Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 13; October-December 2014 pp. 67-69

http://www.krishisanskriti.org/jbaer.html

Production of Biodiesel–A Review

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Abstract—*Biodiesel is an alternative to conventional diesel fuel made from renewable resources, such as non-edible vegetable oils. The oil from seeds (e.g., Jatropha and Pongamia) can be converted to a fuelcommonly referred to as "Biodiesel." No engine modifications are required to use biodiesel in place of petroleum-based diesel. Biodiesel can be mixed with petroleum-based diesel in any proportion. This interest is based on a number of properties of biodiesel including the fact that it is produced from a renewable domestic source, its biodegradability, and its potential to reduce exhaust emissions. The climate change is presently an important element of energy use and development. Biodiesel is considered "climate neutral" because all of the carbon dioxide released during consumption had been sequestered out of the atmosphere during crop growth. The use of biodiesel resulted in lower emissions of unburned hydrocarbons, carbon monoxide, and particulate matter. Biodiesel also increased catalytic converter efficiency in reducing particulate emissions. Chemical characterization also revealed lower levels of some toxic and reactive hydrocarbon species when biodiesel fuels were used. The fuel consumption in the world particularly in developing countries has been growing at alarming rate. Petroleum prices approaching record highs and they will deplete within few decades, it is clear that more can be done to utilize domestic non-edible oils while enhancing our energy security. The economic benefits include support to the agriculture sector, tremendous employment opportunities in plantation and processing. Jatropha and Pongamia are known just crude plants which grow on eroded soils and require a hot climate and hardly any water to survive. These are the strong reasons, enforcing the development of biodiesel plants.*

1. INTRODUCTION

Biodiesel is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which conform to ASTM D6751 (American Society for Testing & Materials). It is the name of a clean burning alternative fuel, produced from domestic, renewable resources and animal fats. Today's diesel engines require a clean –burning, stable fuel that performs well under a variety of operation conditions. It is the only alternative fuel that can be used directly in any existing, unmodified diesel engine. Because it has similar properties to petroleum diesel fuel, biodiesel can be blended in any ratio with petroleum diesel fuel. Specifications for use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as "BXX" with "XX" representing the percentage of biodiesel contained in the blend (ie: B20 is 20% biodiesel, 80% petroleum diesel). It is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics. It is made though a chemical process called transesterification where by the glycerin is separated from the fat or vegetable oil. Fuel-grade biodiesel must be produced to strict industry specifications in order to insure proper performance. It is better for the environment because it is made from, renewable resources and has lower emissions compared to petroleum diesel. It is less toxic than table salt and biodegrades as fast as sugar. It can be made in India from renewable resources such as Jatropha and Pongamia. Its use decreases our dependence on foreign oil and contributes to our own economy.

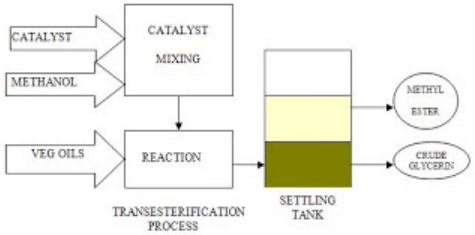
2. BIODIESEL PRODUCTION

The production of Biodiesel, or alkyl esters, is well known. There are three basic routes to ester production from oils and fats.

1. Base catalyzed Transesterification of the oil with alcohol.
2. Direct acid catalyzed esterification of the oil with methanol.
3. Conversion of the oil to fatty acids, and then to alkyl esters with acid catalysis.

The majority of the alkyl esters produced today are done with the base catalyzed reaction. Because it is the most economic for the following reasons.

- Low temperature (150F) and pressure (20psi) processing.
- High conversion (98%) with minimal side reactions and reaction time.
- Direct conversion to methyl ester with no intermediate steps.



VEG OILS: Jatropha.

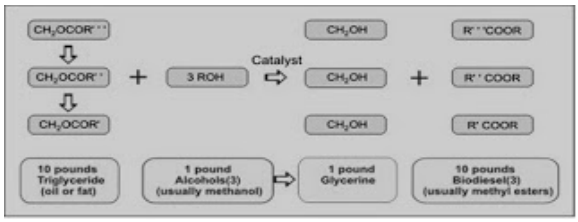
ALCOHOLS: Methanol, Ethanol.
CATALYST: Sodium hydroxide, Potassium hydroxide.

3. TRANSESTERIFICATION

The most common derivatives of agricultural oil for fuels are methyl esters. These are formed by trans esterification of the oil with methanol in the presence of a catalyst (usually basic) to give methyl ester and glycerol. Sodium hydroxide (NaOH) is the most common catalyst, though others such as potassium hydroxide (KOH) can also be used.

100 kg oil+24 kg methanol+2.5 kg NaOH a 100 kg biodiesel+26 kg glycerine

Trans-esterification chemistry



R' R" R"' = oil acids; R = (CH2)xCH3

The methanol and NaOH are premixed and added to the oil, mixed for a few hours, and allowed to gravity settle for about 8 hours. The glycerine settles to the bottom, leaving biodiesel on the top.

The physical and chemical properties of the resulting biodiesel (Jatropha methyl esters) are presented in the following Table alongside those for petroleum diesel and European Union standards for biodiesel.

