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An Alternative Source of Energy-Jatropha Biodiesel

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Abstract—*The world is getting modernized and industrialized day. As a result vehicles and engines are increasing, but energy sources used in these engines are limited and decreasing gradually. This situation leads to seek an alternative fuel for diesel engine. Biodiesel is an alternative fuel for diesel engine. The esters of vegetables oil animal fats are known as Biodiesel. This study investigates the prospect of making of biodiesel from jatropha oil. The seeds of Jatropha contain 50-60% oil. Jatropha produces renewable energy in the form of biodiesel, which emits 80% less CO_2, 100% lower SO_2, and has a higher flash point than petroleum diesel fuel. The Jatropha biodiesel industry currently is relatively minor; therefore, as it grows to a larger scale and the infrastructure is developed, the costs of producing and marketing jatropha biodiesel may decline in the future.*

Keywords*: Bio-diesel, Jatropha Oil, Flash point Trans-esterification, Renewable energy.*

1. INTRODUCTION

Vegetable oils are among the various sources of energy fuels being considered as alternatives to fossil fuels. Rapeseed, soyabean, sunflower, coconut and palm oils have been the main raw materials for biodiesel production. However, these oils are required in refined forms to obtain quality biodiesel and, in addition, they are foodstuffs. This makes production of biodiesel from these sources uneconomical [1]. Non-edible plant oils such as found in jatropha curcas and castor beans may provide better alternatives. Jatropha is a small tree with smooth grey bark. The bark discharges white, watery latex when cut. Generally, the tree can grow between 6.0 and 18.0 ft (1.8–5.5 m) in height, but it can grow to 30.0 ft (9.2 m) given favorable conditions. Grows almost anywhere including wastelands, gravelly, sandy, and saline soils. Complete germination is achieved within 9 days. Survives and thrives on a mere 250 mm (10 inches) of rain a year. Ploughing and planting are not needed regularly since the shrub will continue to grow for about forty years. The plant responds negatively to organic fertilizers like manure during germination. The seeds become mature when the capsule changes from green to yellow after 2–4 months as shown in Figure 1.

Fig. 1: Jatropha Seed

The seeds contain 21% saturated fatty acids and 79% unsaturated fatty acids and they yield 25%–40% oil by weight.

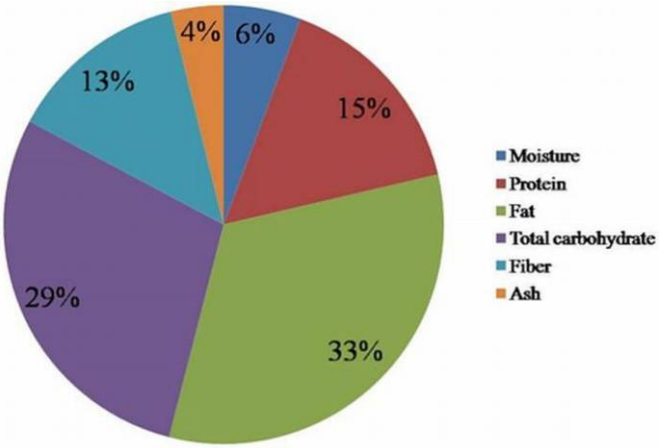

Fig. 2: Chemical elements of a jatropha curcas seed

In Fig. 2, it is observed that the maximum element is Fat having 33% and minimum element is Ash having 4%. The percentage of protein is about 15% which is useful for producing Biodiesel.

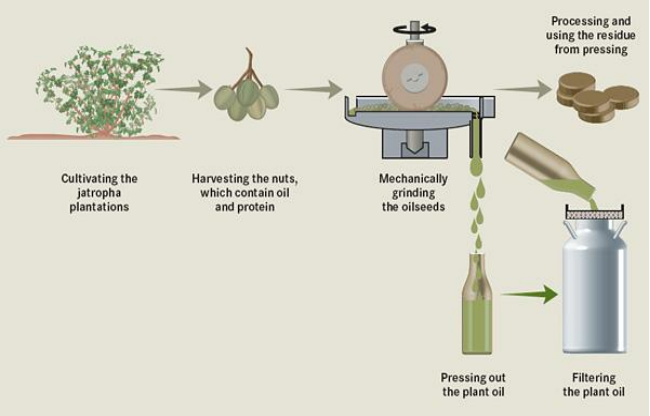

Fig. 3: The Production Process of Jatropha oil

Process consist of cultivating the jatropha plantation, harvesting the nuts, which contain oil and protein, followed by mechanical grinding the oil seeds to pressing out oil from seed and then filter the Jatropha oil.

