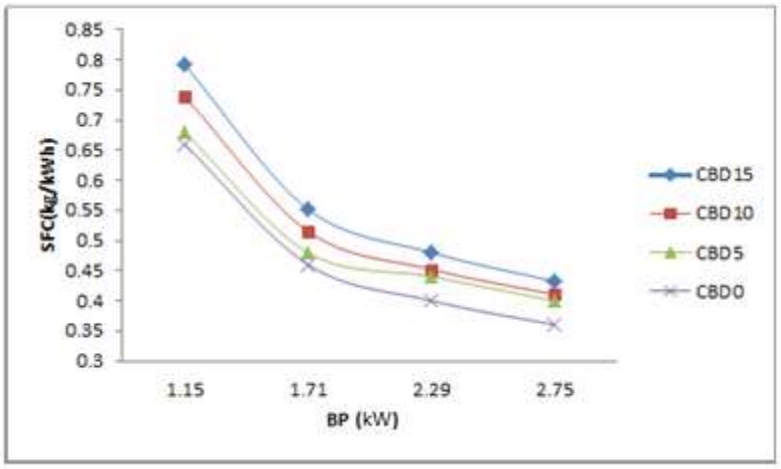

Figure.3. BP in KW vsSpecific fuel consumption in kg/kWh

So the CBD15 blend has the maximum SFC range which is shown in the figure.3. The SFC of CBD5, CBD10 and CBD15 at 1.67kW is 4.43%, 11% and 19% added than that of the CBD0 mixture.

4.3. Brake Power vs smoke emission

Figure.4 represents the amount of smoke gas released during exhaust stroke of the engine. The smoke emission for all the CBD test fuels and diesel were compared for different engine loads. The smoke

emission of the CBD fuels tends to reduce with the addition of biodiesel blend in diesel related to that of the sole diesel [22].

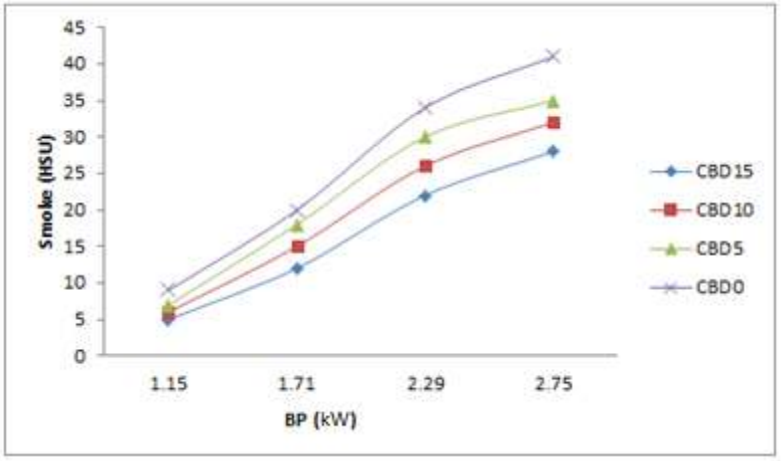

Figure.4. BP in kW vs smoke in ppm

The main aim for the creation of the smoke release is the release of the fuel molecules in the exhaust as a solid carbon particles. But due to the addition of the nanoparticles in the biodiesel, greatest of the fuel particles were scorched in the burning chamber that results in the less emission formation of smoke. For all the engine load operation, smoke emission recorded in the diesel was found to be maximum. This is due to the increment of oxygen in the CBD blended fuel which reduces the creation of smoke emission. The smoke emissions released from the Diesel at 2.29kW is 11.27%, 23.45% and 35.39% higher than the CBD5, CBD10 and CBD15 respectively.

4.4. Brake Power vs CO emission

Figure.5 shows that the CO emission for the CBD0 is higher than CBD blends. The CO formation was reduced with the addition of the CBD blends in the diesel. This results in the complete conversion of the CO to CO_2 which is a product of complete combustion [23].

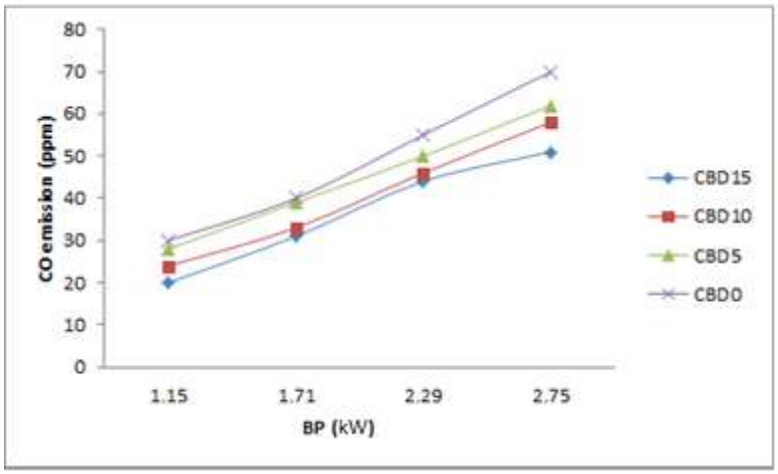

Figure.5 BP in kW vs CO emission in ppm

The CO formation in the exhaust is owing to the reduction of the oxygen contented in the combustion chamber. But the nanoparticles increases the oxygen contented in the ignition compartment which outcomes in the reduction of the development of CO emission. The recorded CO release value of the CBD0 fuel at 2.29kW is 9.19%, 15.96% and 19% more than that of the CBD5, CBD10 and CBD15 correspondingly.

