

## Production of Biodiesel from *Jatropha Curcas* oil by using Pilot Biodiesel Plant

India, like many countries, has high hopes for *Jatropha* as a biofuel source, but little is known about how to make it a successful crop. **Bulk Agro (India) Pvt. Ltd.** digs for the roots of a new enthusiasm.



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## **Production of biodiesel from *Jatropha Curcas* oil by using pilot biodiesel plant**

### **Introduction**

The consumption and demand for the petroleum products are increasing every year due to increase in population, standard of living and urbanization. Diesel consumption pattern in India has not varied much and is around  $36 \times 10^6$  tonnes as reported by the Ministry of Petroleum and Natural Gas (Table 1). The increase in crude oil import affects the country's economy and its development. The diesel vehicles were banned in New Delhi for serious problem of air pollution due to higher emissions of polluted gases. The acid rain, global warming and health hazards are the results of ill effects of increased polluted gases like SO<sub>x</sub>, CO and particulate matter in atmosphere.

Today's diesel engines require a clean burning, stable fuel that performs well under the variety of operating conditions. Biodiesel is the only alternative fuel that can be used directly in any existing unmodified diesel engine. Because it has similar properties to diesel fuel, biodiesel can be blended at any ratio with diesel fuel. In most of the developed countries, biodiesel is produced from soybean, rapeseed, sunflower, peanut, etc., which are essentially edible in Indian context. Among the various vegetable oil sources, non-edible oils are suitable for biodiesel production. Because edible oils are already in demand and too expensive than diesel fuel. Among the non-edible oil sources, *Jatropha curcas* is identified as potential biodiesel source and comparing with other sources, which has added advantages as rapid growth, higher seed productivity, suitable for tropical and subtropical regions of the world.

**Table 1 :**

Year	Production	Import	Total	Import %
1971	6.8	11.7	18.5	63
1981	10.5	16.2	26.7	61
1991	33	20.7	53.7	39
2001	32	57.9	89.9	64
2002	32	73.5	105	70

### **Biodiesel**

Biodiesel is a variety of ester-based oxygenated fuels derived from natural, renewable biological sources such as vegetable oils. It's name indicates, use of this fuel in diesel engine alternate to diesel fuel. Biodiesel operates in compression ignition engines like petroleum diesel thereby requiring no essential engine modifications. Moreover it can maintain the payload capacity and range of conventional diesel. Biodiesel fuel can be made from new or used vegetable oils and animal fats. Unlike fossil diesel, pure biodiesel is biodegradable, nontoxic and essentially free of sulphur and aromatics. The estimated biodiesel requirement of India is presented in the table 2.

## Advantages of biodiesel

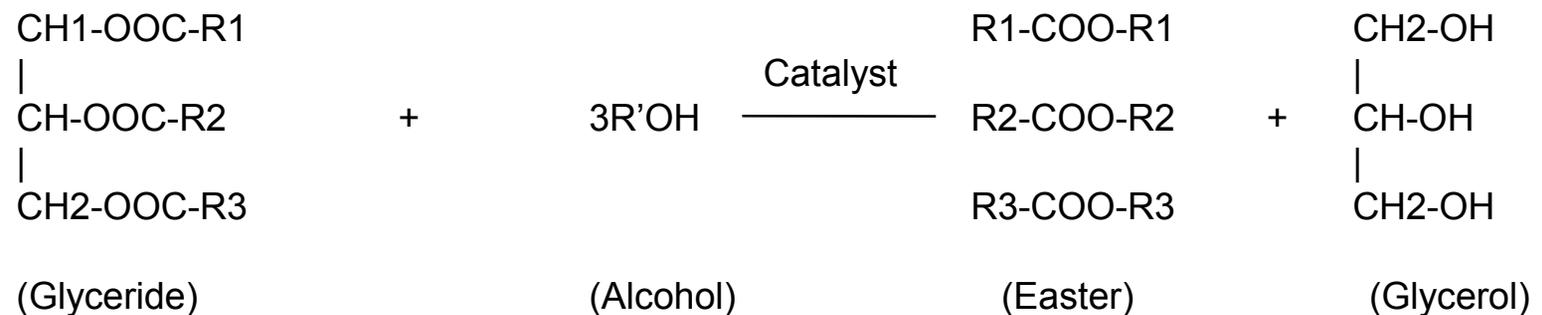
1. Produced from sustainable / renewable biological sources
2. Ecofriendly and oxygenated fuel
3. Sulphur free, less CO, HC, particulate matter and aromatic compounds emissions
4. Income to rural community
5. Fuel properties similar to the conventional fuel
6. Used in existing unmodified diesel engines
7. Reduce expenditure on oil imports
8. Non toxic, biodegradable and safety to handle

