Karanja Oil as an Alternative Fuel for Direct Injection CI Engine- A Review

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Abstract: ***An ever increasing demand of fuels has been a challenge for today's scientific workers. The fossil fuel resources are dwindling day by day. Biodiesel seem to be a solution for future. It is an environmental viable fuel. There is various types of raw material like Jatropha curcus L, Pongamia Pinnata (Karanja), Moha, Undi, Castor, Saemuruba, Cotton seed etc. An non- edible oil seeds and Various vegetable oils including palm oil, soybean oil, sunflower oil, rapeseed oil and canola oil have been used to produce biodiesel fuel and lubricants. In this paper a karanja oil is used as raw material to produce a biodiesel also in this paper the properties of karanja oil ,biodiesel formation process, economics of karanja oil and there result in which the it is used as fuel for CI engine are described***.

Keywords: karanja oil, transesterification, performance, properties.

1. Introduction

Biodiesel is a renewable fuel produced from vegetable and animal fats that can be used in diesel engine with little or no modification. Biodiesel is typically blended with diesel fuel Biodiesel can also be used in its pure form (B-100), but it may require engine modifications to avoid maintenance and performance problems. Biodiesel is gaining more and more importance as an alternative fuel due to the depletion of petroleum resources and price hike of petroleum products. Biodiesel produced from various edible (groundnut, rapeseed, castor, soybean, sun flower) and non-edible (karanja oil, cotton seeds, jatropha etc) vegetable oil.[14]

1.1 Why Pongamia pinnata?

Due to pressure on edible oils like groundnut, rapeseed, mustard and soybean etc. non-edible oil of jatropha curcas and karanja (PongamiaPinnata) are evaluated as diesel fuel. Pongamia pinnata is a species of family Leguminasae, native in tropical and temperate Asia including part of India, China, Japan, Malaysia, and Australia. Commonly it is called as karanja (in MS).

Uses: The total karanja tree has got excellent medicinal properties.

Wood: Karanja is commonly used as a fuel. Its wood is susceptible to insect attack, so wood is not considered as quality timber. But it may be used in agricultural implements, tools and combs.

Oil: A thick yellow – orange to brown oil is extracted from seed. About 24% of yield is obtained by mechanical expeller. The oil has bitter test and disagreeable aroma, so it is considered as a non edible one. In our country this oil can be used as a fuel for cooking and lamps. Also oil is used as lubricant, pesticide and in soap making industries. The oil has medicinal value in the treatment of rheumatism and in skin diseases.

Leaves: Leaves can be used for anthelmintic, digestive, and laxative, for inflammations, piles and wounds. Their juice is used for colds, coughs, diarrhea, dyspepsia, flatulence, gonorrhea, and leprosy. The fresh leaves are eaten by cattle and by goats in arid regions.

De oiled Cake: It constitutes flavonoids, uranoflavonoids, and furan derivatives and is used in treating skin diseases and in bio pesticide. The meal cake can be used as fertilizer, pesticide and used for organic farming. Seed shells can be used as combustibles.

Kernel: It is used for oil extraction and the oil can be used as fuel, soap production, insecticide and medicinal use.

Root and bark: (as alexipharmic, anthelmintic) used for abdominal enlargement, ascites, biliousness, diseases of the eye, skin, and vagina itch, splenomegaly, tumors, ulcers and wounds as cleaning gums, teeth and ulcers.

Fruit hull: It can be used as green manure, biogas production and combustibles. Oil cake can be used as fertilizer and combustibles.

1.2 What is karanja Oil?

Karanja Oil: It belongs to the family leguminaceae, commonly known as *Pongamia Pinnata*. Other name of karanja oils are pongam oil or honge oil. Pongamia is widely distributed in tropical Asia. The tree is hardy, reasonably drought resistant and tolerant to salinity. It is attractive because it grows naturally through much of arid India, having very deep roots to reach water, and is one of the few crops well-suited to commercialization by India's large population of rural poor.