Jatropha Biodiesel properties compared with petro-diesel and EU standards:

Property	units	Jatropha Biodiesel	Petroleum Diesel	E.U standard for Biodiesel
Density @300c	g/ml	0.88	0.85	> 0.8
Combust-ion point	0c	1.92	55	>55
Kinematic viscosity	Cst	4.84	2 -8	5
Calorific Potential	MJ/Kg	41	45	Undefined
Cetane number	---	52	47.5	>48
Ester content	%	>99	0	>99
Sulfur content	%	0	< 0.5	<0.55
Carbon residue	%	0.024	< 0.35	<0.1

4. JATROPHACURCAS

The JatrophaCurcas plant has the potential, for use as an oil crop for Biodiesel. The Jatropha plant is Latin American in origin and is closely related to the castor plant. It is a large shrub / small tree able to thrive in a number of climactic zones in arid and semi-arid tropical regions of the world. It can grow in areas of low rainfall (250 mm per year minimum, 900-1,200 mm optimal) and is drought resistant. And is not browsed by animals.

- Planting density-1,000 plants per Acre
- Productivity-Starts yielding after on year, but the maximum productivity from 5th year onwards.
- Life Span-50 years
- Yield per hectare / year – 0.4 to 12 tonnes

5. BYPRODUCTS

Glycerine

Glycerine (glycerin, glycerol) is the by-product of making biodiesel. What sinks to the bottom of the biodiesel processor during the settling stage is a mixture of glycerine, methanol, soaps and the catalyst. Once separated from the biodiesel, adding phosphoric acid to the glycerine layer precipitates the catalyst out and also converts the soaps back to free fatty acids (FFAs), which float on top. The resultant products are light-colored precipitate on the bottom, glycerine/methanol/water in the middle, and FFA on top. The glycerine will be approx. 95% pure, a product to sell to refiners.

De-oiled Cake

The residual crushed seed, known as de-oiled cake, is a good source of manure, which can be used locally, or for export. The seed husks can be used to make packaging materials.The cake can also be used as animal feed.

6. BIODIESEL ACTIVITIES IN INDIA:

- The Tamilnadu government along with the forest department has planned a project for cultivation of Jatropha in 150,000 hectares in Tamilnadu. Any farmer with land can make their lands available for the jatropha project and the seedlings as well as technical assistance for grow-out will be provided by the forest department.
- The Indian Railway is to raise jatropha along the railway track and plan to plant jatropha along 25,000 route kilometers on two sides of the track to replace 10% of their total petro-diesel consumption.
- •The Maharashtra and Madhya Pradesh Agro-forestry department has been actively encouraging the raising of jatropha in watershed development projects.

7. COMPARISONS AND DISCUSSIONS:

Biodiesel contains no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction so unburned hydrocarbons, carbon monoxide and particulate matter. Biodiesel can be manufactured using existing industrial production capacity and used with conventional equipment, is provides substantial opportunity for immediately addressing our energy security issues. Increased utilization of renewable bio fuels results in significant microeconomic benefits to both the urban and rural sectors.

Biodiesel emission compared to conventional diesel

Emission Type	B100	B20
Sulfates	100%	20%
Total Unburned Hydrocarbons	93%	30%
Carbon Monoxide	50%	20%
Particulate Matter	30%	22%
Nox	13%	2%

8. ADVANTAGES OF BIODIESEL

- The higher cetane number of biodiesel compared to petro-diesel indicates potential for higher engine performance.
- The superior lubricating properties of biodiesel increases functionalengine efficiency
- Their higher flash point makes them safer to store the biodiesel molecules are simple hydrocarbon chains, containing no sulfur, or aromatic substances associated with fossil fuels
- They contain higher amount of oxygen (up to 10%) that ensures more complete combustion of hydrocarbons.
- Biodiesel almost completely eliminates carbon dioxide emissions in its life cycle.
- Various other products from the plant (leaf, bark and seed extracts) have various other industrial and pharmaceutical uses.
- To boost up rural economy.

9. DIS ADVANTAGES OF BIODIESEL.

- High cost of production: will eventually solve itself when large-scale production and use starts. Also, the price of petro-diesel does not take into account its actual cost (when environmental and military costs are included).
- Modifications are required to the automobiles for use of biofuel- many automobile brands are currently marketed ready for use of bio- diesel.
- High CFPP (cold filter plugging point) values and hence solidification and clogging of the system at low temperatures: this problem occurs only in places where the temperature goes down to around 0°C, even here the problem is currently solved by adding additives.

10. CONCLUSION

Biodiesel is safe to handle because it is biodegradable and non-toxic. Biodiesel reduces all the emission. Biodiesel can be used alone or mixed in any amount with petroleum diesel fuel. Biodiesel runs in any conventional, unmodified diesel engine. No engine modifications are necessary to use biodiesel and there is no “engine conversion”. Increased utilization of renewable biofuels results in significant microeconomic benefits to both the urban and rural sectors, and the balance of trade. It is clear that more can be done to utilize domestic surpluses of vegetable oils while enhancing our energy security. Because biodiesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for immediately addressing our energy security issues.

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