**Table 2: Estimated Biodiesel Requirement In India**

Year	Diesel Requirement	Bio Diesel	Requirement MMT	Blending
	MMT	5%	10%	20%
2004-2005	46.97	2.35	4.70	9.40
2006-2007	52.33	2.32	5.23	9.92
2011-2012	66.90	3.35	6.69	13.38

### Chemistry of biodiesel production

Biodiesel is produced by transesterification of large, branched triglycerides in to smaller, straight chain molecules of methyl esters, using an alkali or acid or enzyme as catalyst. There are three stepwise reactions with intermediate formation of di glycerides and mono glycerides resulting in the production of three moles of methyl esters and one mole of glycerol from triglycerides. The overall reaction is:



Alcohols such as methanol, ethanol, propanol, butanol and amyl alcohol are used in the transesterification process. Methanol and ethanol are used most frequently, especially methanol because of its low cost, and physical and chemical advantages. They can quickly react with triglycerides and sodium hydroxide is easily dissolved in these alcohols. Stoichiometric molar ratio of alcohol to triglycerides required for transesterification reaction is 3:1. In practice, the ratio needs to be higher to drive the equilibrium to a maximum ester yield.

### The *Jatropha Curcas* plant and oil

The oil yielding plant *Jatropha Curcas L.* is a multipurpose and drought resistant large shrub, which is widely cultivated in the tropics as a live fence. The *Jatropha* plant can reach a height up to 5 m and its seed yield ranges from 7.5 to 12 tones per hectare per year, after five years of growth. The oil content of whole *Jatropha* seed is 30-35 % by weight basis.

**Table 3: Problems in Use of Jatropha Oil as fuel in Diesel Engine**

PROBLEMS	CAUSES
Coking if injectors on piston and head of engine	High viscosity of raw oil, incomplete combustion of fuel. Poor combustion at part load with raw oil.
Carbon deposits on piston and head of engine	High viscosity of oil, incomplete combustion of fuel.
Excessive engine wear	High viscosity of raw oil, incomplete combustion of fuel. Dilution of engine lubricating oil due to blow-by of raw oil.

The above problems can be solved by converting raw Jatropha oil in to biodiesel through transesterification process.

### **Biodiesel pilot plant**

The biodiesel pilot plant consists of a transesterification reactor with heater, a stirrer, chemical mixing tank, three glycerol settling tanks and washing tank. The capacity of pilot biodiesel plant is 250 litres/day. The cost of the pilot plant is Rs. 2.5 lakhs. The process flowchart for biodiesel production and pilot biodiesel plant are shown in figure 1 and 2.

