Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development
Volume 4, Issue 2, February -2017

Production of Karanja Biodiesel by Ultrasonic Technique

[1]Jayesh B Galchar

[1]Lecturer, Mechanical Engineering Dept. Govt. Polytechnic Rajkot, India[1]

ABSTRACT- *Due to the limited conventional fossil fuels, it has become necessary to find alternative clean and renewable energy resources. Biodiesel is a liquid fuel consisting of mono alkyl esters (methyl or ethyl) of long chain fatty acids derived from vegetable oils or animal fats or micro and macro algal oil. It is a kind of bio- energy as a substitute for conventional petrol diesel fuel. Recently, the production of biodiesel has been increased due to some crucial reasons such as the rise in crude oil price, limited resources of fossil oil, and pollution reduction. This thesis presents an assessment of the alternative technological methods that could be used to produce this fuel. Biodiesel from karanga oil was produced by alkali catalyzed transestrification using ultrasonic technique. However, the production process faces many drawbacks related to the immiscible nature of the reactants and the presence of free fatty acids in the desired oil. Several approaches have been proposed but only to a limited success. Heterogeneous catalysts which are more environmental friendly usually subject to a drawback of low catalytic activity. Ultrasonic irradiation has been proven to be successfully used in a meaningful way to enhance the emulsification of the reactants to increase the mass transfer rate during the reaction. This enhancement leads to reductions in reaction time, catalyst amount, and alcohol-to-oil ratio causing a significant decrease in the production economics.*

Keywords— *Biodiesel, karanja, Ultrasonic technique, diesel, Transestrification*

I. Introduction

The petroleum fuel resources are decreasing gradually and as the demand of fuels increasing more and more due to industrializations and urbanization. The biofuels gives a valuable option against the petroleum fuel as it also helps in environmental pollution problem by producing less emission. Bio-Diesel is defined as fatty acid methyl or ethyl esters from vegetable oils or animal fats which are renewable, eco-friendly and oxygenated. From the research it was concluded that biodiesel can help to reduce the co emission and also helpful to rural economy and gives proper distribution of income but there is some problems which resist for use of them, which are mainly the lack of knowledge and easy availability at market. People think that it may reduce engine power and more fuel consumption and also affect the fuel filter and that may decrease the life of engine.

1.1. Bio-Diesel Basics

In Compression ignition engine bio-Diesel is replacement of diesel or with diesel blends. Renewable energy source such as natural gas, no edible oil, biogas, vegetable (green) are getting much attraction for the producing in cheap, available, secure and healthy atmosphere sources. Bio-Diesel as an alternative fuel derived from vegetable (green) oil or animal fats are oxygenated, ecological, on-toxic and environmentally safe. It consists of alkyl monoester of fatty acids from tri-glycerol. Bio-Diesel are classified into two categories; edible and non-edible oils. Edible oils are such that sunflower, corn, rapeseed, palm, soybean and waste vegetable oils. The non-edible oils are such that Jatropha, Jojoba, Karanja, Polanga oils etc.

Because plants produce oils from sunlight and air, and can do so year after year on cropland, these oils are renewable. Animal fats are produced when the animal consumes plants or animals and these too are renewable. Used cooking oils are mostly plant based, but may also contain animal fats. Used cooking oils are both recycled and renewable. The Bio-Diesel manufacturing process converts oils and fats into chemicals called long-chain mono alkyl esters, or Bio-Diesel. These chemicals are also referred to as fatty acid methyl esters (FAME) and the process is referred to as transesterification. Roughly speaking, 100 pounds of oil or fat are reacted with 10 pounds of a short-chain alcohol (usually methanol) in the presence of a catalyst (usually sodium hydroxide [NaOH] or potassium hydroxide [KOH]) to form 100 pounds of Bio-Diesel and 10 pounds of glycerin. Glycerin is a sugar, and is a co product of the Bio-Diesel process.

