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Production and Performance of Bio Diesel from Cotton Seed and Rice Bran Oil

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ABSTRACT: There is increasing interest in many countries to search for suitable alternative fuels that are environmental friendly. Although straight vegetable oils can be used in diesel engines their high viscosities, low volatilities and poor cold flow properties have laid to the investigation of various derivatives. Bio diesel is a fatty acid alkyl ester, which can be derived from any vegetable oil by Transesterification. Bio diesel is a renewable, bio degradable and non-toxic fuel. Bio diesel made from renewable biological sources such as vegetable oils and animals fats. Object of this work is to optimize experimental conditions for bio diesel production from alkali-catalyzed esterification of oils from renewable plant sources, in this study, cotton seed oil and rice bran oil were trans esterified with methanol using potassium hydroxide as catalyst to obtain cotton seed oil methyl ester and rice bran methylester.

KEYWORDS: Bio-diesel, Rice bran oil, Cotton seed oil, Transesterification, engine performance.

I. INTRODUCTION

The word demand for energy is rapidly increasing .we need energy to cook our meals, to travel and communicate, and to power our factories. The amount of energy available to us determines not only our standard of living, but also how long we live.one of the main energy sources is oil and rate of production is expected to peak in the next few years. There are still plentiful supplies of coal, the other principal energy source, but it is even more because to meet our requirement. Non-renewable fuel emits more hydrocarbons, oxides of nitrogen, sulfur, and carbon mono-oxides, leading to acid rain and climate change. This combination of increasing need a clean energy source that is able to meet word energy needs. This is without doubt the most serious problem facing mankind at present available source energy are: Coal, Petroleum Oil and Gaseous Fuels.

II.RELATED WORK OR BACKGROUND

When Dr. Rudolf diesel demonstrated the first diesel engine at the word exhibition in Paris in 1900, he used 100% peanut oil as fuel. Dr.diesel originally intended that the diesel engine be fuelled by a variety of fuels, including vegetable oil and mineral oil. He promoted the use of vegetable oil as fuel by suggesting that it would greatly benefit the development of agriculture in countries that utilized this potential. The adoption of petroleum- based fuel as the primary fuel for the diesel engine was an arbitrary decision that was largely influenced by the cheaper costs of petroleum at the time. The term, bio diesel, was first introduced in United States during 1992 by the national soy development board (presently national biodiesel board), which has pioneered the commercialization of biodiesel in the USA.The use of biodiesel is nothing new in the United States, but the applicability of biodiesel for large – scale use in private and government fleets is only now beginning to be realized. There are a number of reasons for the growing support of biodiesel. The driving force is, of course, the need to reduce the harmful emissions that result from the burning of petroleum oil as well as our dependence on diminishing reserves of petroleum oil. The ease in which biodiesel can be used as an alternative to regular petroleum diesel

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fuel, along with its economic and environmental benefits, makes it an attractive choice. Biodiesel is a biodegradable, clean-burning combustible fuel derived from new or used vegetable oils or animal fats. Biodiesel meets American society for testing and materials (ASTM) specifications D6751 and is a registered fuel and fuel additive by the U.S environmental agency (EPA). Biodiesel can be used in any internal combustion diesel engine in either its pure form, which is referred to as "neat" biodiesel, or it can be mixed in any concentration with regular petroleum diesel.

COTTON SEED OIL:

Composition: Its fatty acid profile generally consists of 70% unsaturated fatty acids (18% monounsaturated, and 52% polyunsaturated) and 26% saturated fat. When it is fully hydrogenated, its profile is 94% saturated fat and 2% unsaturated fatty (1.5% monounsaturated, and 0.5% polyunsaturated). The cotton seed oil industry claims that cotton seed oil does not need to be hydrogenated as much as other polyunsaturated oils to achieve similar results.



Cotton flower

Cotton plant

Cotton seed

Cotton fiber



Fig: 2.1 Cotton seed oil

RICE BRAN: Rice is a grain belonging to the grass family. It is related to other plants such as wheat, oats and barley which produce grain for food and are known as cereals. Rice refers to two species (*Oryza sativa* and *Oryza glaberrima*) of grass, native to tropical and subtropical south-eastern Asia and to Africa, which together provide more than one-fifth of the calories consumed by humans. The plant, which needs both warmth and moisture to grow, measures 2-6 feet tall and as long. Flat, pointy leaves and stalk-bearing flowers which produce the grain known as rice. Rice is rich in genetic diversity, with thousands of varieties grown throughout the world.