4.5. Brake Power vs NO_X emission

From the figure.6, it is clear that the formation of NO_X emission is more in CBD15 compared to CBD0. The CBD combustion process will produce more temperature results in more NO_X emissions with increase in CBD blends [24].

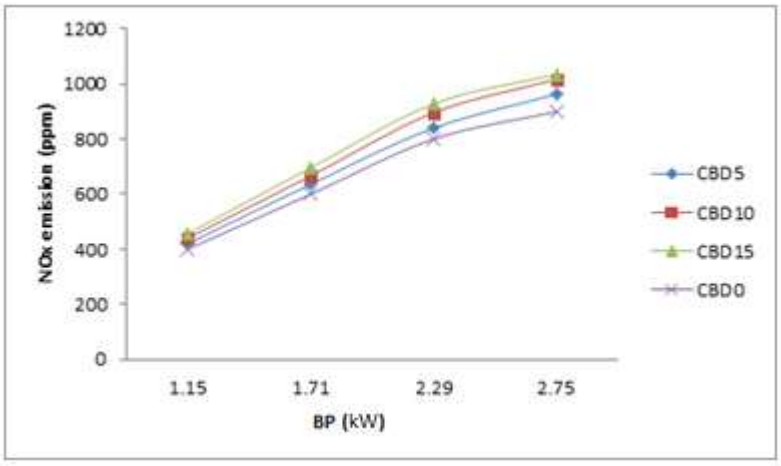

Figure.6 BP in kW vs NO_X emission in ppm

The formation of the NO_X emission is due to the higher temperature, Because of the addition of the nanoparticles the working temperature will increase that results in the higher NO_X formation in the exhaust. The NO_X discharges of the CBD0 at 2.29kW are 5%, 12% and 16% less than that of the CBD5, CBD10 and CBD15 correspondingly.

4.6. Brake Power vs HC emission

The Figure.7 indicates that the HC emission released during the combustion of CBD blends and diesel fuel. The CBD blends have the lesser release of HC emission compared to that of the normal diesel fuel in all the operating loads of the engine.

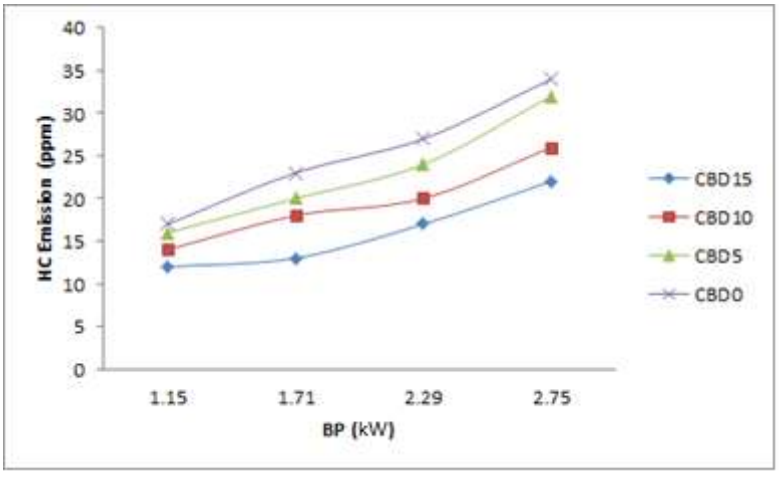

Figure.7 BP in kWvs HC emission in ppm

This is due to the less availability of unburned hydrocarbon fuel in the exhaust system [25]. Also the less cetane number of the fuel in diesel is the chief cause for the maximum HC emission in the exhaust related to that of the CBD fuel. The HC emissions recorded for the CBD0 at 2.29kW engine load is 10.11%, 24.82% and 36.13% more than that of the blended CBD5, CBD10 and CBD15 respectively.

5. CONCLUSION

The castor oil was effectively extracted and it was changed to biodiesel and tested in a CI engine. In command to increase the oxygen content in the fuel the nanoparticles was added in it. Then the CBD was blended with the diesel in various ratio. The blended fuel was successfully tried in a diesel engine in order to find its performance characteristics and emission analysis. Then the results were related with that of the diesel fuel. From the outcomes obtained, it can be concluded that the due to the addition of the Cerium Oxide nanoparticles in the CBD blend the formation of HC, CO and smoke emissions were concentrated. But on the contrary the NO_X emission enlarged due to the result of perfect combustion. At 2.29kW engine brake power, the maximum HC, CO and NO_X emissions released in diesel is -10.11%, -9.19% and 5% than that of the CBD5 biodiesel. In order to reduce all the three emissions the special technique such as Exhaust gas recirculation or Selective catalytic reduction should be adopted in the system.

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