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COMPARATIVE PERFORMANCE AND EMISSION CHARACTERISTICS OF 4-STOKE CI ENGINE FUEL 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, jetropha 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), Emission.*

➢ 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. 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.

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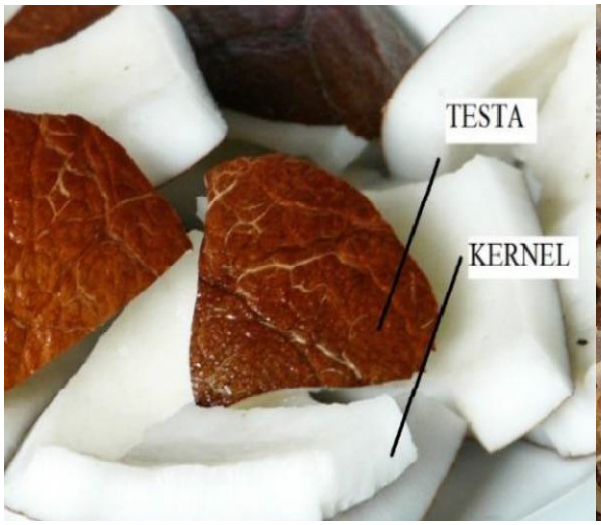

Figure – 1 Coconut testa and kernel

Figure – 2 Coconut testa

Table – 1 Properties of coconut testa biodiesel

SI.No	PROPERTY	ASTM STANDARD	EVALUATED VALUE
1.	Viscosity	1.9-6 cp	4.03cp
2.	Density	575-900 kg/m^3	831.7 kg/m^3
3.	Flash point	100^{o}c, min	122^{o}c
4.	Fire point	-	130^{o}c

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➢ LITERATURE REVIEW

The concept of biofuel dates back to 1885 when Dr. Rudolf Diesel built the first diesel compression ignition engine with full intention of running it on vegetative source (Shay 1993). In 1912, he observed, "… the use of vegetable oils for engine fuels may seem insignificant today. But such oils may in the course of time become as important as petroleum and the coal tar products of present time." However, due to cheap petroleum products, and probably due to economic might of the cartels, investigations of such non-conventional fuels never took off to offer any viable ideas.

In the recent past the search for new source of biodiesel and their effective utilization had been a hot topic among the researchers in India and abroad. In the few years, many researchers have taken intensified work in the field of utilization of biodiesel in CI engine and some of the results are described below.

Several studies have shown significant reductions in smoke and particulate matter (PM) emissions from diesel engines when oxygenates are blended with conventional diesel fuels. There is an interest in oxygenates, and fuel properties such as hydrogen to carbon ratio, aromatic content, and number of carbon-carbon bonds were used as correlating parameters for smoke formation in hydrocarbon flames. All the studies showed a significant reduction in smoke and PM emissions when either pure oxygenates or oxygenate/diesel blends were burned in diesel engines. As a compression ignition fuel, DEE has several favorable properties, including an outstanding cetane number and a reasonable energy density for onboard storage, and in addition, it is renewable. Hence, it can be used as an additive to reduce the ignition delay and improve mixture formation with vegetable oils. Ether-bound oxygen seemed to be more effective in smoke reduction than alcohol- bound oxygen. This research on diesel engines fueled with DEE mixed biodiesel have revealed that the fuel economy and performance were better than those of diesel engines without this oxygenate.

- ***Mohsin M Jujara (2013)*** *"Comparative performance and emissioncharactristics of 4-cylinder 4- stroke ci engine fueled with coconut oil-diesel fuel blend". In this study, it was shown that coconut oil as alter-native diesel engine fuels can be used successfully to operate a direct injection diesel engine without modifications to the engine or the injector system. Coconut oil engine operation resulted in better emissions, and lower NOx emissions compared with standard diesel fuel. increasing the amount of diesel fuel blend increasing the value of bsfc, and decreasing break thermal efficiency.*
- ***Kanji H.Siju et.al,(2013)*** *review "Study on Exhaust Gas Recirculation (EGR) and Catalytic Converter by using blend of Karanja Biodiesel in Diesel engine" In this study, before treatment as Exhaust Gas Recirculation and after treatment system as Catalytic converter used with Karanja Biodiesel in CIDI engine. This*

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study investigate the suitable use of Karanja Biodiesel in conventional diesel engine and exhaust emissions like carbon monoxide (CO), Hydrocarbon (HC), oxides of nitrogen (NOx) reduced simultaneously by the systems.

