

Performance and Emission Characteristics of CI Engine Fuelled with Coconut Testa Biodiesel

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ABSTRACT: Biodiesel is the fuel derived from biological derivatives. Biodiesel is prepared from various feed stock like coconut oil, sunflower oil, jatropha oil etc. Biodiesel can be of saturated type or unsaturated type. Saturated type biodiesel is always preferred over unsaturated type as its degradation level is less and can be transported easily. Biodiesel produced from non-edible feed stocks are preferred over those produced from edible sources as the use of former may lead to food crisis. Thus the best feed stock for biodiesel production is saturated and non-edible. Coconut testa is the outer brown covering of the coconut. The feed stock is non edible, saturated and a waste material. The work studies the performance and emission characteristics of a CI engine fuelled with biodiesel produced from coconut testa.

KEYWORDS: Biodiesel, Coconut Testa, Transesterification, Brake thermal efficiency (BTE), Brake specific fuel consumption (BSFC), Brake mean effective pressure (BMEP), Emission, Exhaust gas temperature (EGT)

I. INTRODUCTION

The fuels currently used in internal combustion engines are nonrenewable. The resources of the fossil fuels will get exhausted. The fossil fuels during combustion produce harmful emissions which is toxic to environment. It is the need of hour to find out alternate energy sources which has advantages over the conventional fossil fuels. Many experiments were conducted on internal combustion engines using fuel derived from nature friendly resources.

Coconut testa is a waste product in coconut processing industries. The industries producing products like coconut milk, virgin oil etc. use only the kernel by peeling out of testa. Due to the wide availability, non-edible nature and high degree of saturation of the oil, biodiesel produced from testa has enormous potential in meeting the future fuel demands.

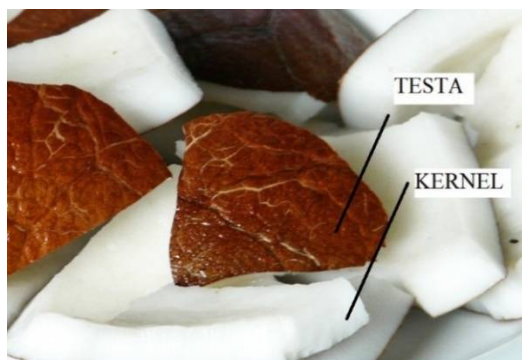


Figure 1: Coconut testa and kernel



Figure 2: Coconut testa

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

Biodiesel was prepared from coconut testa oil using transesterification reaction. It is the reaction between triglycerides in the oil and methanol to form methyl ester and glycerol in the presence of KOH as a catalyst. The properties of the biodiesel were tested and were compared with ASTM standards for biodiesel. The properties conformed to ASTM standards. This work aims at the evaluation of the engine performance and emission characteristics of a compression ignition engine when fuelled with coconut testa biodiesel. The values were compared with the values obtained when diesel was used as a fuel in the engine. The emissions from the engine were studied and were compared with the emissions when diesel was used as the fuel.

Table 1: Properties of testa biodiesel

Sl. No	Property	ASTM standard	Evaluated value
1	Viscosity	1.9 – 6 cP	4.05 cP
2	Density	575 – 900 kg/m ³	832.3 kg/m ³
3	Flash Point	100 °C, min	124 °C
4	Fire Point	-	132 °C
5	Acid Value	0.5 mg KOH/g, max	0.336 mg KOH/g
6	Iodine Value	-	23.57 mgI/g
7	Saponification Value	120 mg KOH/g, max	117.81 mg KOH/g

II. LITERATURE SURVEY

Prakruthi Appayya et al [1] studied the composition of coconut testa. The samples had fat as the major component ranging from 34 to 64%. Oils had 90 to 98.2% triglycerols, 1 to 8% diglycerols and 0.4 to 2 % triglycerols. Oils from testa were richer in monosaturates and polysaturates than other coconut oil samples. These studies indicated that the oil from testa contained more natural anti-oxidants such as tocopherols, tocotrienols and phenolics compared to coconut kernel oil.

