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Production & Evaluation of Biodiesel from Karanja Seeds, A Seed Plentily Available In Rural Odisha

Bibhuti B. Samantaray[1], Dibyajyoti Giri[2], Ranjit K. Behuria[3], Abhisek Samantray[4], Debasish Rath[5], Nihar R. Sahoo[6]

(Department of Mechanical Engineering, the Techno School, BPUT, Bhubaneswar-19, India)

ABSTRACT: *Energy is playing an important role in the development of economy and society both in developed and developing countries. As concern to the environment & vehicular population lead toward fuel crisis there is a trend begin to look for the alternative energy source which are more secure & less pollute. This paper is about the renewable source of Energy i.e. Biodiesel which is more secure & less pollutant as compared to fossil fuel (Diesel). This paper represent the biodiesel production from the Karanja oil which is plentily available in rural Odisha. We have set up a low cost experimental set up in which we have used the transesterification process to produce the Biodiesel and we have found out that the overall quality of the Biodiesel is optimum and satisfactory. The conversion of Crude Karanja oil to biodiesel in our experiment is around 3570 ml out of 5000 ml, which shows a good agreement in the other literature regarding the Biodiesel Production. Also in this paper we have focused on the crude glycerol formation as a byproduct and its utilization. The experiment has been conducted in a controlled environment where the temperature was around 63-67℃ and it has lasted around 92-95 min per experiment with the help of the catalyst KOH and MeOH in the proportion of 6:10 and 8:10 respectively.*

Keywords: *Bio Diesel, Catalyst, Esterification, Glycerol, Karanja Oil.*

I. Introduction

In 1895 Rudolph Diesel himself predicted that "the use of vegetable oil engine fuels may seem insignificant today. In course of time such oils may become as important as petroleum and the coal products of the present time". Due to increase in population & standard of living the demand & consumption of petroleum product is increase day by day. Hence biodiesel is the alternate coming in the way it used in any unmodified diesel engine. Vivek and A.K. Gupta [1] have studied the production of Biodiesel and they found out it has similar properties as diesel it can be also blend with diesel. Vismaya *et al* [2] has found out that the recent depletion and fluctuation in prices due to uncertain supplies for fuel, make us to search on renewable, safe and non-polluting sources of energy and reported that the vegetable oil also may used as direct fuel without refining but it make some problem. India is not self sufficient in petroleum and has to import about two third of its requirements from outside. P.K. Srivastava and Madhumita Verma [3] reported that Presently Indian government spends 90,000 cores for petroleum fuel and annual consumption is around 40 millions tons. One of the solutions is to explore the feasibility of substitution of diesel with an alternative fuel which can be produced in our country on a massive scale to commercial utilization. P.K. Sahoo and L.M. Das [4] described in their paper that India is a net importer of edible oil, hence the emphasis is on non-edible oils from plants such as Jatropha, karanja, neem, mahua, simarouba, etc. out of these plants, and Jatropha and Karanja have shown promise for biodiesel production. K.V. Thiruvengadaravi *et al* [5] said that In India the karanja trees are found in almost all rural areas. Its botanical name is “Pongamia Pinnata” of Leguminaceae family. It can grow in humid & subtropical condition having rainfall of 500-2000mm. Avinash K. Agarwal and K.Rajamanoharan [6] found that the karanja pod are of green in color at the beginning but after about 9-10 months it changes to tan color .The pods are elliptical, about 6 cm long of kidney shapes the kernels are white in color covered by a red skin with yield of 10-20 kg per tree The seed contain 29% oil, protein 18% & moisture 20%. In India production of karanja is approximately 220 million ton per annum. Malaya Naik *et al* [7] found that karanja oil is nonedible, nontoxic, biodegradable fuel. The karanja trees get most suitable condition for growth is in India in rural areas. The seeds are crushed in the expeller to get the oil. Y.C. Sharma and B Singh [8] have found that It basically contain chromanoflavones, chromencontin, furanoflavonols, furranodiketons which make it non edible & use of biodiesel. H. Raheman and A.G. Phadatare [9] found thatTransterification process is the main process of biodiesel production. In this process triglyceride oils are converted under heat to methyl or ethyl esters and glycerin by alcohol and a strong base catalyst.

