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An Experimental Investigation Performance of an Engine Using COCODIESEL as an Alternate Fuel

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Abstract: *with the growth of modern civilization and industrialization in worldwide, the demand for energy is increasing day by day. Majority of the world's energy needs are met through fossil fuels and natural gas. As a result the amount of fossil fuels is on diminishing from year to year. Since the fossil fuel is non-renewable, so fuel price is gouging as a consequence of spiraling demand and diminishing supply. At present the power generation of our country is mainly depends on imported fossil fuels. To reduce the dependency on imported fuel, the use of renewable sources has become more popular. So the aim this project is use the coconut oil as a renewable and alternative fuel. By blending of coconut oil and methanol with diesel to get more efficiency and reduce emissions from the engine. Development of alternatively fueled engines has become vital in order to meet the increasingly stringent emissions norms being implemented globally. Furthermore, alternative fuels provide a cost benefit, due to the lower costs of production of these fuels. Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG) and Hydrogen-CNG blended fuel (HCNG) are promising alternative fuels in India. For the most part, almost anything that can be burned can be used as a fuel source, but to really work on a large scale, an alternate energy source has to meet certain criteria. It has to produce more net energy for less money than current technologies, it must be widely available in large quantities and it should produce minimal pollution. In many applications like Transportation, Power generation, Marine applications etc., diesel Engines are being used as a major source. During last century, the uses of fossil resources are increasing due to significant growth of population and change in life style. This causes crises of fossil fuel depletion For the diesel engines there is an urgent need for suitable alternative fuels .In this paper will be examined the use of diesel-corn oil mixtures in diesel four stroke engine.. With diesel and different blends of corn oil, an attempt is made to analyze the performance and emission characteristics of a diesel engine. Based on experimental analysis of the engine brake power specific fuel consumption thermal efficiencies are calculated. Emissions such as carbon monoxide, carbon dioxide are measured.*

.***Keywords***: *Alternative fuels, COCODIESEL Emissions, Diesel engines, fossil fuel.*

1. INTRODUCTION

Brief History about Alternative Fuels used

PROPANE:-

Liquefied petroleum gas (LPG) consists mainly of propane, propylene, butane, and butylenes in various mixtures. It is produced as a by-product of natural gas processing and petroleum refining. With propane's simple molecular composition, propane - fueled vehicles emit significantly lower levels of carbon monoxide, hydrocarbons and nitrogen oxides than gasoline - fueled vehicles. The level of air - toxic emissions from propane -fueled vehicles is also low. According to the National Propane Gas Association, U.S.A., spark plugs from a propane vehicle last from 80,000 to 100,000 miles and propane engines can last two to three times longer than gasoline or diesel engines.

ETHANOL:-

Ethanol (ethyl alcohol, grain alcohol, ETOH) is a clear, colorless liquid with a characteristic, agreeable odor. Two higher blends of ethanol, E-85 and E-95 are being explored as alternative fuels in demonstration programs. Ethanol is also made into ether, ethyl tertiary-butyl ether (ETBE) that has properties of interest for oxygenated gasoline and reformulated fuels. The environmental benefits of ethanol include: 10% ethanol blends reduce carbon monoxide better than any other reformulated gasoline blend. Ethanol is a safe replacement for toxic octane enhancers in gasoline such as benzene, toluene and xylene. ETBE lowers gasoline volatility and is, thus, particularly effective in reducing VOC emissions from automobiles.

BIODIESEL:-

Biodiesel (mono alkyl esters) is a cleaner-burning diesel fuel made from natural, renewable sources such as vegetable oils. Just like petroleum diesel, biodiesel operates in combustion-ignition engines. The use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide, and particulate matter. It also decreases the solid carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion to CO2), eliminates the sulfate fraction (as there is no sulfur in the fuel), while the soluble, or hydrocarbon, fraction stays the same or is increased. Therefore, biodiesel works well with new technologies such as catalysts (which reduces the soluble fraction of diesel particulate but not the solid carbon fraction), particulate traps, and exhaust gas recirculation (potentially longer engine life due to less carbon).

