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BIODIESEL PRODUCTION FROM JATROPHA CURCAS IN INDIA: A REVIEW

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ABSTRACT

Depletion of conventional fuel resources, increased cost and environmental pollution have increased the search for alternative fuels for Internal Combustion engine. In this context, various studies have been made to test the performance and emission characteristics of engine with various vegetable oils and biodiesels as alternative fuel, fully or partially blended with diesel. Produce biodiesel or methyl esters from vegetable oils is also an important concern.

Indian studies for biodiesels are highly focused on the biodiesel production from jatropha curcas oil. Transesterification is the process used to convert vegetable oils into their methyl esters termed as biodiesel. A two step method is also used for biodiesel conversion of vegetable oils having first step to remove the high fat contents from vegetable oils and second step for transesterification process.

In this review paper, production strategies for biodiesel and various initiatives in India have been discussed. This paper also emphasizes on the different methods for producing biodiesel from vegetable oils in Indian context. Being an agriculture product, the properties of jatropha curcas oil and the biodiesel produced from jatropha curcas oil is region specific.

Keywords- Biodiesel, Transesterification, Free Fatty Acid.

1. INTRODUCTION

Due to availability of wastelands, the environmental problems caused by fossil fuel consumption, as well as the dramatic impact of oil imports on Indian economy, biodiesel production is being considered as an alternative to petrodiesel. Biodiesel is believed to be able to decrease the dependence and improve the adverse environmental impact of using oil in India. However, as it is produced from vegetable oils, and animal fats, biodiesel feedstock may affect the food supplies in long term. So, special attention is paid to find the source of non-edible oils as biodiesel feedstock. In Indian context, Jatropha curcas has been chosen as optimal supply source. Jatropha curcas is having other advantages also, such as it stem can be used as a natural toothpaste and toothbrush, latex from the stem can be used as a natural pesticide and to heal wounds, while its leaves are used as fodder for silkworms. It is also very durable in Indian hot climates. The oil content in Jatropha curcas seed is reported to be 35 to 45% by weight. The oil can be used directly in tractors, agriculture diesel engines, electric generators and water pumps without any processing, causing no damage. For diesel engine use, oil requires to undergo transesterification process, which will help to overcome the problem of inherent viscosity of the oil. In India, biodiesel production from Jatropha curcas oil has been placed on the national agenda, as India introduced its biodiesel program in 2003 with the formulation of National Mission on Biodiesel.3

S.N.	Sector	Approximate consumption
1	Transport (Petrol, Diesel, CNG, Aviation fuel)	51%
2	Industry (Petrol, Diesel fuel oil, Naphtha, Natural Gas)	14%
3	Commercial & others	13%
4	Domestic (LPG & kerosene)	18%
5	Agriculture (Diesel)	04%

*(Source: Punia M.P. et. al., 2012)

National Mission on Biodiesel focused on producing biodiesel form Jatropha curcas oil. India is a developing country and at this stage it cannot go to utilize its land for cultivation of non food crop. Because Jatropha curcas can be cultivated on non productive land, this program got more promotion. To support this program, wastelands across the all states of country recognized and marked as to use for cultivation of Jatropha curcas. This mission recommended a 20% biodiesel blending target (B20) by year 2011 by cultivating Jatropha curcas on 11.2 million ha of underutilized wastelands.

The Ministry of Petroleum and Natural Gas enacted the National Biodiesel Purchase Policy, setting a price of Rs 25 per litre, effective 2006. This price is raised to Rs 26.50 per litre in 2008. Due to difficulties across the industry the blending targets could not be met. The December 2009, National Policy on Biofuels introduced for an indicative blending target of 20% by 2017 for biodiesel.

A few attempts have been made to produce biodiesel from non-edible sources, such as waste cooking oil, grease, animal fat. Jatropha curcas has ecological advantages and has been found to be an appropriate, renewable, alternative source of biodiesel production in India. Due to inherent viscosity of Jatropha curcas oil, it cannot be directly used in diesel engine as it will cause poor atomizing, choking of injectors and increase in engine deposits. Transesterification processing of oil can reduce the triglyceride molecules. The use of chemically altered or transesterified vegetable oil, termed biodiesel or methylesters of vegetable oils, does not require any modification in the engine or its injection system. Methanolysis is the process where methanol is used in biodiesel production and product is methyl ester and glycerol.

The aim of the paper is to review of various methods and processes used in production of biodiesel from Jatropha curcas in Indian context.

2. WASTELAND DISTRIBUTION FOR JATROPHA PLANTATION IN INDIA

The criteria for selection of states depended on the available potential wasteland for jatropha plantation in each state. In Sub-phase I, states with more than 2 million hectares of wasteland were considered. Six states were covered in this category (Madhya Pradesh, Chhattisgarh, Rajasthan, Andhra Pradesh, Maharashtra and Gujarat). In Madhya Pradesh, Rajasthan and Chhattisgarh 20 000 hectares of land in each state was targeted for plantation. In the Andhra Pradesh and Maharashtra, plantation on 10 000 hectares of wasteland area was done. In Sub-phase I, plantation was carried out in 80 000 hectares of land. Gujarat considered under the Sub-phase II plantation due to insufficient availability of land in this sub-phase.

