THOMSON REUTERS ENDNOTE

[Mittal*, 5(5): May, 2016] ISSN: 2277-9655
Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

PERFORMANCE AND EMISSION OF CI ENGINE USING BIODIESEL OF COCONUT OIL BLENDS

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DOI: 10.5281/zenodo.50979

ABSTRACT

Nonconventional energy source is one of the fast growing science in which the biodiesel is one of the method of utilizing nonconventional energy sources. Paper deals with the science of biodiesel technology. Process of biodiesel production is consists of several chemical mechanisms. And the process of transesterification for different experiments and their final conclusion is taken for review. During the review of papers, experimental parameters like Engine performance parameters namely brake power, brake specific fuel consumption, brake thermal efficiency and exhaust emissions of CO, HC, NOx, and smoke density were analysed from studies carried out for different loading conditions and at constant engine speed of at different speeds. The test result indicates that there is an increase in brake thermal efficiency and slightly decrease in specific fuel consumption for all the blended fuels when compared to that of diesel fuel.

KEYWORD: Biodiesel, Diesel, Transesterification, Experiments, Engine Performance Parameters, Emissions.

INTRODUCTION

The increase in population of world demands more utilization of conventional resources. Our present technology is taking the number of steps towards the supply for demand. Biodiesel is one of them, It is a clean burning diesel replacement fuel made of renewable sources such as new and used vegetable oils and animal fats it has been found from many researches biodiesel have massive potential towards the subject of concern. It is also has been found that their use produces less emission which is most important as per the global warming, Ozone layer depletion and other Environmental problems are concern. There are lots of biodiesel sources available. Animal fats, plant leaves, seeds, etc[1]. (all bio-products) can produce biodiesel. Biodiesel is a carbon dioxide neutral as the carbon dioxide are exhausted during the growth of plant. In India, seeds like Jatropha, Karanj, Neem, Castor, and Rubber are popular for biodiesel production. Madhuca Indica (mahua) and coconut are also a potential source of biodiesel. The mechanical and chemical properties are friendly from biodiesel production point of view. The coconut provides a nutritious source of juice, milk, and oil that has fed and nourished populations around the world for generations. On many islands coconut is a staple in the diet and provides the majority of the food eaten[2]. Nearly one third of the world’s population depends on coconut to some degree for their food and their economy. Among these cultures the coconut has a long and respected history. People from many diverse cultures, languages, religions, and races scattered around the globe have revered the coconut as a valuable source of both food and medicine. Wherever the coconut palm grows the people have learned of its importance as an effective medicine. For thousands of years coconut products have held a respected and valuable place in local folk medicine.

METHOD TO CONVERT IN BIODIESEL

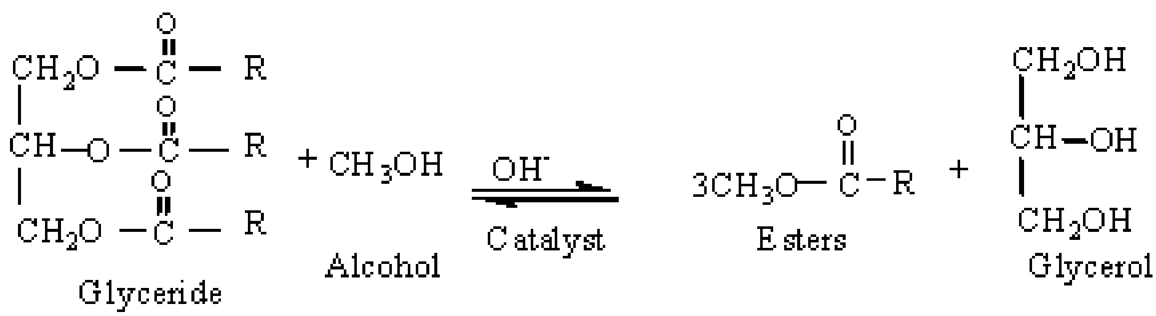
There are two methods are being used in to produce biodiesel are direct mixing and micro emulsion. These methods not helps to lube pollution, high temperature pyrolysis cracking is very difficult to control by its reactant at high temperature. The parameter which helps to control these operations are reaction temperature, ratio of alcohol to vegetable oil, amount of catalyst, mixing intensity, catalyst, and the raw oil used. Ester exchange method is

ISSN: 2277-9655
Impact Factor: 3.785

advanced method than others two Transesterification is the process in which triglyceride can be transformed into mono ester[4]. The advantage of this method is viscosity is reduced and the cetane number is increased as molecular chain is cut into one third.