2. ABOUT COCONUT OIL

Coconut oil properties and their implications on its use as fuel
Overall Process Description

To use coconut oil in Compression (Diesel) engines. Coconut oil can be blended with diesel, straight in an adapted engine or turned into biodiesel. Because of higher specific density and slightly lower energy content, specific fuel consumption using coconut oil is generally 8% higher. Many studies involving the use of vegetable oils such as coconut oil were conducted in the early 1980s. Short term engine testing indicates that vegetable oils can readily be used as a fuel or in a range of blends with diesel. Long-term engine research however shows that engine durability is questionable when fuel blends contain more than 20% vegetable oil. Especially deposits on the pistons, valves, combustion chambers and injectors can cause severe loss of output power, engine lubricant deterioration or even catastrophic failure to engines .Using pure coconut oil in standard engines is very attractive through its low cost, however it requires special technical supervision and may shorten engine life.

Properties of different oils

FUEL	SPECFIC ENERGY	CETANE NUMBER	KINEMATIC VICOSITY @40^0	IODINE VALUE	SOLIDIFICATION POINT	SAPANIFICATION VALUE
Petroleum Diesel	45.3	45-55	4		-9	
Coconut	42	60	20	10	24	268
Palm oil	39.6	42-50	37	54	35	199
Rapeseed	39.7	38	37	125	-10	175
Soybean	39.6	37.8	33	130	-16	191
Linseed	39.7	34.6	29	179	-24	190

Table 1 Properties of different plant oils

APPLICATIONS

1. Two wheeler Application
2. Four wheeler Applications.
3. Utilization of coconut oil in diesel generators for electricity production.
4. Used mainly to produce electricity, to fire boilers and blast furnaces in industry.
5. The pulp and paper industry, and to power large marine and other vessels.
6. It is also used to heat some large, usually older commercial, institutional and multiple residential buildings.

3. TRANSESTERIFICATION PROCESS

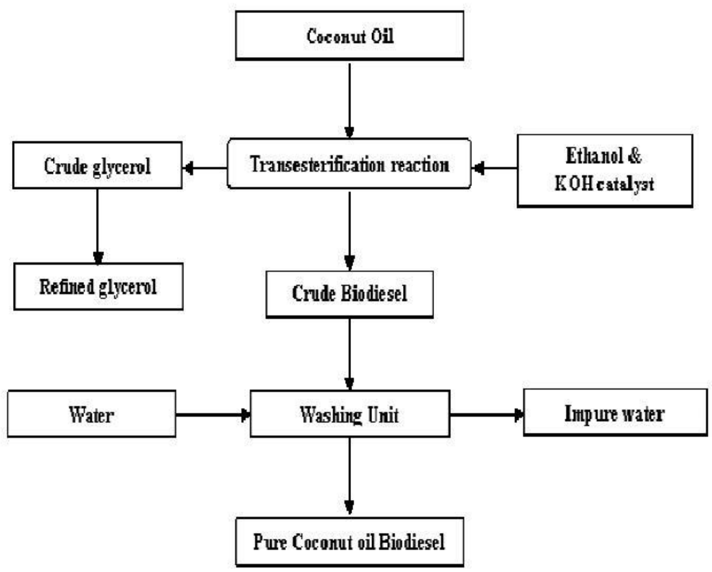
Coconut oil like any other vegetable oils and animal fats are triglycerides, inherently containing glycerin. The biodiesel process (Transesterification) turns the oils into esters, separating out the glycerin from the main product (biodiesel). The glycerin sinks to the bottom and the biodiesel floats on top and can be decanted off. The process is called Transesterification, which substitute's alcohol for the glycerin in a chemical reaction, using a catalyst.

Potassium ethoxide Production and Transesterification Reaction

The method of laboratory scale biodiesel production used by Chitra is adopted in this work. 20.0g of ethanol was measured and poured into a plastic container through a funnel. 0.8g of KOH was carefully added to the plastic container through another funnel and the container was secured tightly with the bung and the screw-on cap. The container was swirled round thoroughly for about 2 minutes until the KOH completely dissolved in the ethanol, forming potassium ethoxide. 100.0g of coconut oil was measured out in a beaker, pre-heated to 65°C and poured into the blender. The prepared potassium ethoxide from the plastic container was carefully poured into the coconut oil. The blender lid was secured tightly and switch on. The mixture was left to blend for the 120 minutes at moderate speed before the blender was switched off at lowest possible agitation by the blender.

Settling and Washing

The mixture was poured from the blender into a bottle for settling and the lid was screwed on tightly. The reaction mixture was allowed to stand overnight to allow phase separation occurred by gravity settling. The Coconut biodiesel at the top was later carefully decanted leaving the glycerol at the base. Thorough washing of the biodiesel was carried as detailed out in some literatures. The process flow chart for the biodiesel production from coconut oil.