- ***P.Balashanmugam et.al,(2013)*** *"Study of Diesel Particulate Emission from Bio-diesel (Waste Cooking Oil) in DI Engine Adding Fuel Additive" The smoke density ,particulate emission,NOx emission is reduced 20 HSU with B20% biodiesel.The peak pressure and rate of heat release slightly increase for biodiesel. This is due to increase in combustion rate due to combustion of Palm oil by flame propagations.*
- ***E. Mensah et.al,(2013)*** *" Engine Performance Evaluation Using Biodiesel Blends From Waste Palm Kernel Oil, Mixed WVOs And Diesel Fuel" Engine performance evaluation and standard test for some fuel properties were conducted to compare biodiesel blends from waste PKO and mixed WVOs with diesel fuel.90% diesel + 10% waste palm kernel oil (BPK10); and 80% diesel + 20% waste palm kernel oil (BPK20) blends of biodiesel gave higher thermal efficiencies, higher brake power and lower exhaust temperatures.*
- ***D.D.Nagdeote et.al,(2012)*** *" Experimental Study of Diethyl Ether and Ethanol Additives with Biodiesel-Diesel Blended Fuel Engine"Diesel -Biodiesel-diethyl ether blend show better stability and can be used in diesel engine without any modification. show excellent ability to eliminate smoke emissions, especially at high engine load. Diethyl ether has higher volatility than ethanol, so BDET exhibits more reduction of smoke. The addition of higher oxygen content and high volatility fuels, such as diethyl ether and ethanol, can be a promising technique for using biodiesel/diesel blend efficiently in diesel engines without any modifications in the engine.*
- ***N.Panigrahi et.al,(2012)*** *is explained "Non-Edible Karanja Biodiesel- A Sustainable Fuel for C.I. Engine" The use of Karanja biodiesel in conventional diesel engines when used alone or with blends with petroleum diesel substantially reduces exhaust emission such as the overall life cycle of (CO2), (PM), (CO), (SOx) and (HC) with reducing the green house emission also. The specific fuel consumption is more or less the same to diesel fuel.*
- ***James eberhardt et.al,(2011)*** *explained the producing and using renewable fuels (DEE) for transportation is one approach for a sustainable energy future for all country of the world. Renewable fuels may also sustanitialy reduce contributions to global climate change.*
- ***Ismetsezer et.al, (2011)*** *"Thermodynamic, performance and emission investigation of a diesel engine running on dimethyl ether*

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and diethyl ether"Engine performance decreases and specific fuelconsumption increases for dimethyl ether and diethyl ether in case of the same fuel injection rate (or unmodified fuel injection system) due to lower heating values of these alternative fuels so the decrements in brake power at 4200 rpm are about 32.1% and 19.4% and also the increments in brake specific fuel consumption at 2200 rpm are about 47.1% and 24.7% for dimethy ether and diethyl ether, respectively. However, brake thermal efficiency of dimethyl ether and diethyl ether is better than or close to diesel due to their favorable combustion characteristic.

- ***Mallela Gandhi et.al, (2011)*** *"Methyl Ester Production From SchlicheraOleosa" Is investigated methyl ester production from schlicheraoleosaThe unrefined Schlicheraoleosaseed oil is chosen as a potential non-edible vegetable oil for the production of biodiesel. Alkaline-catalyzed esterification process could not produce biodiesel from high FFA oils like the Schlicheraoleosaseed oil. Successful efforts are made here for the production of biodiesel from unrefined Schlicheraoleosaseed oil. The two-step esterification process converts the crude high FFA Schlicheraoleosamethyl ester to a suitable form of fuel for diesel engines. Viscosity and density of methyl esters of Schlicheraoleosamethyl ester are found to be close to that of diesel. The flash point of biodiesel is higher than that of diesel.*
- ***M. Bassyounie et.al, (2011)*** *is expiained" Biodiesel Production and Investigations on the Performance of Diesel Engine Using Jatropha Oil" Jatropha oil is a good source for transesterification. There was high exhaust when the only diesel was used but when the blends were used the exhaust gas was much less. This shows that different blends of biodiesel are good to use in the compression ignition engine without any engine modifications. This will also limit the release of toxic gases and use of alternate fuel.*