Rice Paddy

Plantation

Rice bran powder

Rice bran

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Fig: 2.2 Rice bran oil

III. SCOPE OF WORK

Some aspects are identified with the present work, and are presented below

1. Need to study on biodiesel from cotton seed and rice bran oil using different catalyst like CaO, CaTiO₃, and MgO.
2. Conduct the experiment on multi-cylinder engine fuelled by both the oils biodiesel and compare with single cylinder engine performance and emissions to know the effect of biodiesel operation in higher rated engines.
3. Performance of bio-fuelled engines can be improved by adding oxygenated fuel additives.
4. More blends of fuel can be brought under investigation
5. Need to study the performance and emission characteristics on modified piston and compare the results with base piston.

IV. METHODOLOGY AND DISCUSSION

The commonly used methods for Bio fuel production are:

4.1 Transesterification:

Transesterification is the chemical reaction between triglycerides and short-chain alcohol in the presence of catalyst to produce mono-ester. The long-and branched-chain triglyceride molecules are methanol, ethanol, propanol and butanol. Methanol is used commercially because of its low price. Among these various conversion methodologies, the transesterification process has become commercial success.

The transesterification is the method of biodiesel production from oils and fats and can be carried out by two ways:-

- (a) Catalytic transesterification
- (b) Supercritical methanol transesterification

4.1.1 Catalytic transesterification:

The “catalytic transesterification” process is the reaction of a triglyceride (fat/oil) with an alcohol in the presence of some catalyst to form esters and glycerol. A triglyceride has a glycerin molecule as its base with three long chain fatty acids attached.

The characteristics of the oil/fat are determined by the nature of the fatty acids attached to the glycerine. The nature of the fatty acids can in turn affect the characteristics of the bio-diesel. A successful transesterification reaction is signified by the separation of the ester and glycerol layer after the reaction time. The heavier, co-product glycerol settles out and may be sold as it is or it may be purified for use in other industries, e.g. the pharmaceutical, cosmetics etc.

[A] Acid catalyzed transesterification:

The acid catalyzed process is the reaction of a triglyceride (fat/oil) with an alcohol in the presence of acid catalyst preferably sulphonic and sulphuric acids to form esters (biodiesel) and glycerol. These catalysts give very high yields in alkyl esters, but the reactions are slow, - requiring, typically, temperatures above 100 °C, the acid-catalyzed

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transesterification should be carried out in absence of water, in order to avoid the competitive formation of carboxylic acids which reduce the yields of alkyl esters.

[B] Alkaline catalyzed transesterification:

The alkaline catalyzed transesterification process is the reaction of a triglyceride (fat/oil) with an alcohol in the presence of alkaline catalyst such as alkaline metal alkoxides and hydroxides as well as sodium or potassium carbonates to form esters (biodiesel) and glycerol. The alkaline catalyzed transesterification of vegetable oils proceeds faster than the acid catalyzed reaction. Due to this reason, together with the fact that the alkaline catalysts are less corrosive than acidic compounds, industrial processes usually favour alkaline catalysts, such as alkaline metal alkoxides and hydroxides as well as sodium or potassium carbonates.

[C] Lipase catalyzed transesterification:

The lipase catalyzed transesterification process is the reaction of a triglyceride (fat/oil) with an alcohol in the presence of lipase enzyme as a catalyst to form esters (biodiesel) and glycerol. In lipase catalyzed process no complex operations are needed not only for the recovery of glycerol but also in the elimination of catalyst and soap. This is an environmentally more attractive option times are still unfavourable compared to the alkaline catalyzed reaction system

4.1.2 Super critical Transesterification:

The simple transesterification processes discussed above are confronted with two problems. i.e. the processes are relatively time consuming and need separation of the catalyst and saponified impurities from the biodiesel. The first problem is due to the phase separation of the vegetable oil/ alcohol mixture, which may be dealt with by vigorous stirring. These problems are not faced in the supercritical method of transesterification. This is perhaps due to the fact that the tendency of two phase formation of vegetable oil/ alcohol mixture is not encountered and a single phase is found due to decrease in the dielectric constant of alcohol in the supercritical state (at 340 c and 43 mpa). As a result, the reaction was found to be complete in a very short time within 2-4 mi. Further, since no catalyst is use, the purification on biodiesel is much easier, trouble free and environment friendly.