Karanja oil + Potassium Methoxide $\longrightarrow$ Methyl ester + Glycerin

In Transesterification process triglyceride oils are converted under heat to methyl or ethyl esters and glycerin by alcohol and a strong base catalyst. v mamila *et al* [10] have studied that the main factors are the amount of the catalyst and alcohol, reaction temperature, pressure and time, as well as the content of free fatty acid (FFA) and water in oils by. Transesterification process is also called Alcoholysis, because it is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis, except than alcohol is used instead of water. Md. Nurun Nabi *et al* [11] have found that Biodiesel was produced by acid Esterification followed by Transesterification process due to high FFA concentration in the karanja oil. For acid esterification h_2so_4 was used as catalyst. For base catalyzed Transesterification process methanol was used as alcohol and NAOH was used as lye catalyst. Instead of methanol and NAOH, ethanol or KOH can also be used for making biodiesel. L.M. Das *et al* [12] describe that Methanol and NAOH were used for lower cost and higher conversion efficiency. Karanja oil were filtered and preprocessed to remove water and contaminants, during alkaline (base catalyzed) Transesterification. Sara Pinzi *et al* [13] studied that Different ratios of methanol to oil were investigated for low acid value of less than 2mg KOH/g-oil and low FFA concentration of less than 1%. For acid pretreatment a round flask was used. A hot plate with a magnetic stirrer was used for heating the mixture in the flask. The karanja oil was taken into the flask and heated. H.J.Berchmans and S. Hirata [14] have found that Then methanol and 1% H_2SO_4 were added to the flask and heated continuously for an hour. It reported that for complete FFA esterification in some vegetable oils, the reaction temperature has been set to 50 °c, the reaction time 1 h and the acid to oil ratio 1% w/w. During heating and stirring the mixture, acid value and FFA concentration were tested. The FFA concentration should less than 1% so alkalized Transesterification was conducted with pretreatment karanja oil. H. Sharon *et al* [15] have studied that it was expected to get maximum biodiesel when the acid value was less than 2mg KOH/g-oil and the FFA concentration in karanja oil was less than 1% using base catalyzed Transesterification. For base catalyzed Transesterification, different parameters including catalyst to oil ratio (w/w), methanol to oil hg (w/w), and the reaction temperature were investigated. But in this paper we have studied and produced the Biodiesel as well as Crude Glycerol form the Karanja seed, a seed plentily available in rural Odisha in a low cost experimental set up and studied the fuel characteristic and done the emission testing.

II. Experimental Set Up and Procedure

2.1 Experimental setup**:** A schematic of the experimental set-up used for the production of Glycerol is shown in Fig.1. The Experimental setup consists a heating device, a stirrer, a motor, a thermo meter, beaker, separating funnel, washing unit, diffuser unit and chemical unit. A metal frame is being used for holding up the motor and separating funnel at the same time. The crude Karanja oil is kept in the beaker and being heated by the heater with a controlled environment. A stirring rod is dipped into the solution of Karanja oil and the other chemical mixture like MeoH and KoH. The equipment like Beaker, Stirring rod, Separating Funnel, Conical Flask are made up of high resistance Glass Material. The stirrer is rotated by an electric motor of variable RPM ranging from 200 rpm to 600 rpm. A temperature measuring device i.e. thermometer is dipped in the solution for continuous temperature measurement. The beaker is covered with a glass cover to prevent reactant loss as alcohol being volatile vaporized during the reaction so it is necessary to prevent it from vaporizing. Separator is used to separate the glycerol from biodiesel after transesterification process.