2. TRANSESTERIFICATION PROCESS

The processing steps for the most commonly used method viz. base catalyzed transesterification would be as follows. The flow chart to produce Jatropha biodiesel is shown in Fig. 4

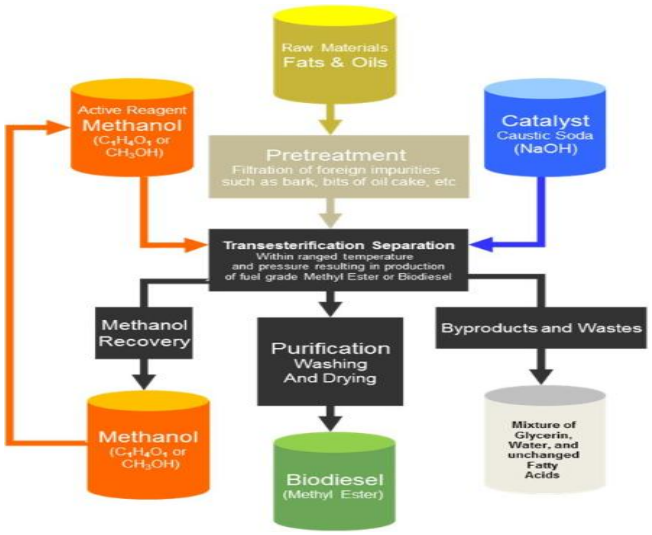

Fig. 4: Flow chart Transesterification Process

It is necessary to do the Transesterification process within the ventilated area and wearing of cloth and glasses are must to avoid any accident.

The following resources are required for producing Jatropha Biodiesel.

a) Jatropha Oil - 1liter,

b) 5 grams of lye (caustic soda);

c) NaOH (> 95%) or KOH (> 85%);

d) 220 ml of methanol (> 99%).

Table 1: Approximate Process Constituent

Jatropha Oil	Alcohol (98%)	Catalyst	Glycerine	Biodiesel
1050 litres	150 litres	4.6 kg	14kg	1200 litres

Followings are the steps of transesterification process.

1. First dissolve the lye into the methanol. Shake or swirl until all the lye has dissolved.
2. This may take 10 minutes. It is normal that temperature rises. This mixture is called sodium methoxide. Now make sure the J Oil is in a vessel large enough (at least 150% of its volume), preferably with a valve at the bottom, and heat it to about 60 °C, then stop heating. Then add the methoxide mixture and make sure it is mixed well for at least 10 minutes. Leave the vessel and let the different constituents separate by sedimentation
3. The glycerine will settle out at the bottom. After 8 to 24 hours the sedimentation is complete and the glycerine can be drained off.
4. What remains is raw biodiesel. If the reaction went well and the biodiesel is clear, it may be used straight, although its quality may be inferior because of impurities. Water washing will remove most of these impurities.

Transesterification is also called alchololysis; it is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. Methanol is most commonly used for the purpose since it is the cheapest alcohol available. Ethanol and higher alcohols such as isopropanol, butanol etc. can also be used for the esterification, however using higher molecular weight alcohols improves the cold flow properties of biodiesel but reduces the efficiency of transesterification process. The reaction is as shown in Fig. 5

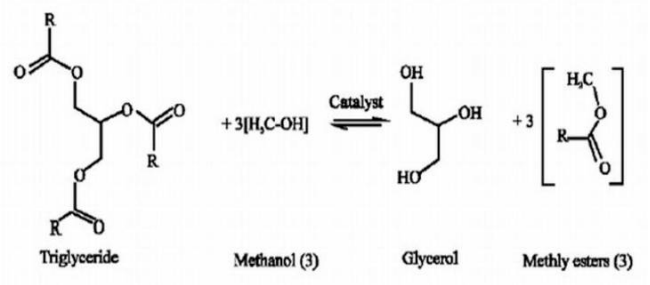

Fig. 5: Chemical Reaction of Jatropha Bio-diesel

The transesterification works well when the input oil is of high quality. However, quite often low quality oils are used as raw materials for bio-diesel preparation. In cases where FFA content of the oil is above 1%, difficulties arise due to the formation of soap, which promotes emulsification during the water washing stage. If the FFA content is above 2%, the

process becomes unworkable. The factors affecting the transesterification process are oil temp, reaction temp, and ratio of alcohol to oil, catalyst type & concentration, intensity of mixing, purity of reactants. Fig. 6 shows Jatropha Biodiesel from Jatropha plant by transesterification process.