Biodiesel production process:

Titration procedure:

1. Measure 1 gram of KOH on scale into a petridish
2. Measure distilled water(1 liter) into 1500ml beaker
3. Pour 1 gram of KOH 1 liter of water
4. Measure 10ml of isopropyl alcohol in a 20ml conical flask
5. Dissolve 1ml of sample oil in isopropyl alcohol
6. Add 2 drops of phenophalein indicator to the above mixture
7. Take a standard burette and fill it with the KOH solution
8. Add the solution in the burette into the conical flask slowly and gently swirl.
9. Record the quantity of solution used from the burette,
10. Repeat the same procedure at least 3 times to get a consistent value for a given sample oil indication of end point after titration.

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Titration



Heating of oil



Separation of bio diesel



Methanol recovery from bio-diesel

1) Titration equation:

$$7.0 + 1 = x$$

X = total catalyst required per litre

Note: the above equations are for 1 liter batches

2) Measure and mix the reactants:

- Measure 500 ml of oil in large mason jar
- Measure 100 ml methanol in a small jar
- Measure the calculated amount of KOH into a petridish
- Dissolve the KOH into the methanol filled jar
- Carefully dissolve the KOH in methanol completely
- Pour the potassium methoxide solution into the large Manson jar containing the oil
- Secure the lid on the Manson jar and make it airtight and use appropriate heating equipment
- Stir the mixture vigorously

3) Separation:

- After the reaction is completed allow the mixture to settle for around 15 to 20 hours.
- Two major products exist: glycerine and biodiesel
- The glycerine phase is much denser than the biodiesel phase and both of them are gravity separated.
- Either the glycerine is drained out from the bottom of the container with appropriate arrangements or the biodiesel can be separated by simply pouring it out from top.

4) Water wash:

- After the biodiesel is separated it is gently washed with warm water 2 or 3 times
- This is done to remove residual catalyst or soaps

5) Drying:

There are several ways to speed up this drying process:

- Increase the amount of air contact with the biodiesel use a larger open topped container.
- Increase the movement of air around the container use a fan to move the air.
- Increase the temperature of the air, warm air can hold more water vapour than cold air.
- Bubbling air through the biodiesel.

Engine emissions: The exhaust of automobiles is one of the major contributors to the world's air pollution problem. Four major emissions produced by internal combustion engines are hydrocarbons (HC), carbon monoxide (CO), oxides of

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nitrogen (NO_x), and solid particulates. One is to improve the technology of engines and fuels so that better combustion Occurs and fewer emissions are generated. The second method is after treatment of the exhaust gases. This is done by using thermal converters or catalytic converters that promote chemical reactions in the exhaust flow. These chemical reactions convert the harmful emissions to acceptable CO_2 , H_2O and N_2 .

TABLE: 4.1Exhaust gas temperature and exhaust emission from engine on different fuel blends of rice bran oil and cotton seed oil

Sl.no	Particulars	diesel	10%	20%	30%	40%	100%
1	Exhaust gas temperature ($^{\circ}\text{C}$)	245	158	153	150	155	159
		340	245	256	250	240	260
		376	338	325	368	342	361
		460	430	434	464	431	477
		655	546	546	555	558	545
2	Carbon monoxide emission (%)	0.51	0.41	0.25	0.56	0.28	0.27
		0.25	0.31	0.30	0.52	0.28	0.28
		0.62	0.51	0.46	0.80	0.53	0.33
		0.32	0.61	0.62	1.24	0.55	0.33
		1.40	0.77	1.01	0.90	0.68	0.66
3	Unburnt hydrocarbon Emission (%)	0.02	0.02	0.02	0.03	0.03	0.03
		0.01	0.02	0.02	0.02	0.03	0.04
		0.03	0.02	0.01	0.02	0.02	0.02
		0.02	0.03	0.02	0.02	0.04	0.03
		0.05	0.07	0.05	0.05	0.06	0.07
4	Nitric oxide emission (ppm)	9	8	15	10	12	9
		44	52	53	57	60	58
		82	71	104	99	93	74
		139	170	162	171	214	177
		218	238	274	256	304	285
5	Nitrogen dioxide emission (ppm)	2.2	3.5	5.6	6.1	4.1	5.0
		3.2	5.3	6.8	8.0	4.7	5.5
		3.5	6.9	9.4	11.8	7.8	6.1
		3.6	15.4	20.02	20.2	10.0	10.4
		25.8	25.4	31.2	26.0	18.3	21.9

Table: 4.2Exhaust gas temperature and exhaust emission from engine on different fuel blends of cotton seed oil:

