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Experimental Investigation of Performance and Emission Tests Using Biodiesel from Custard Apple Seeds Oil in Ci Engine

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Abstract

The depletion of world petroleum reserves and increase environmental concern have stimulated the search of alternative fuel which is to be environment friendly. Bio-fuels have the potential to become alternative fuel for fossil fuels. Biodiesel is renewable, reliable, biodegradable and regarded as clean alternative fuel to reduce exhaust emission. In recent years, much research has been carried to find suitable alternative fuel to petroleum products. In the present investigation experimental work has been carried out to analyze the performance and emission characteristics of a single cylinder compression ignition CI engine fueled with the blends of mineral diesel and biodiesel. The custard apple seeds oil biodiesel is considered as alternative fuels to diesel. A large amount of tree borne oil and fats are available for biodiesel production in developing and under develop countries. Custard apple seeds oil is one of these oils. The utilization of liquid fuels such as biodiesel production from custard apple seeds oil by transesterification process represents one of the most promising options for the use of conventional fossil fuels. However, as the biodiesel is produced from vegetable oils and animal fats, there are concern that biodiesel feed stock may compete with food supply in the long-term. Hence, the recent focus on using custard apple seeds as the substantial feed stocks for biodiesel production.

Keyword: Diesel, Biodiesel, Custard apple seeds oil biodiesel (CASOME), Transesterification, Performance, Emission Characteristics.

1. Introduction

India’s biofuel production accounted for only 1 percent of global production in 2012. Bio-ethanol and bio-diesel are the two biofuels that are commercially produced. Currently, first generation feedstocks such as sugarcane, maize, sugar beet and cassava are commonly exploited forbio-ethanol along with palm oil, jatropha oil and other edible oils from various oilseed crops for the production of bio-diesel. But since the production of these fuels compete with food crops, questions regarding food security and sustainability issues arise. Thus, there is tremendous potential for second generation biofuels in India, especially for cellulosic and agricultural crop residues.

India is a diesel-deficit nation and demand has far out striped supply. India's diesel production will not be able to keep pace with the rapidly growing demand. Government's pricing policy now allows oil companies to decide prices. Diesel is not much cheaper than petrol any more. Diesel demand in the country is growing at an annual rate of 8%. At this rate India will need a brand new 9 Million Tons per year refinery every year. The automobiles industry has estimated that the share of diesel vehicles, in overall vehicle sales has crossed the 40% mark. The price of fuels is now going to be in line with price of crude oil. Hence the Petrol and Diesel prices are no win line with international price levels, which makes biofuel economically attractive.

India's biodiesel processing capacity is estimated at 6,00,000 tons per year. The government owned Oil Marketing companies have now floated a tender again to buy 840 million liters of Biodiesel. However there are few interested suppliers. They prefer to export, rather than selling in India.

1.1 Custard apple

Custard apple is a common name for a fruit, and the tree which bears it, Annona reticulata. It is sometimes erroneously termed sugar apple, sweetsop and, by Spanish-speaking people, anon or rinon, in India, ramphal.The custard apple is believed to be a native of the West Indies but it was carried in early times through Central America to southern Mexico. It has long been cultivated and naturalized as far south as Peru and Brazil. It is commonly grown in the Bahamas and occasionally in Bermuda and southern Florida. Apparently it was introduced into tropical Africa early in the 17th century and it is grown in South Africa as a dooryard fruit tree. In India the tree is cultivated, especially around Maharashtra, Gujarath, Madhya Pradesh, Tamil Nadu, Bihar, Odisha, Assam, Karnataka, Andra Pradesh, Telangan, Rajastan, Uttar Pradesh and runs wild in many areas. Figure 1 shows the custard apple fruit seeds. The seeds is dark brown to black in color being shiny and smoot and contains 20-30 seeds in each fruit.

Figure 1: Custard apple fruit seeds.