Process flow chart for biodiesel production from coconut oil

It is observed that the viscosity of the coconut oil is very high (43.3 mm^2/s). This is consistent with reported results on vegetable oils. As pointed out in earlier works carried out by Peterson *et al.*, (1990) and Alamu *et al.*, (2007) [8], high viscosities of pure vegetable oils reduces the fuel atomization and increase fuel spray penetration, which would be responsible for high engine deposits and thickening of lubricating oil that cause injection coking and ring sickening of the engine and therefore compromising the efficiency of the engine. It can also be deduced from Table 3 that the specific gravity of the coconut oil is higher (0.9134) than the conventional petroleum diesel. This indicates that the coconut oil is denser than the No.2 diesel. This is in agreement with reported works of Peterson *et al.* (1990), Graboski and McCormic (1998) and Yuan *et al.* on vegetable oils and fossil diesel fuel. The Transesterification process yielded 10.4g coconut oil biodiesel and 67.4g glycerol, while 22.20g of the total reacting masses could not be accounted for. Such losses have been attributed to some un-reacted alcohol, residual catalyst and emulsion removed during the washing stage of the production process. As a result of the low yield of the coconut biodiesel recorded, a B10 blend was produced. Comparison of the physical characteristics of the coconut oil, the B10 blend and petroleum diesel are made in Table 3. With the values presented in Table 3, it is observed that the value of the viscosity of the B10 sample is thus far less than that obtained with the raw coconut oil sample. Therefore, the spraying effect that is produced during fuel injection into the combustion chamber of the engine is improved. It is significant from arithmetical calculations that the percentage reduction of viscosity is 92.48% and this indicates a very promising blend that would enhance the cold flow properties of the biodiesel blend. Also, it is seen from Table 3 that the B10 specific gravity (0.8305) is less than that of the coconut oil (0.9134). It has been reported that, specific gravity has correlations with the cetane number and the heating value of a fuel. Hence, this is an indication that the biodiesel blend is less dense than the coconut oil.

EXPERIMENTAL CONDITIONS	AVERAGE
Reaction Temperature ^{0}C	65
Reaction Time (MIN)	120
Coconut Oil Quantity (g)	100
Ethanol Quantity (g)	20.00
KOH Concentration	0.80
Coconut oil Biodiesel Obtained (%)	10.40
Glycerol Obtained (g)	67.40
Mass lost (g)	22.20
Coconut oil Biodiesel yield (%)	10.40

Table 2 Transesterification process

Sample	Coconut Oil	Coconut Oil Biodiesel Blend (B10)	Petroleum /Diesel
Viscosity at room temperature (mm^2/s)	43.3	3.03	2.847
Specific gravity at room temperature	0.9134	0.83.5	0.853

Table 3 Measured characteristics of coconut oil and biodiesel blend

Blends

Biodiesel blends of coconut methyl esters with diesel on 10, 30, 50, 70, and 100% volume basis was prepared and fuel properties are measured following standard procedure.

Properties	Density (Kg/m^3)	Viscosity	Flash Point (^{0}C)	Fire Point (^{0}C)	Calorific Value (Kj/Kg K)
Diesel	816	3.02	52	61	43796
B10	820	3.201	57	62	42936
B30	826.7	3.319	60	65	42701
B50	839.5	3.409	64	69	42100
B70	850.8	3.84	70	76	41650
B100	876.4	4.86	121	128	39251

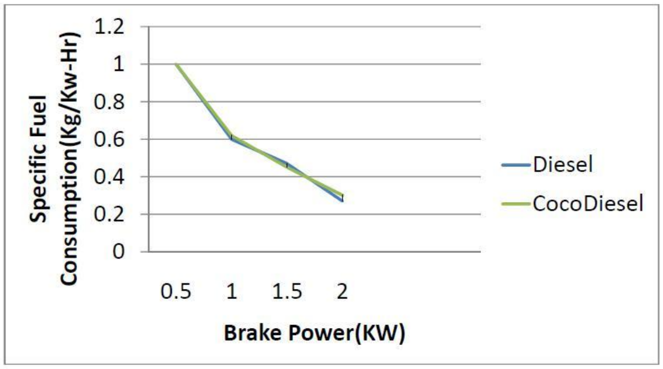
Table 4 Properties of Diesel mixed Biodiesel and its blends