1.2 Bio-diesel production in India

The annual estimated potential of bio-diesel is about 20 million tons per annum [1]. Wild crops cultivated in the wasteland also form a source of bio-diesel production in India and according to the Economic Survey of Government of India, out of the cultivated land area; about 175 million hectares are classified as waste and degraded land [1]. Table 1.2 below

Depicts the annual production of non-edible oil seeds in India [1] .Government agencies like Ministry of Rural Development, Environment and Forestry, Petroleum and Natural Gas, Agriculture, and Non-Conventional Energy

Table 1.2 Annual Production of Non-edible Oil Seeds in India [1]

Type	Production (MT)	Oil %
Neem	500	30
Karanja	200	27-39
Kusum	80	34
Pilu	50	33
Ratanjyot	-	30-40
Jatropha	-	50
Bhikal	-	37
Wild Walnut	-	60-70
Thumba	100	21

Source all play leading roles in this program. The Government of India through its Planning Commission has initiated a national program to cultivate vast areas of waste lands by plantation of oil-bearing trees.

II. Material and Methods

Experimental investigation was carried out for the study of karanja biodiesel production by ultrasonic probe sonicator.

2.1. Experimental set up for Ultrasonic Assist transestrification method

The Oscar horn type ultrasonic reactor are use for the transestrification process as equipment for biodiesel production as shown in Figures 4.1.1 In ultrasonic reactor is probe type sonicator in which the horn is attached with the transducer which produces ultrasonic vibration for the mixture. Ultrasonic probe sonicator frequency is 20 KHz and reaction time is 1 to 30 min programmable and capacity is 500ml.

Table 2.1 Technical specification of Ultrasonic probe sonicator

Parameter	Details	Photograph of ultrasonic probe sonicator
Make	Oscar Ultrasonic	
Model	PR-1000	
Processor	Horn type	
Power Rating	100 watts	
Frequency	20 kHz	
Programmability:	10 memories plus sequencing	
Programmable Timer:	72 hours	
Adjustable Pulse On/Off:	1 second to 24 hours	
Dimensions (W x L x H):	8 x 15.25 x 8.5 in. (203 x 387 x 216 mm)	
Voltage:	110V, 50/60 Hz	

2.2 Biodiesel Production Parameters

First of all Pure Karanja oil (100g) is taken in a 400 ml beaker and for removing the water content it is heated up to 100 °C then cool down up to room temperature after that mixing the oil with Methyl alcohol (CH3OH) in proportion to molar ratio of (1:9 & 1:12) then add the Catalyst BA $(OH)_2$ in range of (0.5%, 0.75% and 1%) by weight of oil. Then add the sulphuric acid 0.1% by weight. Give some time for proper mixing of alcohol and oil. Then put the mixture in to reactor, check the probe of sonicator is fully immersed in liquid mixture which give ultrasonic vibration at 20 KHz frequency and maintain the temperature 45 to 50° C which is display on monitor. In mixture when 2 separate layers are appeared the reaction was completed. The density of Fatty acid is higher so it was settle at bottom. Methyl ester and glycerol was separated after 2 to 3 hr duration. Then the bio-diesel (methyl Easter) is at upper portion and lower portion was glycerol. Then separate the Bio-diesel with centrifuge. After that for removing the catalyst biodiesel mixes with water and then after 2 hr water due to high density collected at bottom and biodiesel at upper layer. By Distillation process methanol was separated for biodiesel. There are two alcohols to oil molar ratio as 9:1 and 12:1 are used for process. The Percentage of catalyst and weight are shown in table 2.2.1

Table 2.2.1 Oil, alcohol and catalyst during the experiment

Molar ratio (alcohol/oil)	Quantity of non-edible oil (gm)	Quantity of methanol (gm)	Catalyst $BA(OH)_3$		
			0.5%	0.75%	1.0%
9:1	100 g	11 g	0.25 g	0.375 g	0.5 g
12:1	100g	8.27g	0.25 g	0.375 g	0.5 g

2.3.1 Experimental Data for Ultrasonic Assist Transestrification Method

The reaction time and yield of biodiesel for each molar ration and percentage of catalyst used are as per the Table 2.3.1

Table 2.3.1.Time (Min) and yield (%) in karanja oil for different molar ratio and catalyst (%).