2. Material And Methodology

The Product VCR Engine test setup 1 cylinder, 4stroke, Diesel (Comp.) The engine used in Make Kirloskar, Type 1cyl., 4strokeDiesel, water cooled, power 3.5kW at 1500rpm, stroke 110mm, bore 87.5mm. 661cc, CR17.5, Modified to VCR engine CR 12 to 18.with Electric start arrangement, battery and charge Cr . The Dynamometer is Type eddy current, water cooled, Load sensor is Load cell, type strain gauge, range 0-50 Kg and Compression ratio is 18 :1.

Seeds of custard apple are collected from fruits sheller and farmer. Oil from seeds is extracted by using Screw Oil Press Machine. Crude custard apple oil undergoes oil filter machine remove the impurities present in the oil. The oil is ready for furother processing. Now take 1 litter of sample oil. That oil is to be heated up to 55 to 60°c temperature but not exceed 70°c. Now take 200 ml of methanol or ethanol in to that add 4.5 grams of KOH, Shake that mixture well up to KOH dissolved fully. It will become potassium methoxide solution. Now add that solution to 1 litre sample oil with constant stirring of raw oil. Stir up to 10 to 15 minute. Leave that solution to settle down up 8 to 10 hours. It will form two distinct layers. Upper layer is called Bio-diesel and lower dark and thick layer called glycerine which is used to make soap. The transesterification process to obtain the custard apple seed oil methylester (CASOME). The biodiesel obtained is used to prepare the various blends such as B10 - (10% Bio Diesel+ 90% Diesel), B20 – (20% Bio Diesel+ 80% Diesel), B30 – (30% Bio Diesel+ 70% Diesel), and B40 – (40% Bio Diesel+ 60% Diesel). The properties of the diesel, CASOME and prepared blends are determined with the help of standard procedures. Table 1 shows the properties of the test fuels.

Table-1: Properties of Custard Apple Seeds Oil biodiesel blends compare with diesel.

Properties of biodiesel blends					
Properties	**Diesel**	**CASOME B10**	**CASOME B20**	**CASOME B30**	**CASOME B40**
Flash point (^{0}C)	55	65	68	70	73
Fire point (^{0}C)	62	72	74	76	80
Density (Kg/m^3)	860	865	870	875	880
Viscosity (80^{o}c)					
Kinematic (cst)	2.54	2.85	3.24	3.70	4.40
CV (KJ/Kg)	42500	41200	40276	39800	38600

3. RESULTS AND DISCUSSIONS

The main objective of the work is to investigate the performance and emission characteristics of diesel engine using custard apple seed oil methyl ester (CASOME), its blends and diesel. After studying the Properties of bio diesel blends then compared to the diesel, B10 and B20 are very near to diesel fuel. This reason we have to take only the results of B10 and B20 only obtained from the test are compared with the diesel fuel.

3.1 Performance analysis

The engine performance parameters such as brake thermal efficiency, brake specific fuel consumption, and exhaust gas temperature are calculated, and represented graphically.

3.1.1 LOAD V/S BTE

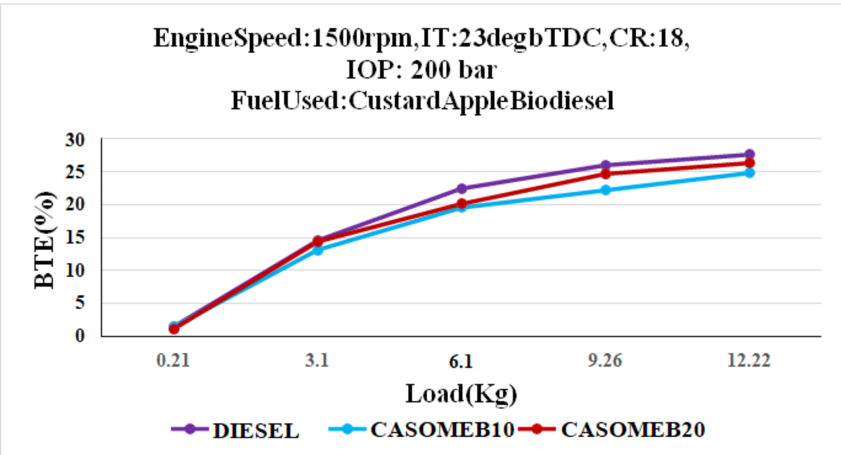

Fig 2. Load v/s BTE

Fig. 2 show an increase of brake thermal efficiency with an increase in the engine load as the amount of diesel in the blend increases. Even a small quantity of diesel in the blend improves the performance of the engine. The brake thermal efficiency of the CASOME B20 blend was better than other blends, which is very close to diesel. This is due to reduction in viscosity which leads to improved atomization, vaporization and combustion. Due to a faster burning of biodiesel in the blend, the thermal efficiency improved. The value is 27.52% as against 28.76% for diesel at 100% load.