Liaquat et al [2] studied the effect of coconut biodiesel blended fuels on engine performance and emission characteristics. As results of investigations, there has been a decrease in torque and brake power, while increase in specific fuel consumption has been observed for biodiesel blended fuels over the entire speed range compared to net diesel fuel. In case of engine exhaust gas emissions, lower HC, CO and, higher CO₂ and NO_x emissions have been found for biodiesel blended fuels compared to diesel fuel.

Mohankumar Chinnamma et al [3] studied Production of coconut methyl ester (CME) and glycerol from coconut oil and the functional feasibility of CME as biofuel in diesel engine. The test run showed the technical specifications torque (Nm) and power (bhp) similar to the efficiency of diesel fuel. The experiment showed a significant increase in the mileage.

Oguntola J Alamu et al [4] studied the production and testing of coconut oil biodiesel fuel and its blend Test quantities of coconut oil biodiesel were produced through transesterification reaction. The coconut oil biodiesel produced was subsequently blended with petroleum diesel and characterized as alternative diesel fuel through some ASTM standard fuel tests.

Godwin Kafui Ayetor et al [5] studied the Effect of biodiesel production parameters on viscosity and yield of methyl esters. The highest yield was obtained with 1% NaOH concentration for all. The effect of methanol in the range of 4:1–8:1 (molar ratio) was investigated, keeping other process parameters fixed. Optimum ratios of palm kernel oil and coconut oil biodiesels yielded 98% each at methanol: oil molar ratio of 8:1.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

Bhuiya et al [6] studied the potential of non-edible oils as an alternative to- edible oil-derived biodiesel. To establish and continue to optimise the procedures for the use of second generation biodiesel, various aspects such as cost effectiveness, necessity of second generation biodiesel, biodiesel conversion technology, improving efficiency of the production process as well as performance and emission characteristics must be scrutinized and studied. The transesterification method is the most suitable method among the several possible methods for biodiesel production.

Istvan Barabas and Ioan-Adrian Todoruț [7] studied on Biodiesel Quality, Standards and Properties. The paper presented the main standards on commercial biodiesel quality adopted in different regions of the world and the importance and significance of the main properties that are regulated (cetane number, density, viscosity, low-temperature performances, flash point, water content, etc.) and unregulated (elemental composition, fatty acid methyl and ethyl esters composition, heating value, lubricity etc.) .

Chuepeng [8] studied the use of biodiesel in diesel engines. The use of biodiesel blends in diesel engines has affected engine performance as well as combustion characteristics, i.e. ignition delay, injection timing, peak pressure, heat release rate, and so on. The combustion of biodiesel in diesel engines improved and regulated emissions except nitrogen oxides emissions were reduced.

Michael C Madden et al [9] studied the toxicology of biodiesel combustion products. The paper examined human responses to combustion products through an extensive literature exists on nonhuman animal effects.

Bianchi et al [10] studied the use of non-edible oils as raw materials for sustainable biodiesel production. The study gave special consideration to the role played by the development of a sustainable and responsible biofuels production, with no impact on food chain. It was concluded that the use of the oilseed deriving from alternative crops or waste oils as a feedstock for biodiesel production represents a very convenient way in order to lower the production costs of this biofuel.

III. ENGINE SPECIFICATIONS

The load test was conducted on single cylinder, four stroke Kirlosker diesel engine. Engine specifications are

Manufacturer	:	Kirloskar
Number of cylinders	:	1
Number of strokes	:	4
Rated Power	:	5 HP
Rated Speed	:	1500 rpm
Bore x Stroke	:	80 x 110 mm
Cooling type	:	Water Cooled
Loading type	:	Rope brake drum loading
Brake drum diameter	:	330 mm