The karanja tree is of medium size, reaching a height of 15-25 meters. The tree bears green pods which after some 10 months change to a tan color. The pods are flat to elliptic,5-7 cm long and contain 1 or 2 kidney shaped brownish red kernels. The yield of kernels per tree is reported between 8 and 24 kg. The composition of typical air dried kernels is: Moisture 19%, Oil 27.5%, and Protein 17.4%. The oil content varies from 27%-39% [8].

1.3 Production of biodiesel through Transesterification reaction

The tranesterification process is the reaction of triglyceride (fat/oil) with an alcohol in the presence of acidic, alkaline or lipase as a catalyst to form mono alkyl ester that is biodiesel and glycerol. However the presence of strong acid or base accelerates the conversion. It is reported that alkaline catalyzed transesterification is fastest and require simple set up therefore, in current study the oil of pongamia pinnata were transesterified with methyl alcohol in presence of strong alkaline catalyst like sodium hydroxide or potassium hydroxide in a batch type transesterification reactor 20,21 The transesterification reaction is given below 22 this process has been widely used to reduce the high viscosity of triglycerides [11].

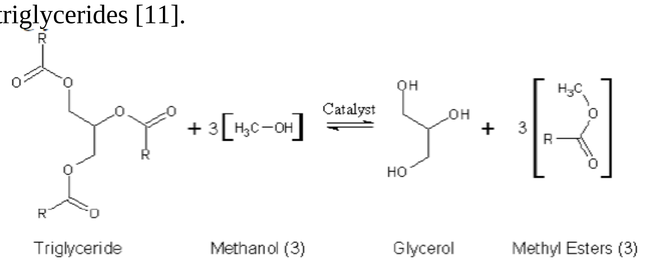

Figure 1: R1, R2, and R3 in this diagram represent long carbon chains that are too lengthy to include in the diagram

To prepare biodiesel from pongamia crude oil first sodium hydroxide was added in to the methyl alcohol to form sodium methoxide, simultaneously oil was heated in a separate vessel of tranesterifaction reactor and subjected to heating and stirring. When temperature of oil reached at 60oC then sodium methoxide was mixed in to the oil and reaction mixture was stirred for one and half hour. After reaction completion, the reaction mixture was transferred in separating funnel. The mixture of glycerol and methyl ester was allowed to settle for 8 hours. After settling for 8 hours glycerol and methyl esters was separated manually. The methyl ester was the washed with hot water to remove traces of sodium hydroxide impurity. The washed biodiesel then distilled to remove moisture and final good quality biodiesel was subjected for chemical analysis [8].

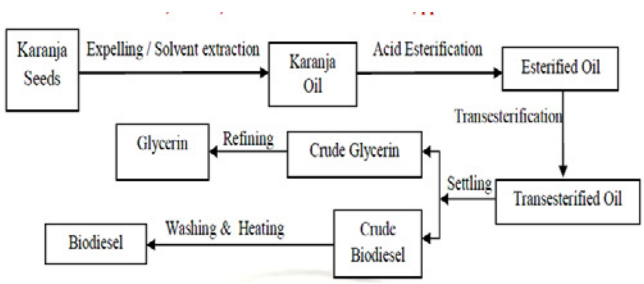

Figure 2: Schematic diagram of production of biodiesel from the karanja seeds

Table 1: Properties of Karanja oil and its biodiesel

Sr. No	*Property*	*Unit*	*Karanja oil*	*B100*
1	Density in gm/cc	Gm/cc	.926	.905
2	Viscoty (at 40oC)	Cst	41.8	8.9
3	Flash point	oC	225	150
4	Calorific value	KJ/Kg	30075	36120.3

1.4 Economics of biodiesel (karanja oil)

The cost of biodiesel produced from karanja and neat diesel are compared to find the suitability of Karanja (non-edible oil) biodiesel as an alternative fuel to diesel. The yield of karanja seeds for 1000 trees planted at the boundary (10% of area) of 1 hectare field is 1000 kg., with a yield of 250 kg of oil and 750 kg of oil cake. (Remaining 90% area i.e. 0.9 hectare can be used for regular farming). The cake can be used as manure which is equivalent to 325 kg of urea. If wasteland is used for plantation of karanja, then 10,000 kg of seeds are obtained giving 2500 kg of oil and 7500 kg of oil cake per hectare. At the current market price this will give an income of Rs.60, 000 ($ 1225) per hectare. Considering yield of 25% oil from karanja seeds and 4 kg of seeds are required to produce 1 kg of biodiesel, a comparison of the cost of karanja biodiesel is given in Table below for different cost of seeds. From the table it is clear that the cost of biodiesel obtained from karanja oil is much less than that of petroleum diesel. Hence biodiesel of karanja can be a good [2] substitute to diesel leading to savings in foreign exchange for importing and generating employment.