3.1.2 LOAD V/S SFC

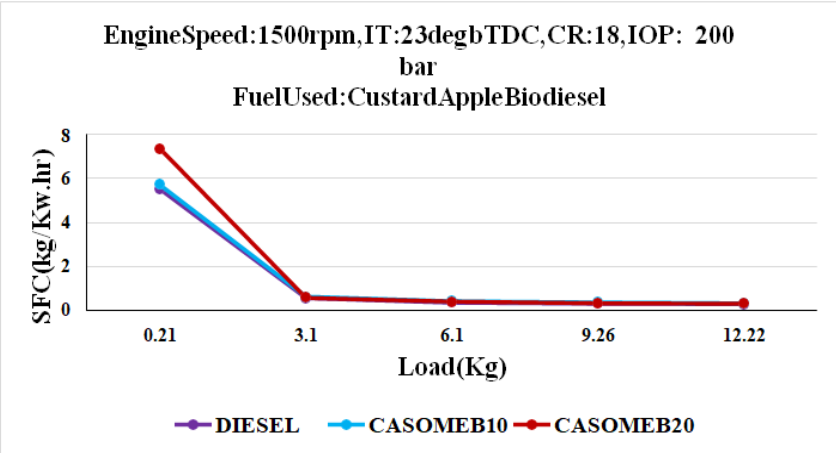

Fig 3. LOAD V/S SFC

Figure 3 shows the BSFC variation of the biodiesel and its blends with respect to brake power of the engine. The BSFC of the engine with neat CASOME B20 is higher when compared to B10 and diesel at all loads. The lowest BSFC's are 0.31, 0.33, and 0.32 kg/kW h for Diesel, B10 and B20 respectively.

3.1.3 LOAD V/S VOL.EFF

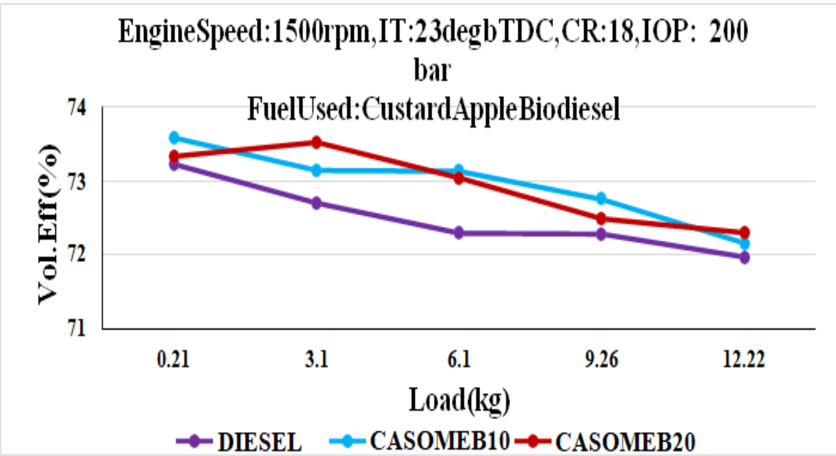

Fig 4. LOAD V/S VOL.EFF

The variation of volumetric efficiency with brake power is shown in **fig 4**. from graph diesel and CASOME B20 has higher volumetric efficiency compare to blends the graph for different blends are in zigzag in nature because of breathing ability of engine for the particular combinations.i.e. ratio of the actually induced at ambient conditions to the swept volume of the engine.