Figure 3: Kirlosker diesel engine

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Special Issue 9, May 2016

IV. RESULTS AND DISCUSSIONS

ENGINE PERFORMANCE

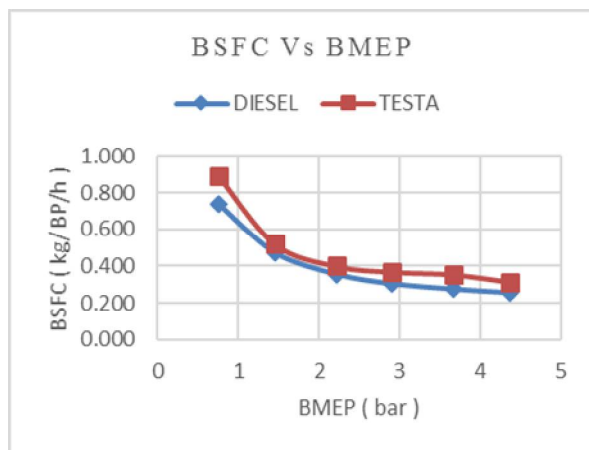


Figure 4: Brake specific fuel consumption Vs BMEP

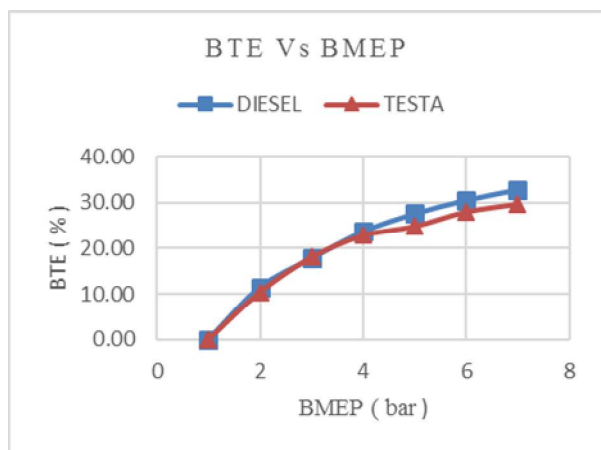


Figure 5: Brake thermal efficiency Vs BMEP

The specific fuel consumption of the CI engine was more when testa biodiesel was used as the fuel as compared to diesel. The brake thermal efficiency of the engine was less when testa biodiesel was used as the fuel. The maximum efficiency of the engine using testa biodiesel was obtained as 29.75%. The maximum efficiency obtained with diesel as the fuel was 32.83%.

EMISSIONS

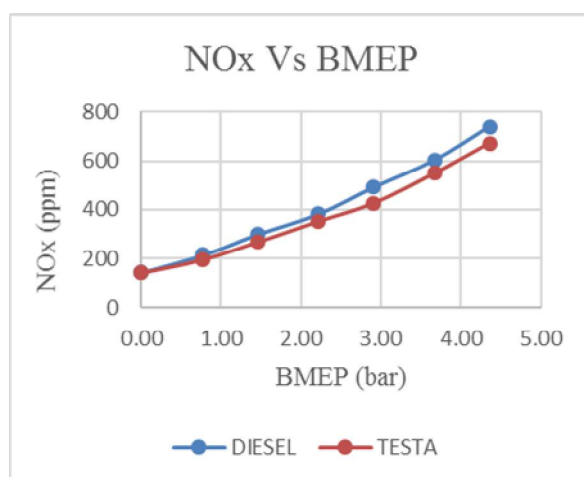


Figure 6: NOx emission Vs BMEP

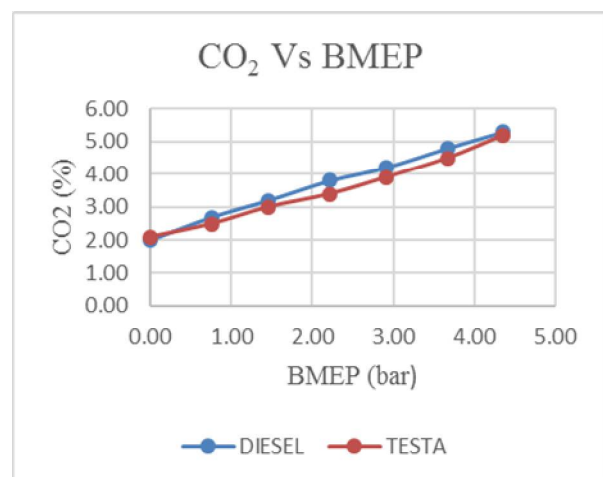


Figure 7: CO₂ emission Vs BMEP

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Vol. 5, Special Issue 9, May 2016