% of catalyst $BA(OH)_2$	Molar ratio (alcohol/oil) 12:1		Molar ratio (alcohol/oil) 9:1	
	Time (min)	Yield (%)	Time (min)	Yield (%)
0.5%	20	92.8	21	95.2
0.75%	14	90.7	18	93.4
1%	9	85.4	15	87.7

III. Results & Conclusion

As per the result obtained for the biodiesel production from karanja oil by ultrasonic methods after performing several experimental run and based on result obtained, the conclusions made is that ultrasonic method is a fast method compare to conventional process with high product yield. The main benefit of this method is simplicity in operation, lower reaction time and higher production yield.

3.1 Fuel properties

The properties of Karanja biodiesel with comparison to pure diesel are shown in Table 2.1; the density of that is nearer to that of diesel whereas flash point is higher than diesel and the water and sulphur content is lower than diesel

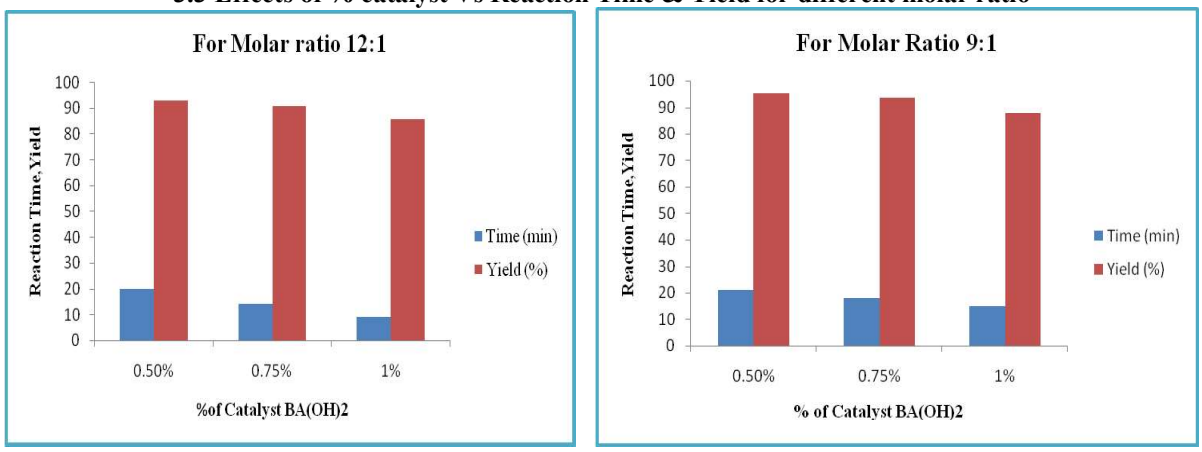
Table 2.1 Comparison of the property of Karanja biodiesel and diesel

Properties	Karanja biodiesel	Unit	Limit	Diesel
Appearance	Clear	----	----	clear
Color	Brownish	----	----	----
Density at 15^0 C	890	kg/m3	860-900	840
Kinematic viscosity at 40^oC	5.86 x10-6	m2/sec	3.5-5 x 10-6	4.86 x10-6
Flash point	>66	^oC	Min 100	51
Sulphur contents	0.01	w/w%	Max 0.05	0.35-0.55
Water content	0.05	w/w%	0.02-0.05	0.005

3.2. Costing of biodiesel production

Here we use the batch production methods for the biodiesel production. The cost of karanga oil is 60 rupees per liter and cost of methanol is 50 rupees per liter and Ba (OH) 2 is 40 rupees per kg and the energy consumption of ultrasonic machine is 1 unit per hr which cost is 4.5 rupees. From the karanja oil 90% yield is achieved and energy consumption 1 litter production of biodiesel is ½ units per half an hour so the total cost for production of the biodiesel is approximately 62 rupees per liter here we use the blends of biodiesel so it is nearer to diesel cost. If we go through the mass production, then the cost of biodiesel will reduces.

3.3 Effects of % catalyst Vs Reaction Time & Yield for different molar ratio



References

[1] N. Stalin and H. J. Prabhu1 "Performance Test Of IC Engine Using Karanja Biodiesel Blending With Diesel" ARPN Journal of Engineering and Applied Sciences October 2007 ARPN Journal of Engineering and Applied Sciences.

[2] Venkata Ramesh Mamilla, et.al "Preparation of Bio diesel From Karanja Oil" International Journal of Energy Engineering 2008.