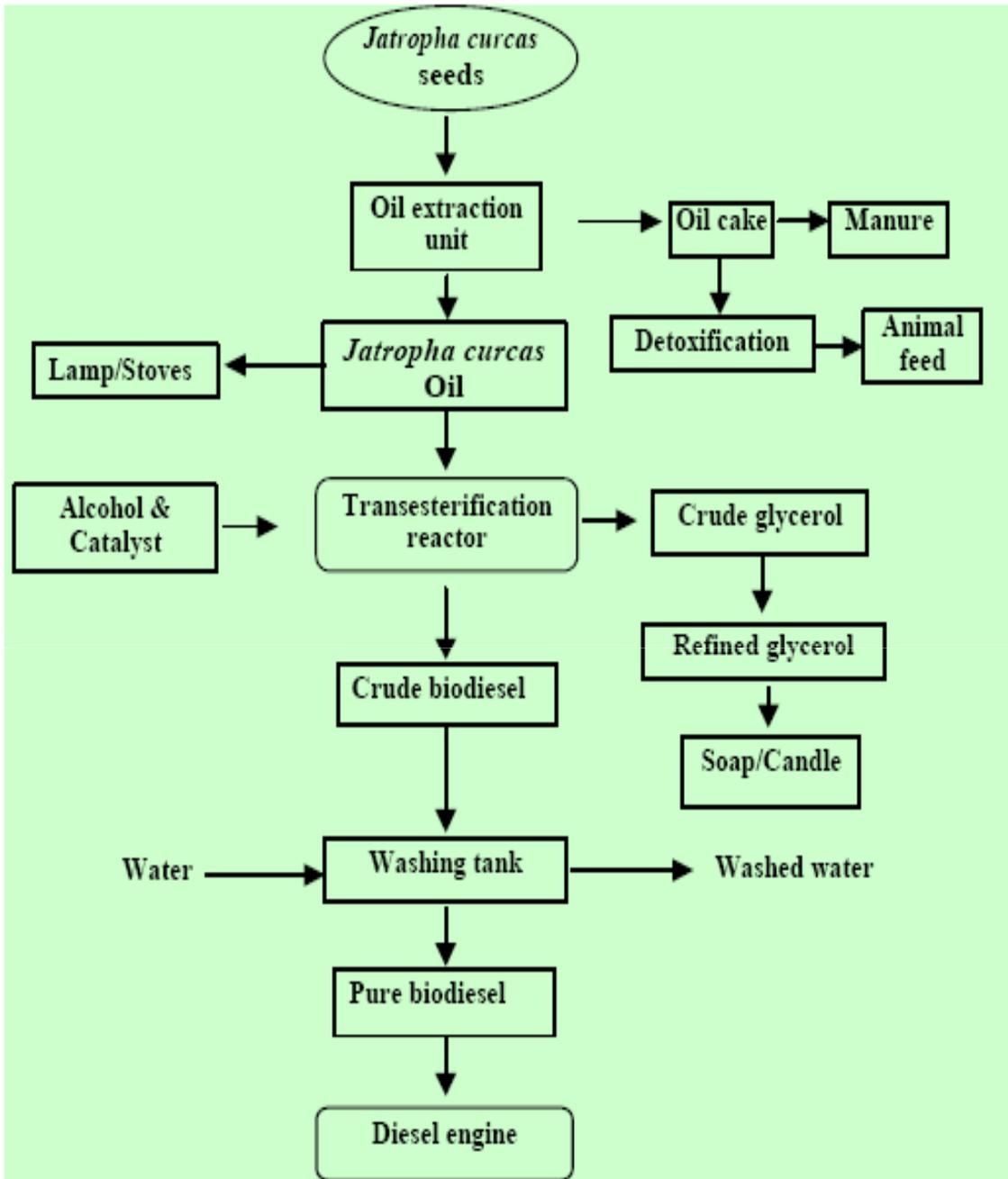
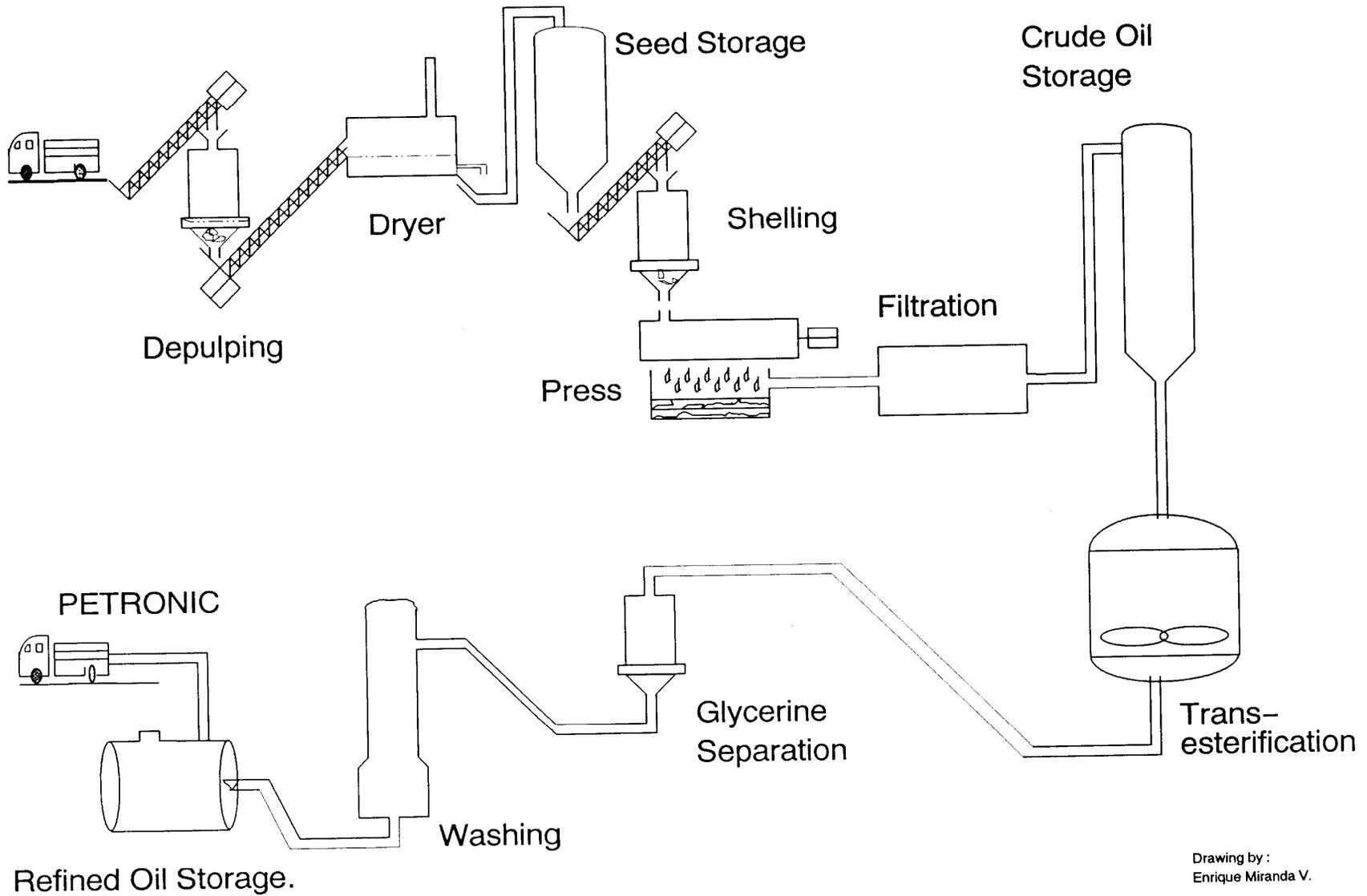