2.2 Experimental procedure**:** Karanja oil is being produced from Karanja seeds through crushing in the expeller. Initially 500ml of Karanja oil was taken inside the beaker. At first it heated at 63-67℃ for the removal of moisture. The oil was then cooled down. The transterification process was carried out in a basic medium to achieve it. Here we used KOH as catalyst. The required amount of catalyst 25gm KOH taken and dissolved completely in 100 ml of pot methanol by using stirrer provided in the potassium methoxide. The alkali methoxide solution added into the oil for vigorous mixing by means of a mechanical transterification vessel. The free fatty acids cloudy looking is called glycerin, It sink to the bottom and the methyl ester- a translucent liquid, will remain on top. The required temperature of 63-67^{0}C was maintained throughout the reaction time of 92-95 minutes by means of controlled environment. The reacted mixture was then poured into the separating funnel. The mixture was allowed to separate and settle overnight by gravity into a clear liquid biodiesel on the top with light brown glycerol at the bottom. The next day, the glycerol was drained off from the separating funnel leaving the bio-diesel at the top. The raw bio-diesel was collected and water washed to bring down the pH of bio-diesel to 7. This pure bio-diesel gives the ester yield measured on weight basis and important fuel properties were determined and compared with the properties of raw oil and BIS standards for biodiesel. Transterification was done at boiling point of mixture as that is the highest temperature achievable at normal condition. To increase the contact surface area reactants are agitated using stirrer. Hence stirrer rod also enhance the reaction rate.