The kinematic viscosity of different blends of mixed and biodiesel blends B10, B30, B50, B70 and B100 are higher than the viscosity of diesel. But up to B30 the viscosity of mixed biodiesel is close to the viscosity of diesel. It can also be observed that the viscosities of all biodiesel blends are higher than the mixed biodiesel blends. Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix:

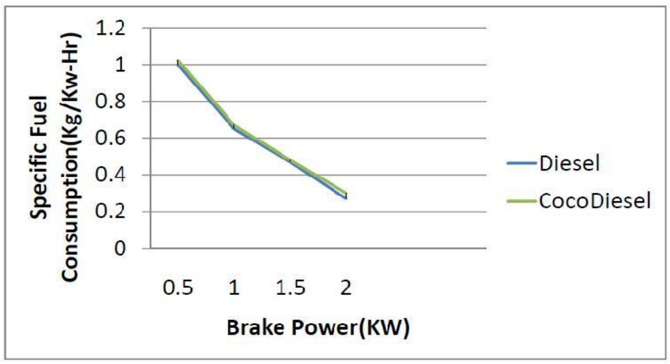
100% biodiesel is referred to as B100, while
20% biodiesel, 80% petro diesel is labeled B20
5% biodiesel, 95% petro diesel is labeled B5
2% biodiesel, 98% petro diesel is labeled B2

4. Performance factors

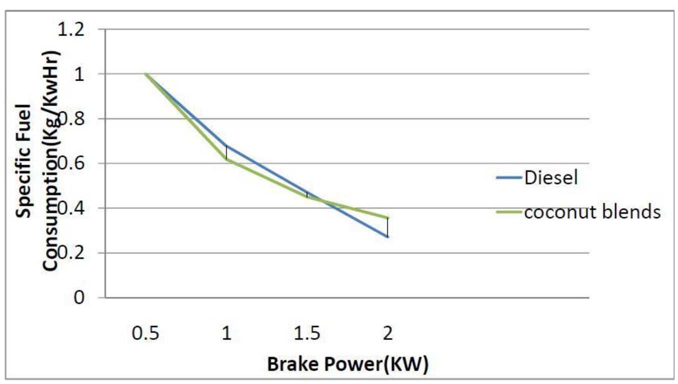
1. Variation of specific fuel consumption with Brake Power for B10 blends



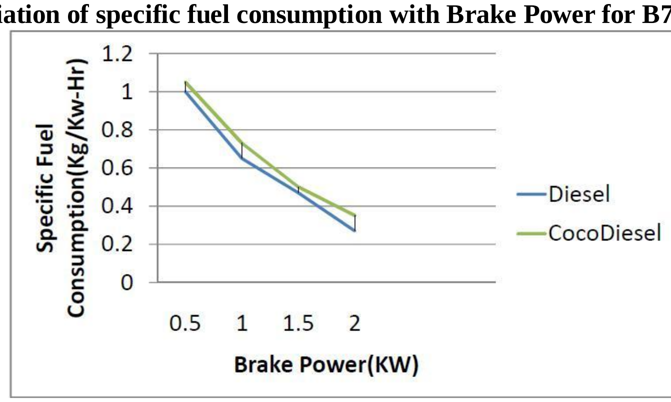
2. Variation of specific fuel consumption with Brake Power for B30 blends



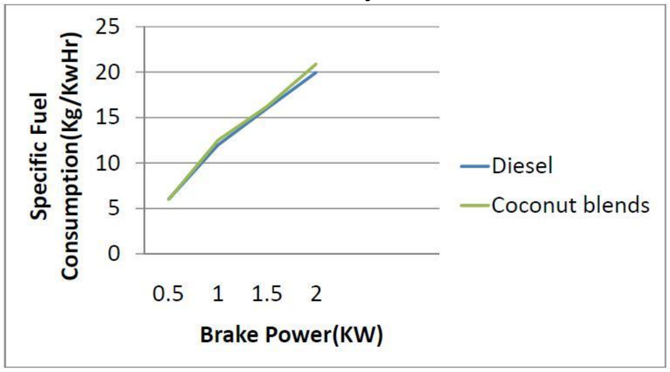
3. Variation of specific fuel consumption with Brake Power for B50 blends