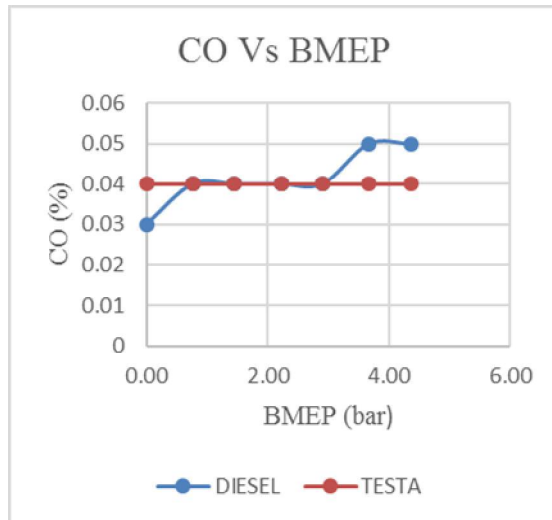


Figure 8: CO emission Vs BMEP

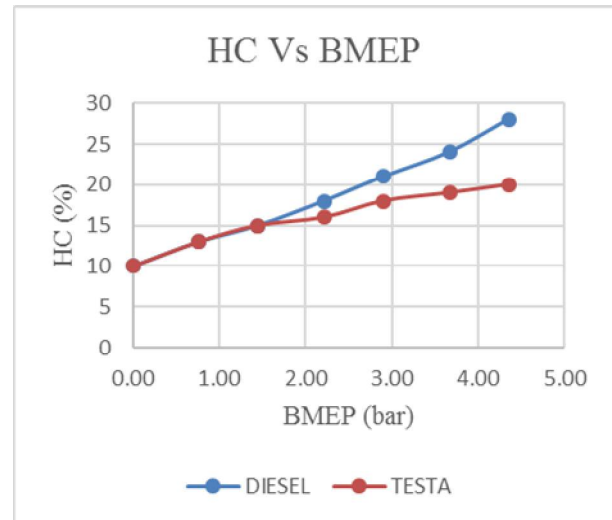


Figure 9: HC emission Vs BMEP

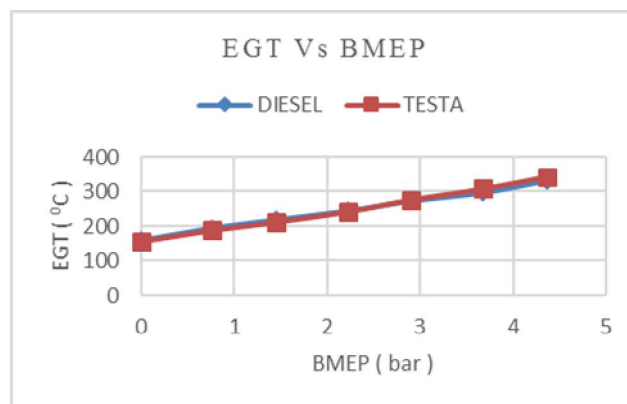


Figure 10: Exhaust gas temperature Vs BMEP

NO_x emission of the CI engine when fuelled with testa biodiesel was slightly less than the NO_x emission when diesel was used as the fuel. The maximum emission obtained using testa biodiesel was 673 ppm, while that obtained with diesel was 741 ppm. CO₂ emissions remained almost the same for testa biodiesel and diesel. Maximum emission was 5.2% for testa biodiesel and 5.3 % for diesel. Carbon monoxide emission was in between 0.03% and 0.05 % in both the cases for all values of brake mean effective pressure. The hydrocarbon emission increased with BMEP for both diesel and testa biodiesel. HC emission was less for testa biodiesel. The maximum exhaust gas temperature with testa biodiesel was 340 °C and maximum exhaust gas temperature with diesel was 337 °C.

V. CONCLUSION

The performance and the emission characteristics of the CI engine fuelled with coconut testa biodiesel was studied. These were compared with the values when diesel was used as the fuel. The brake thermal efficiency of the engine was less for testa biodiesel as compared to diesel. The brake specific fuel consumption of testa biodiesel was more than diesel. The exhaust emissions were less as compared to diesel. Testa biodiesel can be used in CI engine as a substitute

International Journal of Innovative Research in Science, Engineering and Technology

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for diesel. In order to reduce the emission and increase the brake thermal efficiency, it can be blended with diesel at different ratios.

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