1.2 CONVERSION OF VEGETABLE OIL TO BIODIESEL (TRANSESTERIFICATION)

The process of Conversion of Vegetable oil to biodiesel is transesterification. It is a process of producing the methyl esters or ethyl esters from triglyceride. For this purpose, the catalyst is added to the methanol or ethanol and heated up to certain desired temperature. This solution is then added to the hot vegetable oil slowly as a result the triglyceride is converted into ethyl esters or methyl esters[5]. Formation of ethyl esters or methyl esters is depend upon the use of ethanol or methanol respectively. The Madhuca Indica seeds are considered as one of the potential feedstocks for the biodiesel production in India therefore the annual production of Madhuca Indica flower was expected to increase in the future.



Selection of vegetable oils is different according to the climate and soil conditions of country. Soybean oil is used in USA, rapeseed and sunflower oil is used in Europe, palm oil in south East Asia and in Philippines coconut oil are most favourable.

1.3 PROPERTIES OF COCONUT OIL

Table 1: Properties of coconut biodiesel and conventional diesel oil

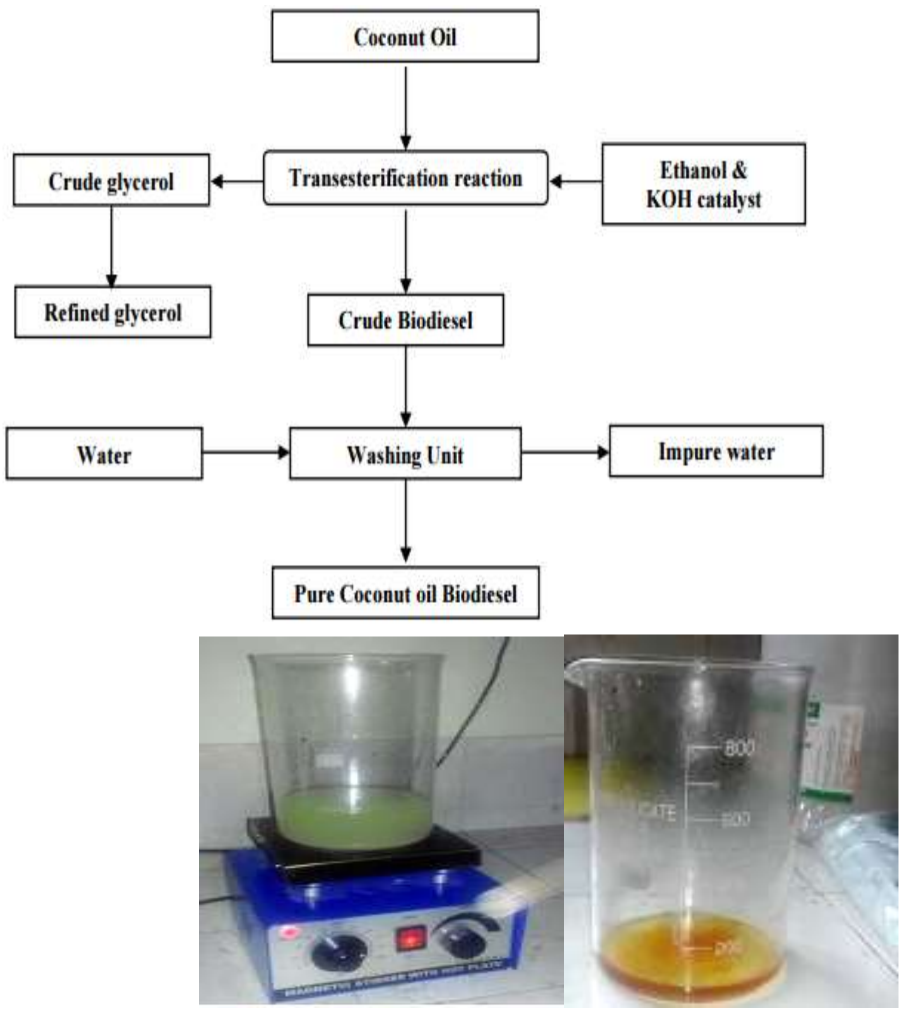
Properties	Units	Coconut biodiesel oil	Diesel oil
Specific gravity	-	0.8733	0.83
Cetane number	-	70	48
Flash Point	°C	110	60-80
Pour Point	°C	-12	18
Viscosity	mm2/s	2.83	1.3-4.1
Density	Kg/m3	0.924	0.84
Aniline point	°C	54	42
Acid Value	mgKOH/g	0.81	0