3.1.4 LOAD V/S EGT

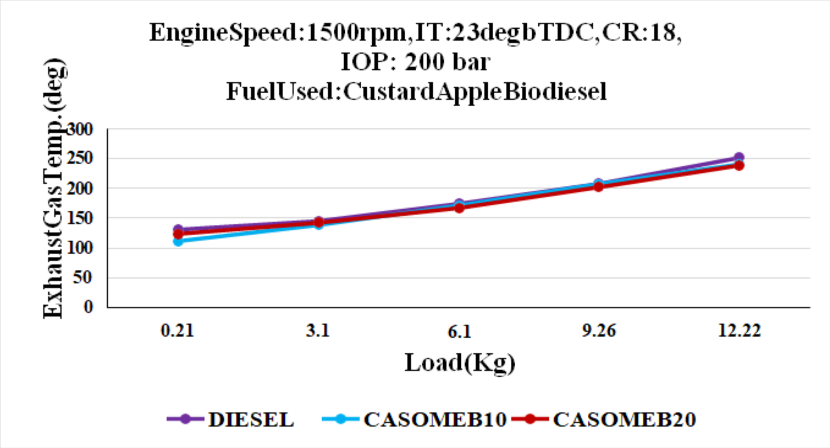

Fig 5. LOAD V/S EGT

The variation of gas temperature with brake power for different blends shown in **fig 5.** It is evident from the graph that exhaust gas temperature is increased along with the increase in load for all fuels. The increase in exhaust gas temperature with load is obvious from the fact that more fuel is required to take additional load. The exhaust gas temperature was found to increase with increasing concentration of biodiesel in the blends. This could be due to lower heat transfer rate incase of biodiesel which in evident from trends of thermal efficiency.

3.2Emission analysis

The emission analysis includes the study of carbon monoxide, unburnt hydrocarbons and nitrogen oxides. As these parameters play an important role in the environment pollution. The results of the emission parameters with the brake power are plotted and results are analyzed and compared to the results of diesel.

3.2.1 LOAD V/S HC

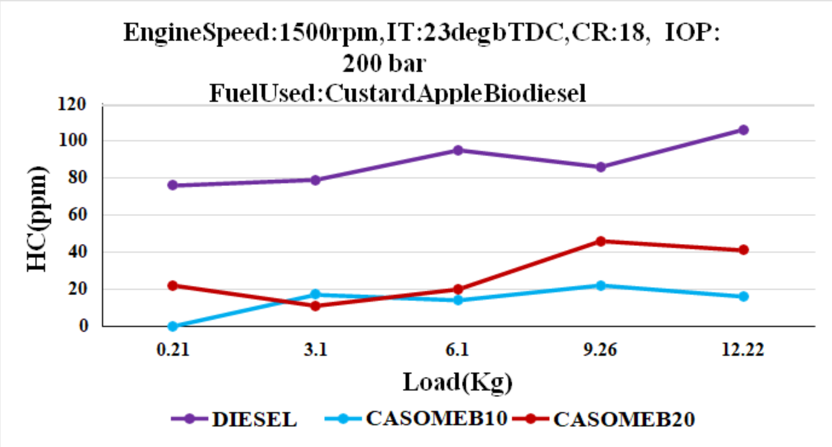

Fig 6. LOAD V/S HC

Unburned HC emissions: the UHC exhaust emissions are shown in **Fig.6**. For the methyl ester and its blends, the UHC emissions were less than for the diesel fuel because of the better combustion of the bio-diesel inside the combustion chamber due to the availability of excess content of oxygen in the CASOME blends as compared to pure diesel fuel. The highest UHC reduction was found for CASOME.