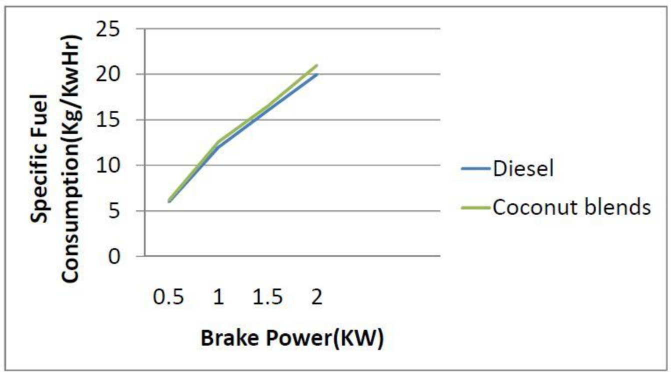
4. Variation of specific fuel consumption with Brake Power for B70 blends



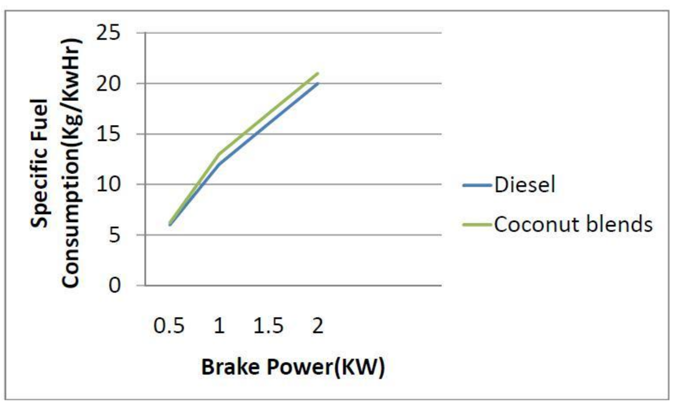
5. **Variation of Brake Thermal Efficiency with Brake Power for B10 Blends**



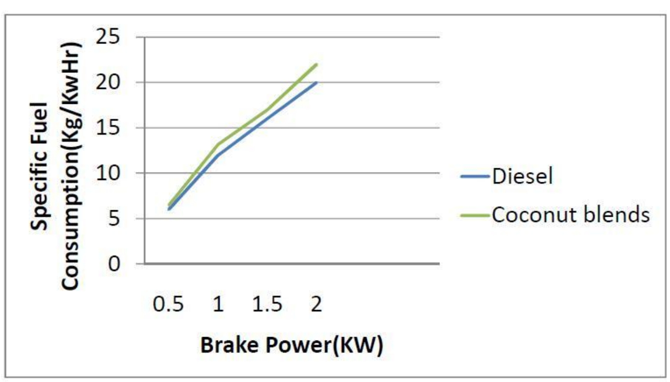
6. **Variation of Brake Thermal Efficiency with Brake Power for B30 Blends**



7. **Variation of Brake Thermal Efficiency with Brake Power for B50 Blends**



8. **Variation of Brake Thermal Efficiency with Brake Power for B70 Blends**



From the experimental analysis we can say that it's better to go for B10 blends because B10 blends properties are equal or mostly nearer to the diesel properties. While the other blends are that is B30, B50, B70, B100 blends are going to deviate from the diesel curve by considering the properties of all fuel properties like specific energy and kinematic viscosity and density, Iodine value, saponification value, etc…through brake power and specific consumption and brake thermal efficiency.

5. Factors affecting coco diesel.

1. Flash and fire points

Flash point of oil is the minimum temperature at which sufficient flammable vapour is driven off flash when brought into contact with a flame. The fire point is the minimum temperature at inflammable vapors will continue to form and steadily burn once ignited. Flash and fire points may vary with the nature of original crude oil, the viscosity and method of refining. For the same viscosities and degree of refinement, the paraffinic oils have higher flash and fire points than naphthenic oils.