MATERIALS AND METHODS

2.1Alkali catalysis transesterification: This process is carried out when the free fatty acid is less than 1%. Most commonly used base catalysts are sodium hydroxide and potassium hydroxide.

- **Transesterification process:** Alcohol (methanol) and catalyst (KOH) are mixed thoroughly. Coconut oil is then added to the mixture and stirring is done continuously at 60-80˚C for 2 hours[6]. The whole mixture is cooled and allowed to settle for 24h.
- **Production of biodiesel: Oil** was heated up to a temperature of 60°C in water bath to melt coagulated oil. The heated oil was poured into the conical flask containing catalyst-alcohol solution, and this moment was taken as the starting time of the reaction. The reaction mixture was then stirred at a fixed speed of 300rpm for 2 h.

- **Separation of biodiesel:** The product of reaction was exposed to open air to evaporate excess methanol for 30 min[11]. The product was then allowed to settle overnight to produce two distinct liquid phases crude ester phase at the top and glycerol phase at the bottom. Glycerol was separated using separating funnel.
- **Biodiesel purification:** The crude ester was separated from glycerol using separating funnel. Crude methyl ester containing excess alcohol, soap and glycerol was washed with water five times the amount of crude biodiesel, so that the molecules will move freely and separate easily and quickly. It was purified by washing with distilled water to remove all the residual by-products[7]. The crude biodiesel and water mixture was shaken thoroughly for 1 min and placed on a table to allow separation of biodiesel and water layers[8]. The washing process was repeated for several times until the washed water became clear. The washed biodiesel was heated at 110 ºC for 3-4 mins, so that remaining water will be evaporated.



. *Figure 2: Flow chart of the Transesterification process*

EXPERIMENTAL DETAILS

ISSN: 2277-9655
Impact Factor: 3.785

Engine	Kirloskar (Model AV1), single cylinder, 4 stroke, and water cooled C.I. engine.
Stroke	0.110 m
Bore	0.080 m
Rated power	3.7 kW @ 1500 rpm
Lubricating oil	SAE30/SAE40 (room temperature above 45^{0}C
Design Fuel	Diesel
Alternator	Kirloskar (Model: KBM –104), 50Hz, 1500 rpm, 230V, 17.4Ampere