3.2.2 LOAD V/S CO

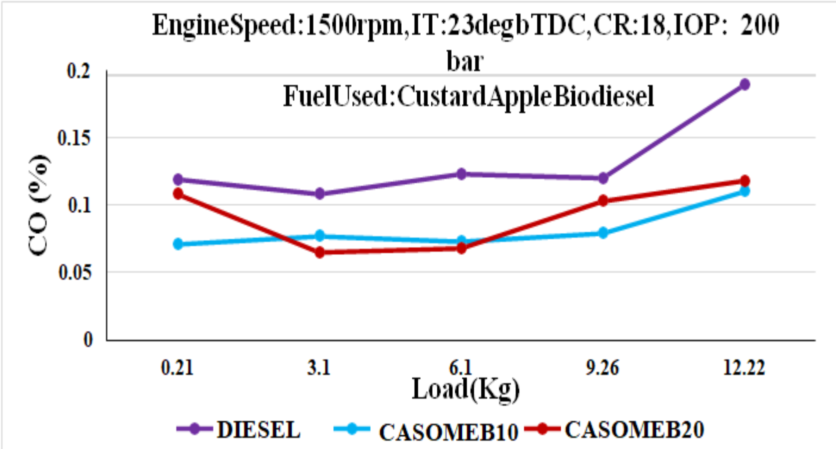

Fig 7. LOAD V/S CO

Carbon monoxide the CO emissions occur due to the incomplete combustion of fuel. The comparative analysis is shown in **Fig.7**. All blends of CASOME are found to emit significantly lower CO concentration compared with that of diesel fuel over the entire load. When the percentage of blend of biodiesel increases, CO emission decreases. The excess amount of oxygen content of biodiesel results in complete combustion of the fuel and supplies the necessary oxygen to convert CO to CO2.

3.2.3 LOAD V/S NOx

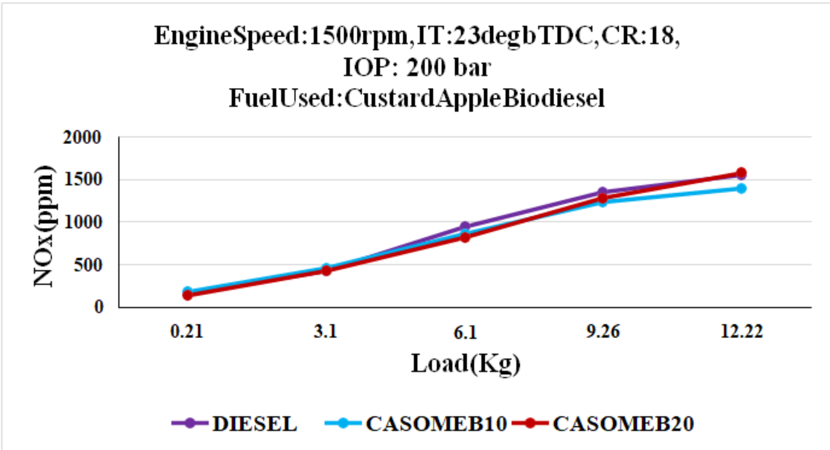

Fig 8. LOAD V/S NOx

NOx emissions: Three conditions which favor NOx formation are: higher combustion temperature, more oxygen content and faster reaction rate. The above conditions are attained in biodiesel combustion very rapidly as compared to diesel fuel. Hence, NOx formations for biodiesel blends are always greater than diesel fuel. The increase in the NOx emissions may be associated with the oxygen content of the methyl ester, since the fuel oxygen may provide additional oxygen for NOx formation and also the difference in the compressibility of the tested fuels can cause early injection timing and produce higher NOx emissions.