Fig. 6: Jatropha Biodiesel

3. PHYSICAL AND CHEMICAL COMPARISON OF BIODIESEL

Jatropha oil has similar characteristics to fossil diesel fuel, and it can be directly used in the diesel engines of buses, trucks, tractors, and other diesel engines. The high stability in low temperatures makes it very attractive for use in jet fuels, and this has been tested successfully. Table 2 shows the various physical and chemical properties of fuel-grade biodiesel like ignition point, specific gravity, volatility by volume, stability, solubility in water, atomic weight, appearance etc.

Flash point is specified in biodiesel to serves as a restriction of the amount of alcohol in biodiesel for safety measures in transportation and storage. It is also a biodiesel quality related to the fatty acid structure [6]. Flash point can be adjusted through blending biodiesel with petro-diesel in appropriate proportions. Blends of 20% biodiesel to 80% petro-diesel (B20) have been recommended by various researchers.

Density is specified in several standards and the purpose is to exclude unrelated materials from being used as biodiesel feedstock [6]. It is also used in the determination of the viscosity of biodiesel.

Table 2: Physical and Chemical Properties of Fuel-Grade Biodiesel

Properties	Characteristics
Ignition point °F	266
Specific gravity (dimensionless)	0.85–0.90
Volatility by volume (%)	< 2
Stability	Very high
Solubility in water	Insoluble
Atomic weight (amu)	292
Appearance and odour	Pale yellow liquid with mild fruity odour
Chemical formula	$C_{13}H_{30}O_2$~$C_{10}H_{11}O_5$

Density is specified in several standards and the purpose is to exclude unrelated materials from being used as biodiesel feedstock [6]. It is also used in the determination of the viscosity of biodiesel.

Calorific value or heat of combustion of plant oils that are commonly used as raw materials for biodiesel production Calorific value or heat of combustion of plant oils that are commonly used as raw materials for biodiesel production varies from 5443 to14654 kJ/Kg. This is within the range of that of hexadecane, also known as Cetane (10714 kJ/mole), which is used as a reference standard material for the determination of the ignition quality of petro-diesel [7, 8].Table 3 shows the characteristics of jatropha oil in comparison with fossil diesel.

Table 3: Characteristics of Jatropha Curcas Biodiesel and Comparison With Diesel

Characteristic/Variable	Jatropha biodiesel	Petroleum diesel
Density at 68°F (kg.m^3)	869.5	859.7–899.4
Viscosity at 40°C (cSt)	4.2	3.5–5.0
Flash point (°C)	191	101
Cetane number	58–62	> 51

Jatropha is also safer to store than petroleum diesel since it has a higher flash point. In addition, Jatropha oil viscosity is slightly lower than the fossil diesel, which allows smooth flow of the oil through the injector.

4. ENVIRONMENTAL IMPACT

As a perennial shrub, jatropha can sequester carbon (C). A full-grown tree absorbs around 7.9 kg of CO_2 every year (PSO 2010). If the plant density is 2,500 plants.ha^{-1}, it is possible to acquire an 18.1 t.ha^{-1} of greenhouse gas sequestration per year. Jatropha produces renewable energy in the form of biodiesel, which emits 80% less CO_2 and 100% less SO_2 than fossil diesel. Biodiesel from food crops such as corn can cause food shortages. For biodiesel, jatropha yields similar fuel per acre (ha) than soybean or other energy crops.

5. USE OF BIODIESEL IN TRANSPORT

The biodiesel is widely used in the following area of transportation:

- Biodiesel buses are used in Europe and in mid western United States.
- In India, Shatabdi train was run from Delhi to Amritsar using B5 (5%) biodiesel blend and no problem was observed during run.

Mercedes Benz C220 CDI vehicle was run in various states of the country using 100% biodiesel by CSMCRI, Bhavnagar without any problem with a mileage of 13.5km. per litre which is comparable with fossil fuel.

6. CONCLUSION

Biodiesel derived from neutralized jatropha oil is suited for use in diesel engines given that its kinematic viscosity, flash point, cetane no., density and calorific value are comparatively same. It reduces green house effect on our environment by reducing CO_2 gas emission. It is very friendly with environment because it increases percentage of O_2 in exhaust gas than the ordinary diesel.

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