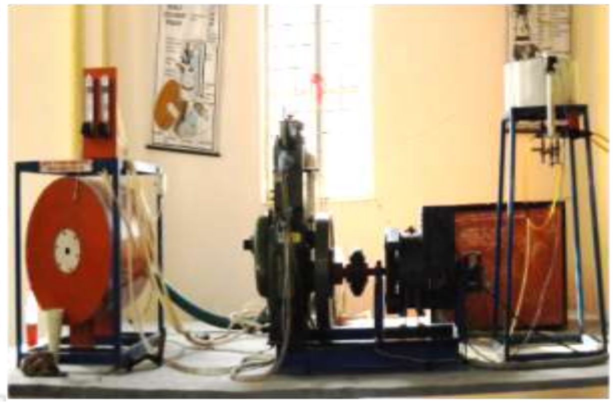
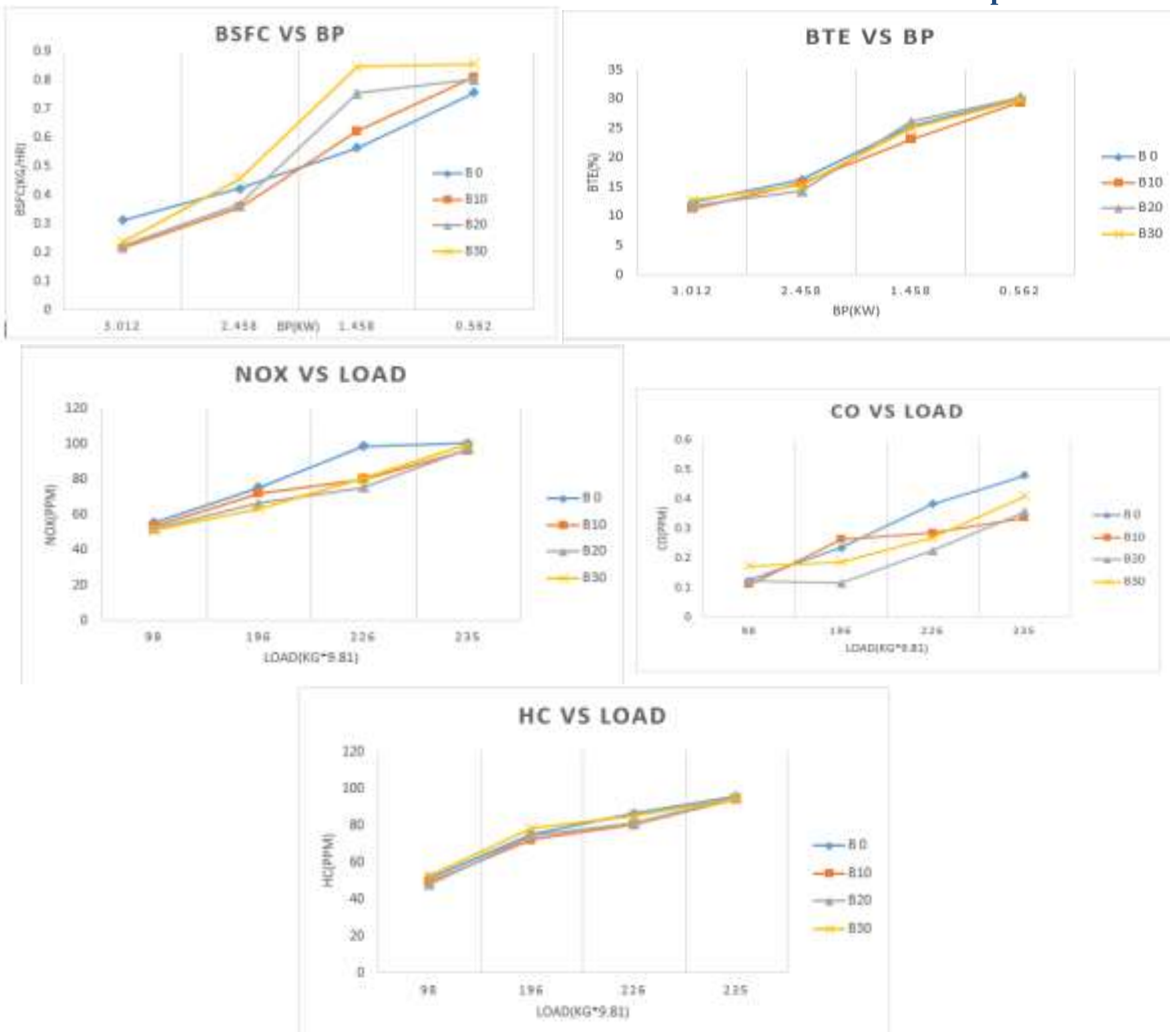


Figure 3: Schematic diagram of engine test rig.