3.2.4 LOAD V/S CO_2

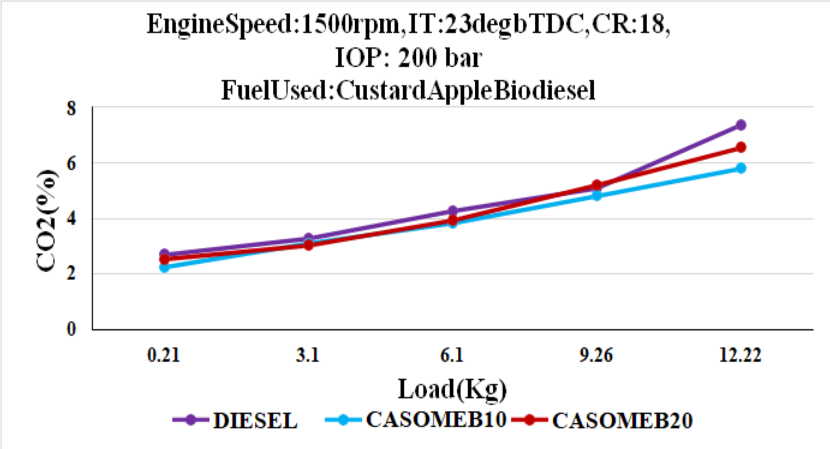

Fig 9. LOAD V/S CO_2

It is observed from the **Fig.9.** that CO2 emission initially decrease, reach the lowest and subsequently increase with the increase for all the fuels tested. CO2 emission is higher for biodiesel compared to Diesel at all loads. It is found that CO2 emissions are more for diesel than that of CASOME biodiesel. Higher CO2 emissions reduce harmful CO emissions. The percentage reduction in HC emissions for CASOME biodiesel is about 60% as compared to that of Diesel.

3.2.5 LOAD V/S O_2

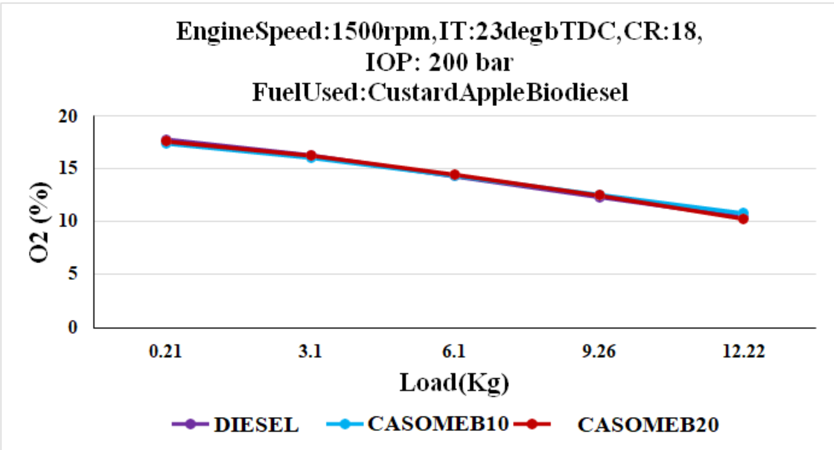

Fig 10. LOAD V/S O_2

Oxygen (O2) in exhaust. The oxygen in the exhaust of biodiesel blends is higher compared to the exhaust of neat diesel. Higher the percentage of biodiesel blend higher is the presence of oxygen in exhaust. In **Fig. 10.** it is observed that the oxygen in exhaust decreases with increase in loads. CASOME B20 shows highest oxygen in exhaust compare to CASOME B10.

4.CONCLUSION

In the present work, the experiments are conducted with custard apple seed oil methyl ester and blends for performance and emission characteristics of diesel engine. The obtained results of CASOME and its blends are compared with diesel.

- The values of the physical properties obtained for biodiesel and blends are close to diesel.
- By observing all results of biodiesel from custard apple seed oil, custard apple seeds can be used as

biodiesel. All the properties are in the range of ASTM biodiesel standards, this can be promising factor to use custard apple seeds as one of the biodiesel source.

- The prepared fuel samples are tested in diesel engine with some modifications.
- An increase of brake thermal efficiency with an increase in the engine load as the amount of diesel in the blend increases. Even a small quantity of diesel in the blend improves the performance of the engine. The value is 27.52% as against 28.76% for diesel at 100% load.
- BSFC variation of the biodiesel and its blends with respect to brake power of the engine. The BSFC of the engine with neat CASOME B20 is higher when compared to B10 and diesel at all loads. The lowest BSFC's are 0.31, 0.33, and 0.32 kg/kW h for Diesel, B10 and B20 respectively.
- Unburned HC emissions: For the methyl ester and its blends, the UHC emissions were less than for the diesel fuel because of the better combustion of the bio-diesel inside the combustion chamber due to the availability of excess content of oxygen in the CASOME blends as compared to pure diesel fuel. The highest UHC reduction was found for CASOME.
- All blends of CASOME are found to emit significantly lower CO concentration compared with that of diesel fuel over the entire load. When the percentage of blend of biodiesel increases, CO emission decreases.
- The test results of biodiesel are closer to the diesel.

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