Sl.no	Particulars	diesel	10%	20%	30%	40%	100%
1	Exhaust gas temperature ($^{\circ}\text{C}$)	245	145	156	150	140	120
		340	238	225	268	242	160
		376	330	334	364	331	261
		460	446	446	455	458	377
		655	536	536	625	424	445
2	Carbon monoxide emission (%)	0.51	0.21	0.20	0.46	0.28	0.27
		0.25	0.20	0.22	0.22	0.28	0.28
		0.62	0.45	0.46	0.50	0.53	0.33
		0.32	0.30	0.28	0.25	0.30	0.33
		1.40	0.35	1.01	0.80	0.68	0.66
3	Unburnt hydrocarbon Emission (%)	0.02	0.01	0.01	0.01	0.02	0.03
		0.01	0.01	0.01	0.01	0.02	0.03
		0.03	0.01	0.01	0.01	0.01	0.02
		0.02	0.02	0.02	0.01	0.02	0.03
		0.05	0.04	0.03	0.04	0.04	0.06

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4	Nitric oxide emission (ppm)	9	6	10	8	11	5
		44	48	45	48	55	45
		82	60	95	98	93	65
		139	130	145	165	208	124
		218	218	256	230	248	235
5	Nitrogen dioxide (ppm)	2.2	2.5	4.3	5.1	2.1	3.0
		3.2	3.3	5.8	6.0	2.2	4.5
		3.5	4.7	4.4	10.8	5.8	4.1
		3.6	12.2	15.05	18.2	8.0	8.4
		25.8	18.4	25.2	16.02	14.3	15.9

IV. EXPERIMENTAL RESULTS

TABLE: 4.1 PERFORMANCE CHARACTERISTICS OF DIESEL FUEL

Sl no	Load (w) Kg	Engine Speed (N) Rpm	Mass of air Consumed (m_a) Kg/hr.	Mass of fuel consumed (m_f) Kg/hr.	Air Fuel Ratio	Brake Power (BP) KW	Indicated power (IP) KW	η_{mech} %	η (BTE) %	η (ITE) %	BSFC Kg/kw-hr	ISFC Kg/kw-hr
1	0	1510	0.49	0.46	1.07	0	1.25	0	0	22.75	0	0.368
2	4	1501	0.35	0.50	0.69	0.97	2.22	43.69	16.24	37.17	0.519	0.227
3	8	1485	0.29	0.70	0.41	1.92	3.19	60.82	22.96	38.15	0.361	0.221
4	12	1470	0.25	0.85	0.28	2.85	4.16	69.95	28.07	40.97	0.294	0.208
5	16	1435	0.29	1.18	0.24	3.71	5.13	75.63	26.32	36.39	0.306	0.240

Table: 4.2 Performance characteristics of 100% cotton seed bio diesel

Sl no	Load (w) Kg	Engine Speed (N) rpm	Mass of air Consumed (m_a) Kg/hr.	Mass of fuel consumed (m_f) Kg/hr.	Air Fuel ratio	Brake Power (BP) Kw	Indicated power (IP) KW	η_{mech} %	η (BTE) %	η (ITE) %	BSFC Kg/kw-hr	ISFC Kg/kw-hr
1	0	1519	26.6	0.39	68.2	0	2.00	0	0	46.11	0	0.195
2	4	1512	26.0	0.47	55.3	0.95	2.95	32.20	18.17	56.44	0.495	0.159
3	8	1498	25.5	0.66	38.6	1.88	3.88	48.45	25.61	52.86	0.351	0.170
4	12	1471	24.7	0.86	28.7	2.77	4.77	58.07	28.96	49.87	0.310	0.180
5	16	1453	25.1	0.94	26.7	3.65	5.65	64.62	34.92	54.05	0.257	0.166