The experimental study was conducted on a single-cylinder, four-stroke DI diesel engine. The general specifications of the test engine are shown in Table 4 Cussons P8160 type standard engine test bed which consists of an electrical dynamometer was used. The electrical dynamometer is a swinging field direct current (DC) apparatus rated for 10 kW power absorption at 4000 rpm operating speed. The engine load was measured with a strain gauge load cell sensor. Engine speed was measured with a magnetic pick-up sensor. The schematic view of the test equipment's is shown in Fig. 3 Diesel fuel flow was measured with a high-precision electronic balance[9]. Inlet air, exhaust gas, lubricating oil temperatures were measured with an ELIMKO-6000, multi-point electronic temperature indicator. The thermocouples used were NiCr–Ni type, which can measure up to 1200 Celsius. Cylinder pressure was measured using an AVL 8QP500c water cooled quartz pressure transducer and amplified with Cussons P4110 combustion analyser charge amplifier channel. A rotary encoder was coupled with the engine crankshaft. A National Instruments USB 6259 data acquisition card was used for recoding signals on triggered mode with 0.36 CA resolutions. Mean pressure data were calculated using 50 consecutive cycles[10]. The net heat release rate (NHRR) analysis was calculated according to a single zone combustion model based on the first law of thermodynamics. An MRU DELTA 1600 exhaust gas analyser was used to measure NOx (CLD), CO (NDIR) and HC (FID). The soot concentration level was measured using a VLT 2600-S partial flow smoke meter. In this study, blends of chicken fat based biodiesel fuel (B10, B20, B30 – blended in volume at the ratio of 10%,20%,30% with diesel fuel) and diesel fuel were evaluated. Magnesium based additive was added into the blend at a ratio of 12 mmol/L. Properties of diesel fuel and test fuel (B10,B20,B30) blended with 12 mmol g additive are examined. Experiments were conducted at full load conditions and different engine speeds varying between 1800 and 3000 rpm in intervals of 200 rpm. Before each test, the engine was warmed up with diesel fuel. Engine oil temperatures were kept stable around 80 Celsius.

OBSERVATION AND RESULTS

4.1 PERFORMANCE GRAPHS: FAME (Fatty Acid Methyl Ester) is environment friendly, alternative, and nontoxic, safe, biodegradable has a high flash point and is also termed as Bio-Diesel. Biodiesels can be prepared from the natural oils like cotton oil, mustard oil, coconut oils etch by the transesterification process and oils having low FFA contents best suited for the trans esterification process. Base catalysed transesterification process is more sensitive to reaction conditions as compared to acid catalysed.



Performance characteristics and emission characteristics of diesel engine with coconut oil biodiesel blend with load

Brake thermal efficiency: The brake thermal efficiency plots in above Figure show an increase of brake thermal efficiency with 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 from the above graph we can see that for 20% of the biodiesel blend the thermal efficiency is very much comparable with the diesel fuel. In general, the thermal efficiency of the diesel increases with the load and the break horse power of the engine.

Break specific fuel consumption: From the above graph as we can see that as the load and power increases the bsfc also decreases and from the above we can see that it is having slightly low bsfc than the diesel in all the three percentages (10%,20%,30%) of the blends of the biodiesel hence diesel will take more fuel to produce 1KW of power than the biodiesel blends.

CO emission: With the increase in the load the CO emission increases and diesel have a greater CO emission than that of the biodiesel blends and 10% and 20% of the biodiesel blends produces the best results. It indicates that the combustion efficiency improves with the blend of cotton oil with diesel. The combustion rate and hence the reduction in carbon monoxide emissions with the addition of diesel to cotton oil improves as compared to neat diesel.

HC emission: The HC emission of the coconut biodiesel blend with the diesel will have the almost the same results as we can see from the above graphs the all the three blends have approximately same HC emissions during the testing as the load increases on the engine.

NO emission: NO concentration decreases as the amount of cottonseed oil in the blend goes up This reduction in NO with cotton oil operation is due to the less intensity of premixed combustion compared with diesel. The increase in NO is due to good mixing rate of fuel and air which leads to an increase in the premixed combustion.

CONCLUSION

From this study, it was shown that coconut oil biodiesel and its blend with diesel fuel gives higher bsfc than diesel fuel and lower emissions because of the better atomization of the fuel and better air and fuel mixing before the combustion. Beside this coconut oil has a much better lubrication property than other bio-fuels. Test quantities of coconut oil biodiesel were produced through transesterification reaction using 432g coconut oil, 400.0% ethanol (wt% coconut oil), 3.2% potassium hydroxide (KOH) catalyst at 65°C reaction temperature and 110 min. reaction time. The process yielded 11.2% biodiesel. The coconut oil biodiesel produced was subsequently blended with petroleum diesel and characterized as alternative diesel fuel through some ASTM standard fuel tests.

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