In continuation of finding alternate fuel for CI engine, an attempt has been made to investigate the performance and combustion characteristics on a CI engine fueled with methanol and KOH of Coconut testa oil with various blend level (0-100%). Also, studied the emission characteristics for the same engine.

➢ ENGINE SPECIFICATIONS

Table – 2 Engine specification

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Type of Engine	Vertical, 4-Stroke cycle, single acting, High speed, DI, diesel engine.
Number of Cylinder	One
Speed	1500rpm
Maximum power output	5Hp(=3.7 kW)
Bore	80mm
Stroke	110mm
Cubic Capacity	0.553 liters
Normal compression ratio	16.5:1
Fuel timing by spill	23 Deg. BTDC
Lubrication	Forced Full Pressure lubrication
Type of cooling	Water cooled
BMEP at1500 rpm	5.42 bar

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Figure – 3 Single cylinder 4 stroke diesel engine.

RESULTS AND DISCUSSIONS

ENGINE PERFORMANCE

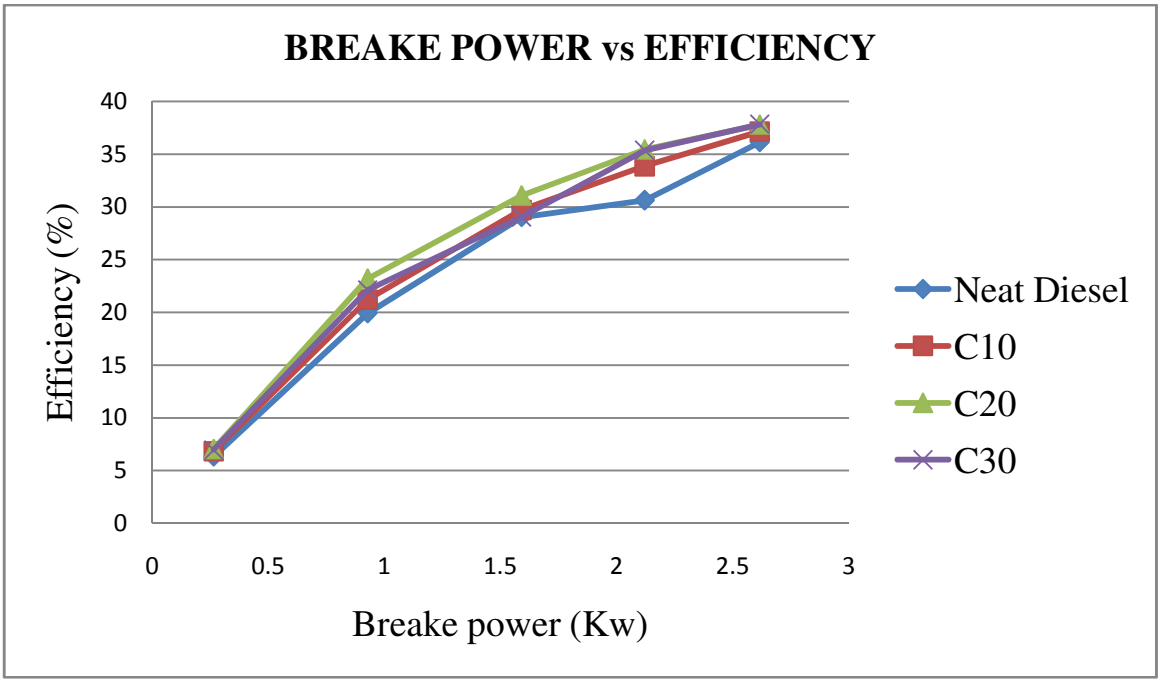

Figure – 4 Breake powerVs Efficiency

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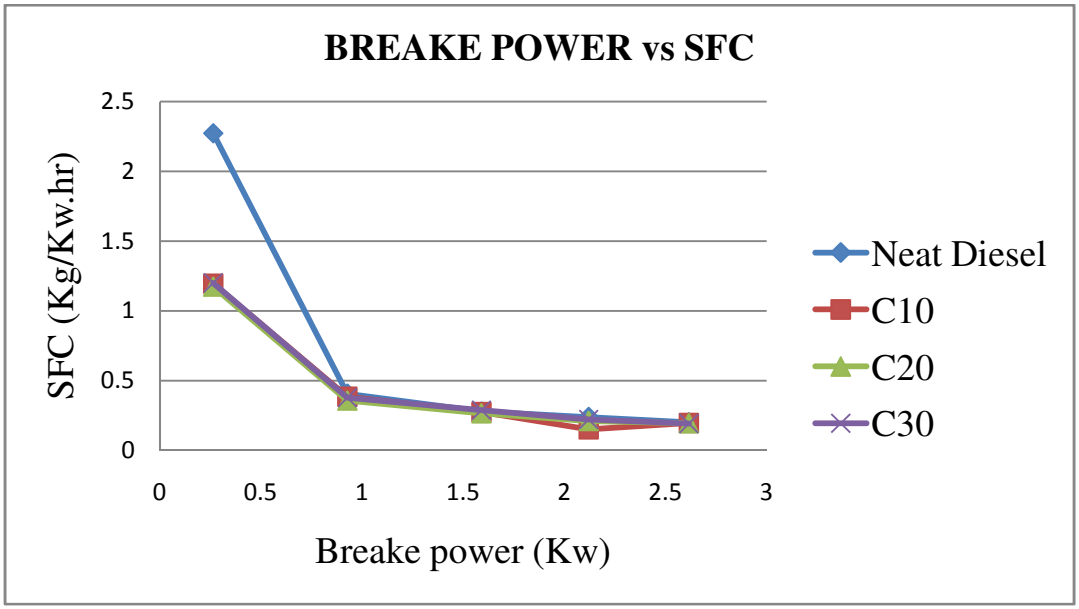

Figure – 5 Breake power Vs SFC

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 37.82%. The maximum efficiency obtained with diesel as the fuel was 36.12%.