Table 2: Comparison of cost of biodiesel (karanja oil) and diesel

S. No	*Details cost in $/ Case*	*I*	*II*	*III*
1	Cost of Karanja seeds/kg	0.122	0.163	0.204
2	Cost of 4 kg of seeds	0.488	0.652	0.816
3	Expelling charges for 4 kg seeds	0.122	0.122	0.122
4	Processing charges for 4 kg seeds	0.163	0.163	0.163
5	Total (2+3+4)	0.773	0.937	1.101
6	Cost of cake @0.1$/kg, for 3kg	0.3	0.3	0.3
7	Cost of glycerol ($) @1$/kg, for 0.122 kg	0.122	0.122	0.122
8	Net cost of biodiesel/kg {5-(6+7)}	0.351	0.515	0.679
9	*Current market price of diesel/kg	0.96	0.96	0.96

* Rates as on January 2009

Four techniques can be used to reduce the viscosity of vegetable oil are as follows;

1. Heating
2. Transesterification with alcohol
3. Blending with diesel or alcohol
4. Micro-emulsion

2. Literature Review

Avinash Kumar Agrawal and K. Rajamanmohan [7], conducted experimental investigation of performance and emission of karanja oil and its blend(10%,20%,50% and 75%) visa-vis mineral diesel in a single cylinder agricultural diesel engine. In this study physical and thermal properties of karanja oil were evaluated. Author conducted two set of experiment, one set for unheated and second for preheated fuel samples. Without preheating set of experimentation shows higher brake thermal efficiency except B100 and BSFC up to 50% was lower than diesel .pre-heating set of experimentation shows higher brake thermal efficiency and lower BSFC for all blends as compared with diesel fuel. BSFC for unheated and heated karanja oil were lower and exhaust gas temperature was generally higher than diesel for all blends. NOx emission was found to be less as compared with diesel for both set oil.

Y.C. Sharma et al 2008 [8] In this paper he studied about the development of biodiesel from karanja tree, mainly found in rural India has been investigated. The biodiesel was developed from oil expelled from the seeds of the tree. Molecular weight of the oil was determined and found to be 892.7. Both the acid as well as alkaline esterification was subsequently performed to get the final product. NaOH was found to be a better catalyst than KOH in terms of yield. Maximum yield of 89.5% was achieved at 8:1 molar ratio for acid esterification and 9:1 molar ratio for alkaline esterification, 0.5 wt. % catalyst (NaOH/KOH) using mechanical stirrer.

Sudipta Choudhury et al 2007 [9] in this paper he presents the suitability of Pongamia Pinnata (karanja) as a source of renewable fuel substituting petro diesel in CI engine. physical and chemical properties of karanja oil suggest that it cannot be used directly as CI engine fuel due to higher viscosity, density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposits in combustion chamber. Based on engine emission studies i.e. CO, NOX and hydrocarbon, we can say that all the parameters are within maximum limits that conclude safer use as an alternate fuel. The straight karanja oil blend up to 25% with the petro diesel meets the standard specification. However blending of this oil with petro diesel up to 20% (by volume) can be used safely in a conventional CI engine without any engine modification that could help in controlling air pollution.

