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Research Article

Production of biodiesel from (RSO) rubber seed oil and jatropha curcas seed oil (JCSO)

***Imaekhai Lawrence, Okhinoghor I Jim and Airaodion Justice Uwaifo**

Department of Production Engineering, Faculty of Engineering, Ambrose Alli University, Ekpoma, Nigeria

*Corresponding Author E-mail: oboscos@yahoo.com, okhinoghorjim@gmail.com

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Abstract

This work explicitly analyzes experimental investigation of the production of biodiesel from the engagement of rubber seed oil and jatropha seed oil. The seeds were collected separately from Ebudin village in Esan Central local government Area of Edo State, Nigeria where large deposits of these raw materials were discovered. The raw materials light oil content, properties and performance characteristics qualifies their uses as source of energy. The seeds of jatropha curcas and hevea brasilensis (rubber seed) were grinded and extracted using a screw press. The extracted vegetable oil of jatropha curcas and hevea brasilensis were transesterified, tested on unmodified diesel engine, determining its performance on a diesel engine.It was however discovered that transesterified jatropha curcas and rubber seed oils has a better performance in place of petroleum diesel in regards to the exhaust gas emission, speed and power generated of the different fuels.

Keywords: Transesterification, Biodiesel, Production, Rubber seed oil (RSO), Jatropha curcas seed oil (JCSO).

INTRODUCTION

Biodisel is an alternative fuel produced from renewable biological sources. The non edible vegetable oil of both jatropha curcas, rubber seed e.t.c has the potentials of providing viable alternative to diesel fuel (Gubitz *et al*., 2007). Jatropha curcas and rubber seed are both non-edible plants, their seed oil can be used to run diesel engines without requirement changes in design or modification because, they have similar chemical and performance characteristics with that of petroleum diesel (Hairsh *et al.,* 2008).

According to Imaekhai (2000), Jatropha curcas and rubber seeds are perennial crops and their life span last for hundreds of years with constant production of fruits both are renewable source of energy and can be cultivated in massively within the country undermining soil content. These seeds posses' high performance characteristics, good properties and quality oil content which proves their uses as source of energy.

It is therefore imperative to exploits and develops these seeds for variable and cheaper fuel alternatives that will lead to the diversification of the energy sector in Nigeria.

The process of converting vegetable oil into methyl ester is transesterification, where alcohol reacts with triglycerides of fatty acids (vegetable oil) in the presence of catalyst (Iyayi *et al.,* 2007). Jatropha oil them becomes one of the prime non edible sources available in Nigeria. The vegetable oil used for biodiesel production might contain free fatty acids which will enhance saponification reaction as side reaction during the transesterification process (Joseph *et al.,* 2007; Payout *et al.,* 1987; Satish, 2005; Tick 1999)

Vegetable oil has compactable characteristics with the compression Ignition Engine (C.I Engine) systems (Traore *et al.,* 2004). Vegetable oil is miscible with diesel fuel proportionally and can be used as extenders. For example, India highly depends on importation of petroleum crude and two third of its requirements are met through imports (Imaekhai, 2003). The gases emitted by petrol, diesel driven vehicles have an adverse effect on the environment and human health which has been explicit in Nigeria (Imaekhai, 2003).

Biofuels has some advantages over fossil fuels both in technical feasibility of blending with other fuels performance in engine, environmental implications and economically (Vogt *et al.,* 1987).

The government of Nigeria should be committed to the development of biofuels, like straight vegetable oils (S.V.O) ethanol and biodiesel, briquettes or biogas, produced from biological source. Biofuel is a generic name of liquid solid or gaseous fuels.

Biofuel

It's considered carbon neutral, as the biomass absorb roughly the same amount of carbon dioxide during growth as when burnt. Biofuel is a generic name of liquid, solid or gaseous fuel that is produced from biological source, its a product produced from biomass. Biofuel is considered much clean than petrol/diesel alternative (Webster *et al.,* 1989) as also noticed in the course of this work.