EMISSION

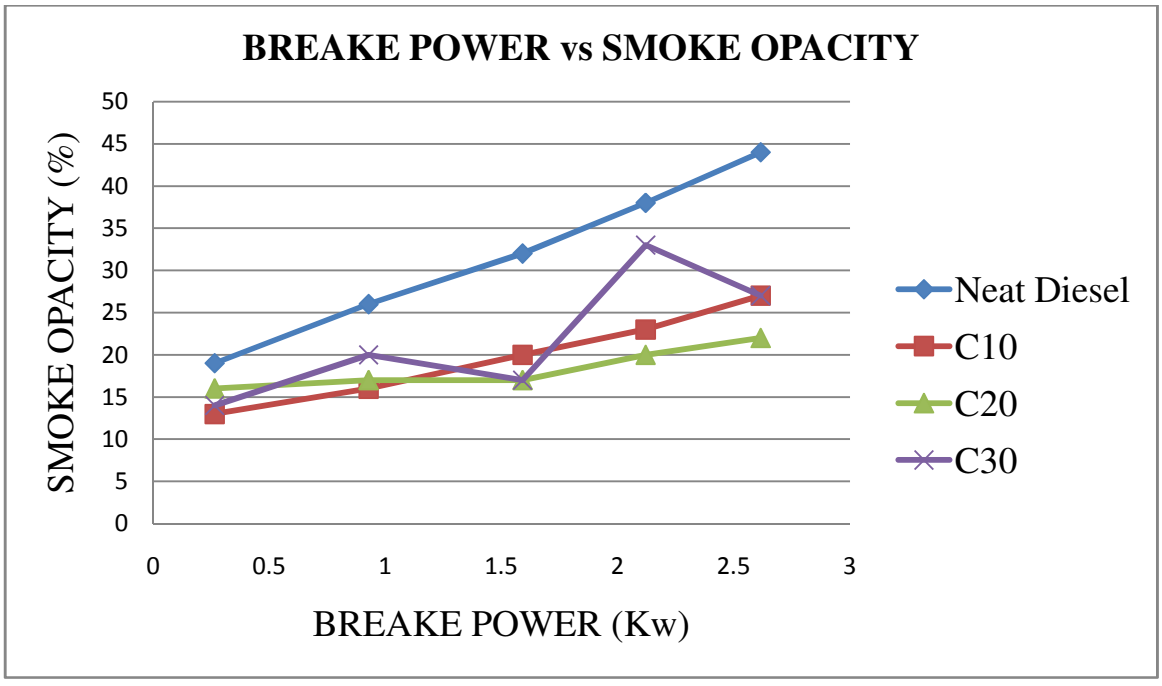

Figure – 6 Breake power Vs Smoke opacity

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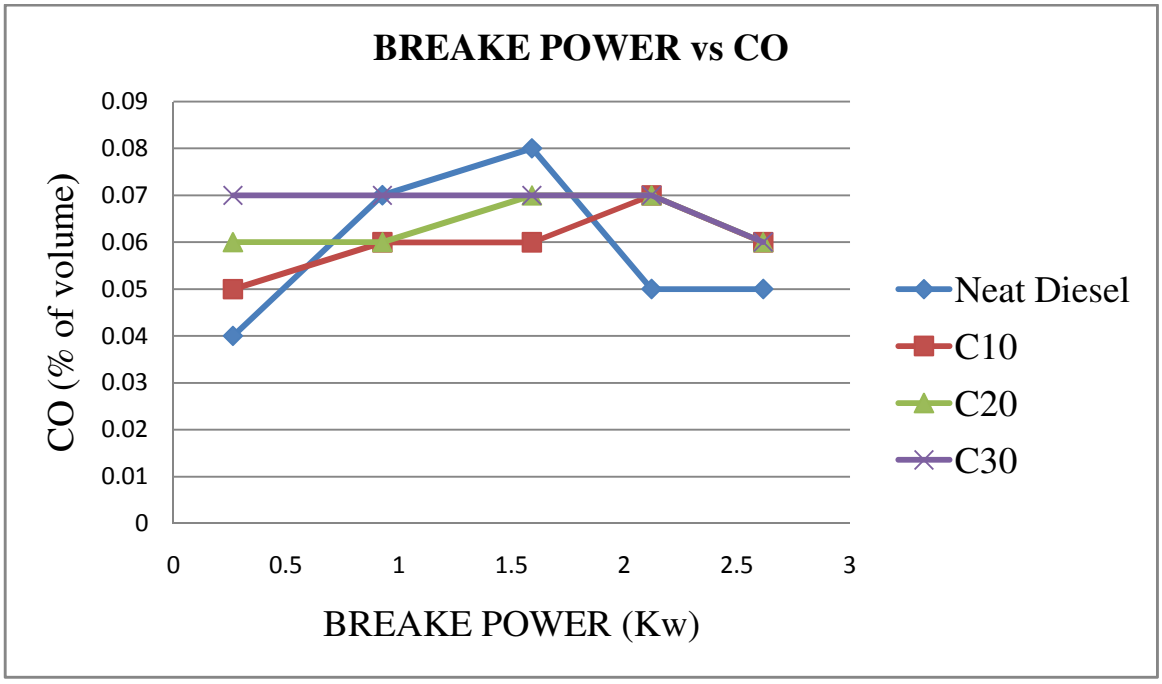