3. Experimental Set-Up Description

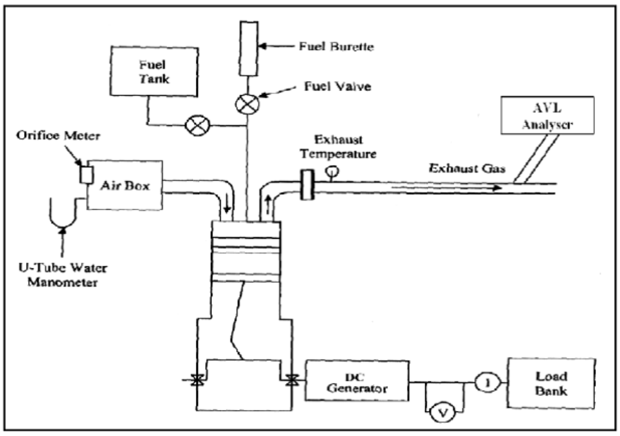

Figure 3: Experimental setup

4. Result

The many researcher work on the karanja oil and they found some result as shown in following graph. Brake thermal efficiency of Karanja oil methyl ester found lower than that with diesel fuel. However thermal efficiencies of Blends up to B-20 were very close to diesel. Volumetric efficiency for diesel and Karanja methyl ester blends was constant at different BP since the injection pressure of single cylinder diesel engine was constant.(12) BSFC was found to increase with increase in blend proportion as compared to diesel fuel in the entire load range. Karanja methyl ester (biodiesel) and Diesel were analyzed for physical and chemical properties given in Table 1. Higher viscosity is a major problem in using vegetable oil as fuel for diesel engine. In the present study, viscosity was reduced by esterification followed by tranesterification from 41.8cst to 8.9cst

Engine load V/S Volumetric Efficiency

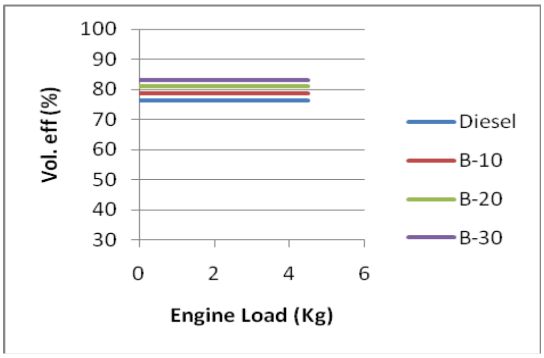

Figure 4: Engine load V/S Volumetric Efficiency

Engine load V/S BSFC

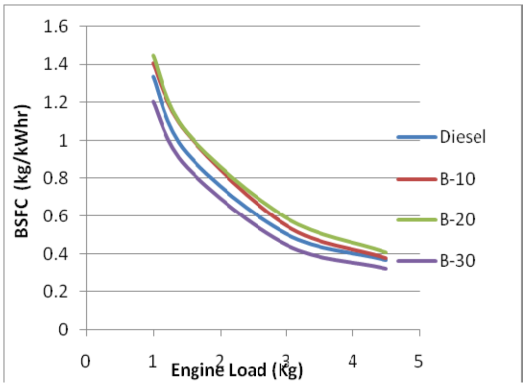

Figure 5: Engine load V/S BSFC

Engine load V/S BTE

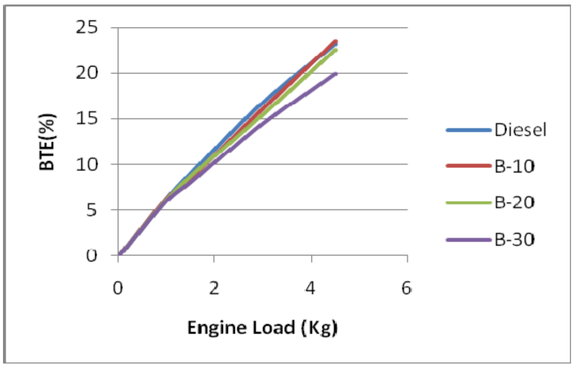

Figure 6: Engine load V/S BTE

5. Conclusion

Biodiesel use could preserve the environmental air quality by decreasing harmful emissions released by regular diesel fuel. Biodiesel are produce locally, which decreases the nation's dependence upon foreign energy and can employ hundreds or thousands of workers, creating new jobs in rural areas and crop cultivation of biodiesel plants will boost the rural economy. In this paper we study the properties of karanja oil, transesterification process, properties and result of karanja oil as an alternative fuel for CI engine. So we can conclude that the karanja oil can be used as an alternative fuel for diesel engine.

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