Table: 4.3 Performance characteristics of rice bran oil's B40 fuel

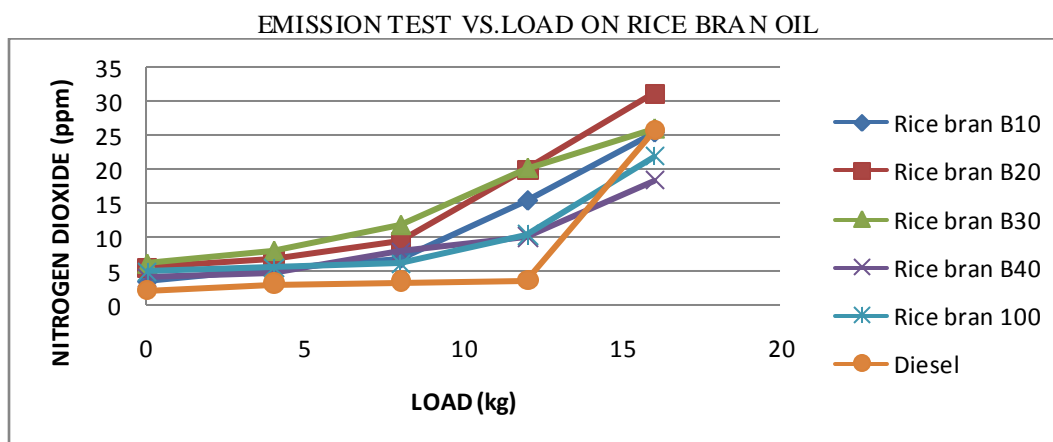
Sl no	Load (w) Kg	Engine Speed (N)	Mass of air Consumed (m_a)	Mass of fuel consumed (m_f)	Air Fuel Ratio	Brake Power (BP) kw	Indicated power (IP) Kw	η_{mech} %	η (BTE) %	η (ITE) %	BSFC Kg/kw-hr	ISFC Kg/kw-hr
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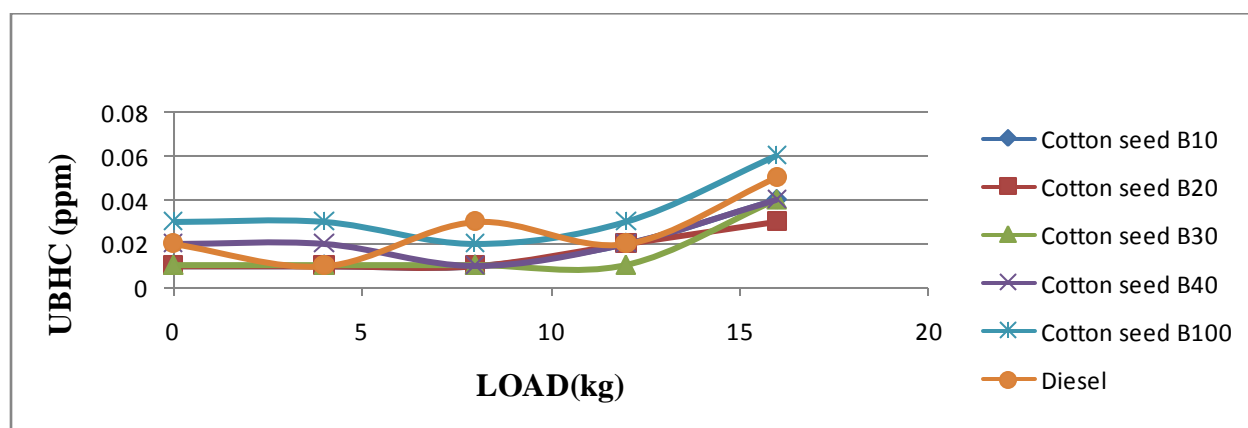
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			Kg/hr.	Kg/hr.								
1	0	1519	26.38	0.388	67.98	0	1.64	0	0	36.31	0	0.236
2	4	1507	26.18	0.492	53.21	0.92	2.56	35.93	16.06	44.70	0.534	0.192
3	8	1493	25.89	0.642	40.33	1.84	3.48	52.87	24.62	46.58	0.348	0.184
4	12	1478	25.15	0.806	31.20	2.73	4.37	62.47	29.09	46.59	0.295	0.183
5	16	1452	24.73	1.085	22.79	3.58	5.22	68.58	28.34	41.33	0.289	0.207



Graph: 4.1 Nitrogen Dioxide Emission from the Engine at different BrakeLoad on different Fuel Types

EMISSION TEST VS.LOAD ON COTTON SEED OIL



Graph: 4.2Unburnt hydrocarbon Emission from the Engine at different load on differentblends

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V.CONCLUSIONS

The exhaust gas temperature of the engine on all the blends of methyl ester of cotton seed oil bio-diesel was found to be lower than that of diesel at different load. The emission of carbon monoxide from the engine was found to be lower on all the blends of methyl ester of rice bran oil – diesel compared to diesel at different load. The emission of unburnt hydrocarbon from the engine was found to be lower than that of diesel at different load. And NO_x from the engine found to be higher on the 20%, 30%, 40% blends as compared to diesel.

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