Figure – 7 Breake power Vs CO

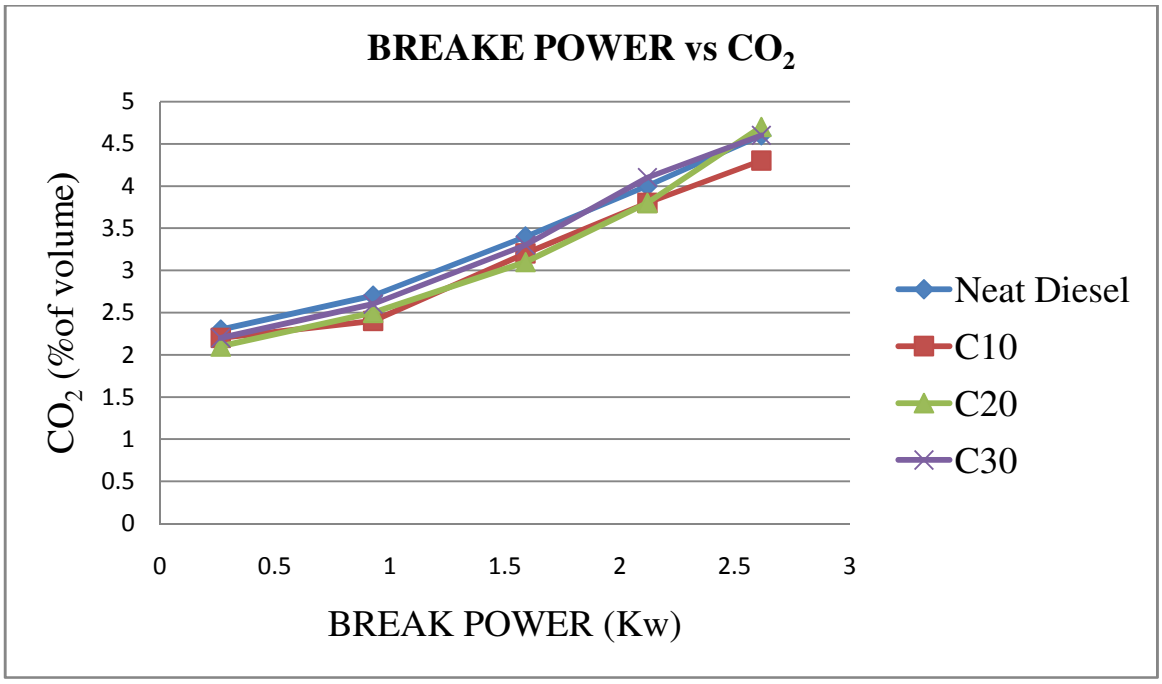

Figure – 8 Breake power Vs CO_2

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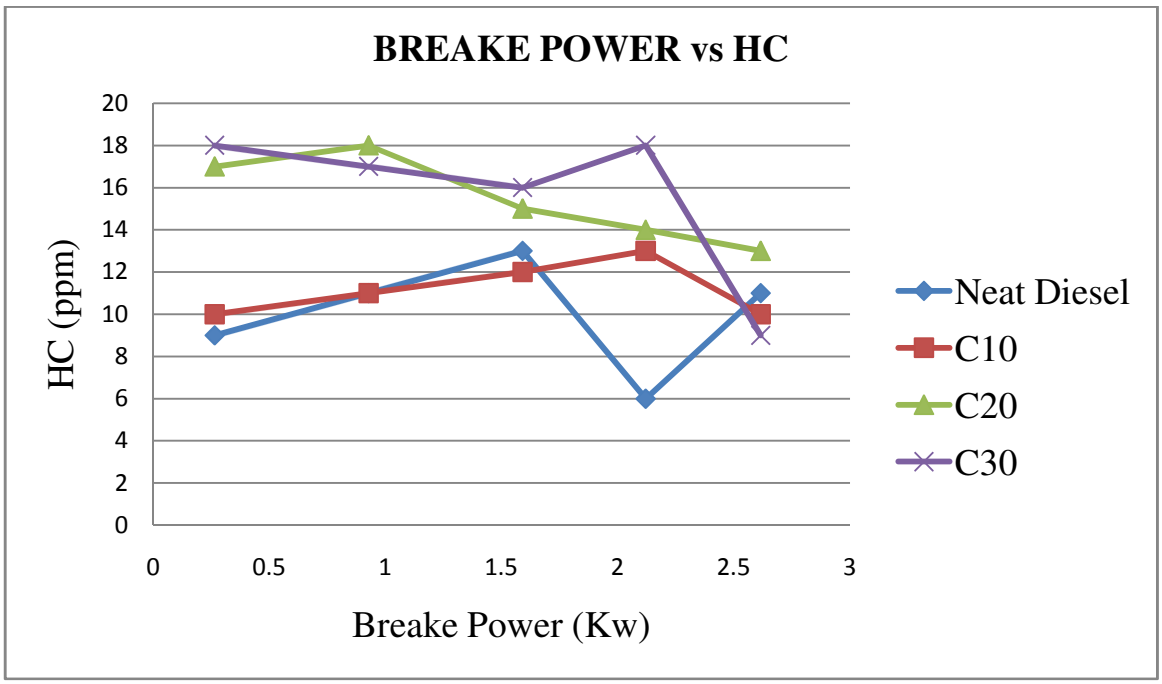