Some biofuels currently in use are; Biobutanol**,** Biodiesel**,** Bioethanol**,** Biogas**,** Vegetable oil.

The use of biofuel helps reduce the costs associated with the purchasing fossil fuels such as petrol and diesel. The Biodiesel of Jatropha curcas and rubber seed is a fuel extracted from their seeds and is now being used as substitute for petroleum diesel in most industrialized nations.

BIOBUTANOL

Biomass is also called biobased butanol fuel and a second generation alcoholic fuel with a higher energy density and lower volatility versus ethanol.

BIODIESEL

Biodiesel can be mixed with petroleum diesel in any percentage, from 1-90, which is represented by number following a b for example, B5 is 10 percent biodiesel with 90 percent petroleum and B100 is 100 percent biodiesel. Biodiesel is an alternative fuel formulated exclusively for diesel engines. It is made from vegetable oils or animal fats.

BIOMASS

Biomass is the energy source derived from organic matter. Biomass is derived from plant materials such as wood from the forest, agricultural process, industrial and human or animal waste. Biomass is carbon, hydrogen and oxygen based. Essentially, the use of biomass for energy is the reversal of photosynthesis.

Photosynthesis equation

$$CO_2 + H_2O \underset{\text{Light}}{\overset{\text{Heat}}{\rightleftharpoons}} CH_2O + H_2O + O_2$$

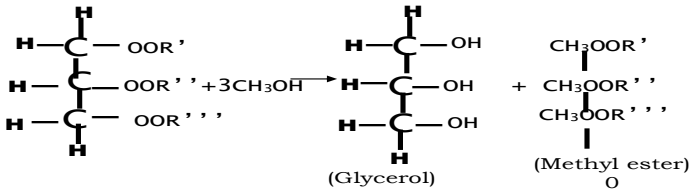
Naturally, biomasses ultimately decomposed to its elementary molecules with heat released. It is the only enable source of carbon and can be processed into convenient solid, liquid and gaseous fuels. Biomass does no contribute global warming. It is the most unique renewable source of energy among all others. In the course of this study, biomass source to be employed that is Jatropha curcas seed and rubber seed, whose oil are substitute for diesel oil known as biodiesel.

Transesterification Reaction

Transesterification is a catalyzed reaction between vegetable oil and alcohol to yield fatty acid alkyl esters (the biodiesel). The main component of vegetable oil is tryglycerides (triacyl glycerols). During this reaction with an alcohol, the three fatty acid chains are released from the glycerol skeleton and combine with the alcohol to yield fatty acids (esters) the bi-product of the reaction is glycerol, the reaction is base catalyzed.

Vegetable oil obtained have good combustion characteristics, it causes serious problems in engines, such as carbon deposits built up, poor durability, high viscosity and lower calorific value. These problems can be overcome by refining the oil with a chemical process called TRANSESTERIFICATON.

Transesterification Reaction Equation



METHOD

The production of jatropha curcas and rubber sees oil includes: the collection and de-husking of seeds, drying of seeds, Grinding of seeds, Extraction of the oil from the seeds, Transesterification process.

Collection of seeds: The jatropha curcas and rubber seed were collected at Ebudin, Edo State. They were separated, de-hustled in other to get access to the cream colour endocarp of both seeds.

Drying of seeds: Collected seeds were sun-dried separately for three weeks in order to reduce the water content of the seeds.

Grinding of seeds: The collected and dried seeds were separately grinded in order to aid extraction of the oil.

Extraction of the oil: Pressed method was employed in extracting the oil, this method is reliable and cheap.

After successful grinding, sieving is done with a cassava screw press machine. The base of the cassava screw press machine is properly sealed with polyethene bag so that the oil extracted will not pour to the ground. The crushed jatropha was put in a baft and placed in a punched pan. The pan was taken to the press and a large wood is placed on top of the filter cloth inside the pan. The crushed jatropha in the filter cloth received the pressure and oil began to extrude out from the cloth to the punched pan into a big collecting bowl. As the pressure is increasing the oil extruding was increasing until it got to a stage where there is no more oil left in the cake (the residue of the crushed seed). The volume of oil extruded from the 6.09kg jatropha seeds was liter.