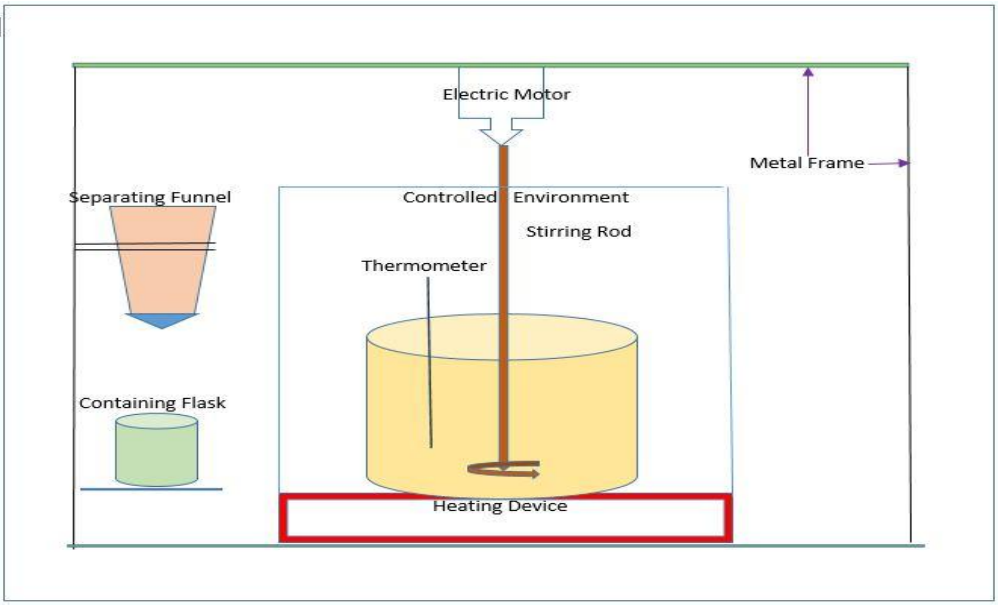

Figure.1. Schematic of the experimental setup

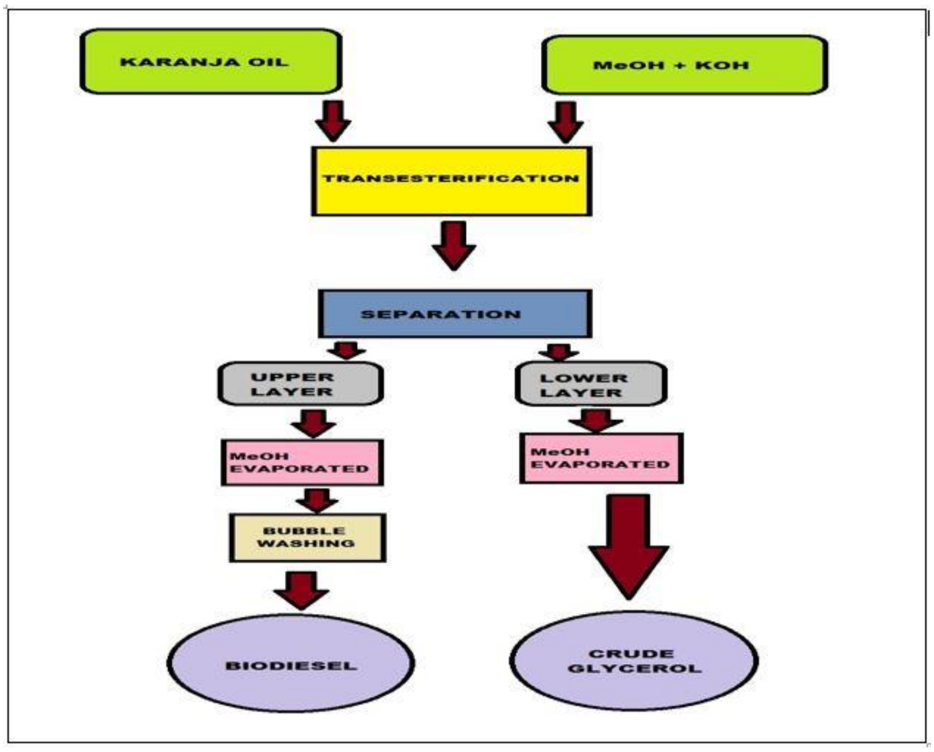

Figure 2. The Detailed Biodiesel Production Process.

III. Results and Discussion

We have conducted the experiment in the above mentioned process and environment for several times to get more precession. The characteristic of the Biodiesel and the emission studies has been described below after testing.

3.1 Characteristics

After the esterification process we obtained around 3570 ml of biodiesel from 5000 ml of Karanja oil in the proportion 714 ml biodiesel from 1 liter of karanja oil. We found that color of biodiesel is turn to reddish yellow & kinematic viscosity of karanja oil was found nearly 10 times more than biodiesel at 50^0c. After esterification, the kinematic viscosity reduced to 3 times than that of pure karanja oil. Increase in diesel amount decrease the viscosity in the blend. The calorific value of biodiesel was found to be 35.88 MJ/kg, which is less than the calorific value of diesel (42.21 MJ/kg) and greater than crude Karanja oil (34 MJ/kg). As flash point is found to be more than 100^0c. Here Different property of the diesel and karanja oil are compared with the biodieel in the table given below.

Property	Diesel	Karanja oil	Biodiesel
Density (kg/m^3)	840	865	850
Viscosity (c. stokes)	3.8	5	2.8-5.1
Specific gravity	0.85	0.87	0.85
Heating value (kj/kg)	42000	36000	38285
Flash point(^{0}c)	60	208	130
fire point(^{0}c)	67	238	138

3.2 Emission Studies:

3.2.1. No_x Emission

The amount of NO_x produced for B20 to B100 varied between 5 and 12 ppm as compared to 12 and 13 ppm for diesel. As compared to diesel 26% reduction in NO_x was obtained from its blends the reductions in emissions occurs generally from the complete combustion of fuel.

3.2.2. Carbon Monoxide

The diesel engine run using blends B10 to B100 have produced variation of Carbon Monoxide. The minimum and maximum CO produced were 0.005 %, 0.016% resulting in a reduction of approximately 92%and 75%, respectively as compared to diesel.

3.2.3. Smoke density

The smoke density produced during the test of fuels as per B20 to B100 were 0.8% and 3.2% with a maximum and minimum reduction of approximately 80% and 20% respectively as compared to diesel.

3.2.4. Exhaust Temperature:

The exhaust temperature for fuels in B20–B100 is measured varied between 250◦C and 320◦C as compared to 260◦C and 340◦C for diesel which is nearly same. So the exhaust heat is constant through the load range process.