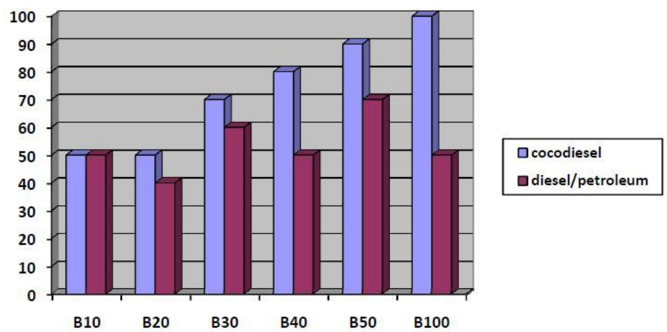


Figure 3 comparisons of flash points with different blends

2. Viscosity effect on fuel oil

The properties of biodiesel are similar to those of diesel fuels. Viscosity is the most important property of biodiesels since it affects the operation of fuel injection equipment, particularly at low temperatures when an increase in viscosity affects the fluidity of the fuel. High viscosity leads to poorer atomization of the fuel spray and less accurate operation of the fuel injectors. The lower the viscosity of the biodiesel, the easier it is to pump and atomize and achieve finer droplets. The conversion of triglycerides into methyl or ethyl esters through the Transesterification process reduces the molecular weight to one third that of the triglyceride and reduces the viscosity by a factor of about eight. Viscosities show the same trends as temperatures, with the lard and tallow biodiesels higher than the soybean and rapeseed biodiesels. Biodiesels have a viscosity close to that of diesel fuels. As the oil temperature increases its viscosity decreases. The viscosity, density, and flash point values of methyl esters decrease considerably via the Transesterification process.

3. Octane value of the Fuel

A higher self ignition temperature of the fuel and a low pre-flame reactivity would reduce the tendency of knocking. In general, paraffin series of hydrocarbon have minimum tendency of knocking. The naphthenic series comes in between the two. Usually compounds with more compact molecular structure are less prone to knock. In aliphatic hydrocarbons unsaturated compounds show lesser tendency than saturated hydrocarbons, the exception being ethylene and acetylene, propylene.

4. Reducing tendency of knocking

By reducing the distance of flame travel by centrally locating the spark plug and also by avoiding pockets of stagnant charge. Satisfactory of cooling of the spark plug and of exhaust valve area which are reducing the source of hot spots in the majority of the combustion chambers. Reducing temperature of last portion of the charge, through the application of a high surface to volume ratio in the part where the last portion of the charge burns. Heat transfer to the combustion chamber walls can be increased by using surface area to volume ratio thereby reducing the temperature.

6. Advantages

- There is no sulfur dioxide emission.
- Plant oils are carbon neutral: the amount of carbon emitted by Coco diesel fuel is less.
- There will be a reduction in diesel consumption with the production of Coconut Oil fuel at the plantation site. Coconut oil Fuel would be used in nearby regions thus saving energy and reduce GHG emissions.
- They are renewable.
- Vegetable oil combustion has cleaner emission spectra.

- Some inedible vegetable oil species are more tolerant to biotic and a biotic stress, which makes them potential candidates for turning degraded and wasteland into productive land.
- The production of vegetable oil is less energy intensive.
- Vegetable oils have higher energy content than other energy crops like alcohol.
- Their liquid nature is convenient for transport and processing.
- Because of their high heat content, which is close to 90% of diesel fuel, storage requires no governmental conditions since it is a biological product with a high flash point and low volatility.
- Vegetable oils have a favorable output/input ratio of about 2–4:1 for non irrigated crop production.
- They require simpler or no processing technology.
- Vegetable oil fuels are pH neutral, contain no water, and are relatively stable.
- It is a well-known fact that CO2 released by petroleum diesel was fixed from the atmosphere during the formative years of the earth. But CO2 released by vegetable oils gets continuously fixed by plants and may be recycled by the next generation of crops.
- The carbon cycle time for fixation of CO2 and its release after combustion of petroleum-based fuel can be a few million years, whereas that for vegetable oil is claimed to be only a few years.
- The natural sulfur content of plant fuels is also low (less than 100 ppm) in comparison to that of diesel fuel.

7. Conclusions

The yield of the biodiesel from Table 1 was so low in quantity but a substantial amount of volume was needed as a sample so as to effectively investigate its characteristics hence, the need to blend the biodiesel with conventional petroleum diesel through ratio 10 : 90; that is a B10 (10% biodiesel). From Table 3, it is observed that the viscosity of the coconut oil is very high (43.3 mm2/s). This is consistent with reported results on vegetable oils. High viscosities of pure vegetable oils reduces the fuel atomization and increase fuel spray penetration, which would be responsible for high engine deposits and thickening of lubricating oil that cause injection coking and ring sickening of the engine and therefore compromising the efficiency of the engine. It can also be deduced from Table 3 that the specific gravity of the coconut oil is higher (0.9134) than the conventional petroleum diesel. This indicates that the coconut oil is denser than the No.2 diesel. Also, it is seen from Table 3 that the B10 specific gravity (0.8305) is less than that of the coconut oil (0.9134). It has been reported that, specific gravity has correlations with the cetane number and the heating value of a fuel. Hence, this is an indication that the biodiesel blend is less dense than the coconut oil.

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