[3] Dahai Yu Li Tian, et al "Ultrasonic Irradiation With Vibration For Biodiesel Production From Soybean Oil By Novozym 435" Renewable and sustainable Energy reviews 2008

[4] Babak Salamatinia et al "Optimization Of Ultrasonic-Assisted Heterogeneous Biodiesel Production from Palm Oil: A response surface methodology approach" Fuel Processing Technology Elsevier Journal 2009.

[5] Siriporn Larpkiattaworn et al " Ultrasonic On Transesterification Reaction For Biodiesel Production" 7th Biomass Asia Workshop, November 29-December 01, 2010, Jakarta, Indonesia

[6] Ramachandran S. Jahagidar, et al "Performance Characterization of Single Cylinder DI Diesel Engine Fueled with Karanja Biodiesel" Proceedings of the World Congress on Engineering 2011 Vol III WCE 2011, July 6 - 8, 2011, London, U.K.

[7] Ambarish Datta and Bijan Kumar Mandal "Biodiesel Production and its Emissions and Performance: A Review "

International Journal of Scientific &Engineering Research, Volume 3, Issue 6, June-2012

[8] Ali Sabri Badday et al "Intensification Of Biodiesel Production Via Ultrasonic-Assisted Process: A Critical Review on Fundamentals and Recent Development" Renewable and Sustainable Energy Reviews 16 (2012) 4574–4587, 6 June 2012.

[9] Bobade S.N and Khyade V.B. "Preparation Of Methyl Ester (Biodiesel) From Karanja (Pongamia Pinnata) Oil" Research Journal of Chemical Sciences Vol. 2(8), 43-50, August (2012)

[10] K. Ramachandran et al "Recent Developments for Biodiesel Production by Ultrasonic Assist Transesterification Using Different Heterogeneous Catalyst: A Review" Renewable and sustainable Energy reviews Elsevier Journal 2013.

[11] Babak Salamatinia et al "Intensification of biodiesel production from vegetable oils using ultrasonic-assisted process: Optimization and kinetic" Chemical Engineering and Processing: Process Intensification Elsevier Journal 2013.

[12] Swarup Kumar Nayak et al "Experimental Investigation on Performance and Emission Characteristics of a Diesel Engine Fuelled with Karanja Oil MethyEster Using Additive" International Journal of Engineering and Technology (IJET) 2013.

[13] Ganesh Singh Chauhanet al "Experimentation on Chemical Feasibility of Karanja Seed Oil to Use as In Diesel Engines Using 4-Stroke Single Cylinder DI Diesel Engine Test Rig"" International Journal of Engineering Research and Applications (IJERA) 2013.

[14] V. D. Sonara and Dr. Pravin P. Rathod "A Review Study on Bio-Diesel Droplet Ignition" International Journal of Engineering Research and Technology (IJERT) 2013

[15] Sushma. S et al "Production of Biodiesel From Hybrid Oil (Dairy Waste Scum and Karanja) and Characterization and Study of Its Performance on Diesel Engine" International Journal of Engineering Research and Technology (IJERT) 2014.

[16] Rahul Saha Vaibhav V. Goud "Ultrasound assisted transesterification of high free fatty acids karanja oil using heterogeneous base catalysts" Biomass cony bioref Springer-Verlag Berlin Heidelberg 2014

[17] Vlada B. Veljkovic et all "Biodiesel production by ultrasound-assisted transesterification: State of the art and the perspectives" Elsevier 2011

[18] Hanif A. Choudhury et all"Ultrasonic biodiesel synthesis from crude Jatropha curcas oil with heterogeneous base catalyst: Mechanistic insight and statistical optimization" -Elsevier 2013

[19] M. Maghami et all "Production of biodiesel from fishmeal plant waste oil using ultrasonic and conventional methods" - Elsevier 2014

[20] Simone Michelin et all "Kinetics of ultrasound-assisted enzymatic biodiesel production from Macauba coconut oil " - Elsevier 2014

[21] K. Noipin et all"Optimization of ethyl ester production assisted by ultrasonic irradiation" Elsevier 2014

[22] Mohammed Takase et all "Biodiesel production from non-edible Silybum marianum oil using heterogeneous solid base catalyst under ultrasonication" Elsevier 2014