IV. Conclusion

- It is confirmed that karanja oil also can used as a product for biodiesel which is used as a fuel in diesel engine as the replacement or supplementary fuel.
- The fuel properties as viscosity, density, flash point, fire point and calorific value of the biodiesel is compared with diesel which is found nearly same.
- It is found that in biodiesel blends emissions such as Carbon monoxide, smoke density and NO_x on average of 85%, 50% and 28%, respectively.
- It was found that 40% volume of biodiesel blends with diesel can be crude diesel which can be used in the diesel engine. Using the nonedible oil like karanja will surely improve the economics of the biodiesel formation process.

REFERENCES

[1] Vivek and A.K Gupta, Production Biodiesel From Karanja Oil, Journal of scientific& Indian research, Volume 63, 2004, 39-47.

[2] Vismaya, W.Sapna Eipesona, J.R .Manjunatha, P. Srinivas and T.C. Sindhu Kanya, Extraction And Recovery Of Karanjin: A Value Addition To Karanja (Pongamia Pinnata) Seed Oil, Industrial Crops and Products, 32, 2010, 118– 122.

[3] P.K. Srivastava and Madhumita Verma, Methyl Ester Of Karanja Oil As An Alternative Renewable Source Energy , Fuel 87, 2008, 1673–1677.

[4] P.K. Sahoo and L.M. Das, Process Optimization For Biodiesel Production From Jatropha, Karanja And Polanga Oils, Fuel 88, 2009, 1588–1594.

[5] K.V. Thiruvengadaravi, J. Nandagopal, P. Baskaralingam ,V. Sathya Selva Bala and S. Sivanesana, Acid-Catalyzed Esterification Of Karanja (Pongamia Pinnata) Oil With High Free Fatty Acids For Biodiesel Production, Fuel 98, 2012, 1–4.

[6] Avinash Kumar Agarwal and K.Rajamanoharan, Experimental Investigations Of Performance And Emissions Of Karanja Oil And Its Blends In A Single Cylinder Agricultural Diesel Engine, Applied Energy 86, 2009,106-112 .

[7] Malaya Naik, L.C. Meherb, S.N .Naik and L.M.Das, Production of Biodiesel from High Free Fatty Acid Karanja (Pongamia Pinnata) Oil, Biomass& Bioenergy, 2008, 354 – 357.

[8] Y.C. Sharma and B Singh, Development Of Biodiesel From Karanja, Tree Found In Rural India, Fuel 87, 2008, 1740–1742.

[9] H. Raheman and A.G. Phadatare, Diesel Engine Emissions & Performance From Blends Of Karanja Methyl Ester And Diesel, Biomass and Bioenergy 27, 2004, 393 – 397.

[10] Venkata R. Mamilla, M. V. Mallikarjun, Dr. G.Lakshmi and N. Rao, Preparation Of Biodiesel From Karanja Oil, International Journal of Energy Engineering, DOI 10.5963/IJEE0102008.

[11] Md. Nurun Nabi , S.M. Najmul Hoque and Md. Shamim Akhter , Karanja (Pongamia Pinnata) Biodiesel Production In Bangladesh, Characterization Of Karanja Biodiesel And Its Effect On Diesel Emissions, Fuel Processing Technology, 90 ,2009, 1080–1086.

[12] L.M. Das, Dilip K. Bora, Subhalaxmi Pradhan Malaya K. Naik and S.N. Naik, Long-Term Storage Stability Of Biodiesel Produced From Karanja Oil, Fuel, 88, 2009, 2315–2318.

[13] Sara Pinzi , Paul Rounce , Jose M. Herreros, Athanasios Tsolakis and M. Pilar Dorado, The Effect Of Biodiesel Fatty Acid Composition On Combustion And Diesel Engine Exhaust Emissions, Fuel, 104 2013, 170–182.

[14] H.J.Berchmans and S. Hirata, Biodiesel Production From Crude Jatropha Curcas Seed Oil With High Content Free Fatty Acids, Bioresource Technology 99, 2008, 1716–1721.

[15] H. Sharon, R. Jayaprakash, M. Karthigai selvan, D.R. Soban kumar, A. Sundaresan and K. Karuppasamy, Biodiesel Production And Prediction Of Engine Performance Using SIMULINK Model Of Trained Neural Network, Fuel 99 ,2012,197–203.