In Sub-phase II, the states having 1-2 million hectares of potential waste-land were considered for plantation in Sub-phase II. The remaining states considered in Sub-phase III. A wasteland area of 200 000 hectares distributed in the remaining states in Sub-phase III. The balance area of 95 000 hectares redistributed in states covered in sub-phase I and II.

3. MATERIALS AND METHODS

3.1 Raw Materials

Jatropha curcas is the feedstock for biodiesel in India. It is cultivated on wastelands and so, it is not affecting the production of food crops. Jatropha curcas oil is extracted from its seed by appropriate methods of oil extraction. The chemicals generally used are Sodium hydroxide (NaOH), Potassium hydroxide (KOH), methanol (CH_3OH) and Sulphuric acid (H_2SO_4). The general fatty acid composition of Jatropha curcas oil is given in table 1. The FFA contents in Jatropha curcas is case sensitive as it could be different as per the soil.

Table 1: *Fatty acid composition for Jatropha curcas oil*

Fatty acid	Formula	Systematic name	structure	Wt%
Palmitic	$C_{16}H_{32}O_2$	Hexadecanoic	16:00	15.24
Stearic	$C_{18}H_{36}O_2$	Octadecanoic	18:00	8.22
Oleic	$C_{18}H_{34}O_2$	Cis-9- Octadecanoic	18:01	47.1
Linoleic	$C_{18}H_{32}O_2$	Cis-9,cis-12- Octadecanoic	18:02	27.25

*(Source: S.G.Bojan et. al., 2012)

3.2 Production Process

3.2.1 Transesterification

It is the process of reacting oil with alcohol (generally methanol or ethanol) in the presence of catalyst (generally Sodium hydroxide or Potassium hydroxide, in some cases hexane is used as co-solvent). Firstly oil is heated to 70 o C in a round bottom flask to drive off the moisture and stirred vigorously. Pure alcohol (generally 20% by volume of oil) is dissolved with catalyst (around 3.5% - 5%) in separate vessel and then it is poured into the flask of the oil. The mixture is maintained at 60oC for 60 minutes. Stirring device should be a low speed to avoid bubble formation. The temperature and time duration of the process is also to be optimized. After completion of process biodiesel will be available with glycerol. The mixture is to be settled down for 24 hours so that biodiesel could avail over the glycerol and easily extracted. This biodiesel may be impure having contents of catalyst and alcohol.

3.2.2 Washing and Separation

Biodiesel availed after transesterification process may be having impurities as contents of catalyst and alcohol. To remove this, hot water is sprayed over biodiesel so that impurities could be washed with water. After this, biodiesel has to settle down. In this process pure biodiesel avails on top and water with impurities is settled down. Biodiesel is separated from this pool.

3.3 Biodiesel Characterization

The specific gravity reduces after the tranesterification process, viscosity is also reduces from 57 to 4.73 centistokes, which is very similar to that of diesel. Flash point and fire point are specified for safety during transport and storage. Flash point of Jatropha curcas oil decreases to 66°C (earlier 128°C to 136°C) after tranesterification processes, which indicates its improved volatile characteristics and easy to handle.

Density increases that mean more mass of fuel per unit volume that would give higher energy available for work output per unit volume. Cloud and pour point are criterion used for low temperatures performance of fuel. Lower cloud point shows satisfactorily performance in cold climate conditions. The higher cloud point may affect the engine performance under the cold conditions. Pour point as low as nearly equal to diesel is very helpful in low temperature conditions. In case of vegetable oils, under cold conditions, wax precipitates and they lose their flow characteristics. Wax can chock filters and fuel supply line. Under cold conditions, fuel cannot be pumped through the fuel injectors. In the country like India, temperature can go down to 0°C in winters.

4. CONCLUSION

In India Jatropha curcas oil is said to be the biodiesel feedstock. Cultivation of Jatropha curcas on wastelands allocated is very promising feature of this as it will not affect the production of food crops. The biodiesel is very helpful to providing employment to the rural workers, increases the income of them. Industries for biodiesel production from Jatropha curcas oil are further very promising to provide the employment to the rural India.

As Jatropha curcas oil is highly viscous and its other properties such as fire point, cloud point, flash point, and pour point are not as promising as the biodiesel of oil. Previous studies explore that with the help of tranesterification process, Jatropha curcas oil could be better characterized as diesel. Properties of biodiesel are very improved as viscosity reduces up to 4.7 centistokes (very closer to that of diesel fuel), cloud and pour point are also improves. Reduced flash point and fire point make it easy to transport and store.

The production of biodiesel operation is carried out in various units, further work is therefore needed to be develop a unit operation which will involve an automated reactor, able to produce biodiesel form Jatropha curcas seed in single unit plant. The use of biodiesel in compression ignition engine fully or partially blended with diesel will improve reliance of India on petrodiesel.

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