The same process was carried out for a 2.1kg milled rubber seeds and the volume of oil gotten was 1 liter.

Transesterification Process: 700ml of vegetable oil was heated and expose moisture at a temperature of 75 ± 5^0C for 3 hours. 9g of Naoh was weighted and dissolved in 150ml of methane. When fully dissolved, it was then mixed with dried oil and heated in a laboratory hot plate at a temperature of 100^0C for eight hours (9hr). The mixture is allowed to cool to room temperature and two separate layers are observed in the mixture. The top layer which is methyl ester (Biodiesel) is less dense that glycerin which is at the bottom layer. At the end, of the transesterification reaction, ester are separated and washed three times with distilled water to remove unreacted sodium hydroxide and methanol. The same reaction process is done for rubber seed oil sample.

RESULTS

Performance of Jatropha and Rubber Seed Oil on Diesel Engine Testing

The four stroke single cylinder diesel engine was tested by measuring its speed with loaded with load and when not loaded using tachometer. The exhaust gas were similarly analysed using SV-SQ Automotive Exhaust Gas Analyzer. Three types of fuels were used, which are petroleum diesel, and the transestenfied oil of the seeds of jatropha curcas and levea brasilensis.

Table 1. The analyzer readings without load

Carbon monoxide CO	0.14%
Carbon dioxide CO_2	2.60%
Hydro carbon HC	62ppm
Oxygen O_2	20.30%
Nitrogen monoxide NO	27ppm
Excess Air coefficient	5. 95%

The speed of the engine (N) with Load is 16,231rpm.

Table 2. The analyzer readiness without load

Carbon monoxide CO	0.10%
Carbon dioxide CO2	2.55%
Hydro carbon HC	45ppm
Oxygen O_2	17.84%
Nitrogen monoxide NO	30ppm
Excess Air coefficient (λ)	6.00%

T**able 3**. Results of the Tests Conducted without Load

Diesel contents	100% petroleum diesel	100% Jatropha seed oil	10% rubber seed oil
Carbon monoxide CO (%)	0.24	0.13	0.14
Carbon dioxide CO_2 (%)	3.39	2.69	2.60
Hydrocarbon HC (PPM)	286	54	62
Oxygen O_2 (%)	20.52	20.01	20.30
Nitrogen monoxide No (PPM)	10ppm	27	27ppm
Excel air coefficient (x)	4.74	5.43	5.95
Speed Of Engine (N) in rpm	16,00	18,342	16,231
Power of engine (P) in KW	2.96	33.93	30.02

Table 4. Results of the Tests Conducted with Load

Diesel contents	100% petroleum diesel	100% Jatropha seed oil	10% rubber seed oil
Carbon monoxide CO (%)	0.29	0.15	0.10
Carbon dioxide CO_2 (%)	3.40	2.80	2.55
Hydrocarbon HC (PPM)	290	70	45
Oxygen O_2 (%)	20.01	19.73	17.84
Nitrogen monoxide No (PPM)	15	35	30
Excel air coefficient (λ)	5.52	6.68	6.00
Speed Of Engine (N) in rpm	15,000	16,021	14,112
Power of engine (P) in KW	4.2KW	44.45	39.15

CONCLUSION

In using the three fuels, (petroleum diesel, transesterified jatropha curcas oil and transesterified rubber seed oil), transesterfied jatropha curcas oil has the highest speed and power compared to the other two fuels and also the petroleum fuel has the highest carbon dioxide ($C0_2$) which is a harmful substance than the other transesterified jatropha curcas oil and the transesterified rubber seed oil.

Therefore, it is seen in table 3 and 4, that transesterified jatropha curcas oil and transesterified rubber seed oil have lesser carbon monoxide (Co) than the petroleum diesel.

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