Figure – 9 Breake power Vs HC

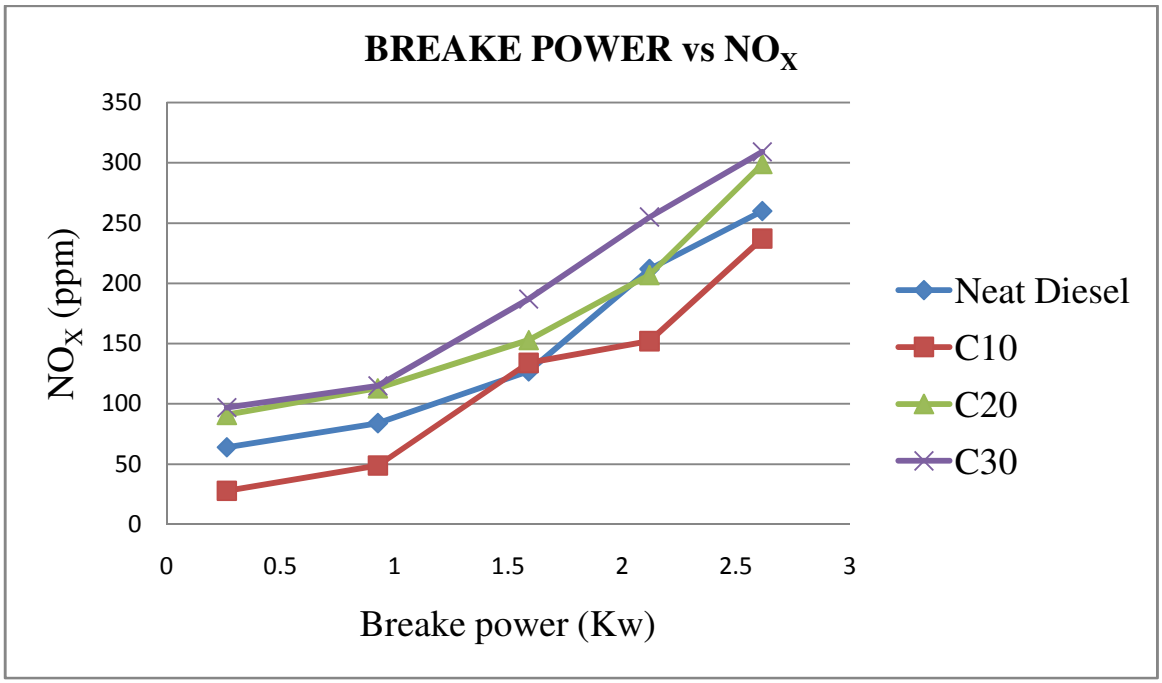

Figure – 10 Breake power Vs NO_X

NOx emission of the CI engine when fuelled with testa biodiesel was slightly less than the NOxemission when diesel was used as the fuel. The maximum emission obtained using testa biodiesel was 260 ppm, while that obtained with diesel was 237 ppm. CO_2 emissions remained

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almost the same for testa biodiesel and diesel. Maximum emission was 4.3% for testa biodiesel and 4.6 % for diesel. Carbon monoxide emission was in between 0.05% and 0.06 % 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.

➢ CONCLUSION

The performance and the emission characteristics of the CI engine fuelled with coconut testa biodieselwasstudied. 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 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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