Fig. 1. Process flowchart for biodiesel production from jatropha seeds and by products

### Pilot biodiesel plant operation

In the pilot biodiesel plant, *Jatropha* oil is blended with alcohol and catalyst mixture in transesterification reactor. The reactor is kept at reaction temperature for specific duration with vigorous agitation. After reaction, the biodiesel and glycerol mixture is sent to the glycerol settling tank. The crude biodiesel is collected and washed to get pure biodiesel. Depending upon the need, the size of the unit can be scaled up to get higher production capacity. The fuel properties of *Jatropha* biodiesel produced in the pilot plant are given in the table 4.



Drawing by :  
Enrique Miranda V.

## Table 4: Fuel Properties of Jatropha Oil and Its Biodiesel

Properties	Jatropha Oil	Jatropha Biodiesel	Diesel
Density, g/ml	0.920	0.865	0.841
Viscosity@40 C, Cst	3.5	5.2	4.5
Calorific Value, MJ/kg	39.7	39.2	42.0
Flash Point, Celcius	240	175	50
Cloud Point, Celcius	16	13	9



Fig. 3 Jatropha biodiesel with glycerol samples

## Salient features of the pilot biodiesel plant:

- Simple in operation
- Low cost technology
- Shorter reaction time

## Economics of biodiesel production

Cost of raw jatropha oil = Rs. 22/litre

Biodiesel processing cost = Rs. 9/litre

Cost of production = Rs. 31/litre

Less return from crude glycerol = Rs. 3/litre

Net cost of production = Rs. 28/litre

Dealers margin = Rs. 1/litre

Profit = Rs. 3/litre

Sale price of biodiesel = Rs. 32/litre



## Conclusion

Jatropha biodiesel is ideal solution to meet out higher diesel demand and oil imports. By mixing of 20 per cent biodiesel with diesel will help India to save  $7.3 \times 10^6$  tones of diesel per year. In India about 33 million hectares of wasteland is available and can effectively be used for cultivation of Jatropha plants. By installing the developed pilot biodiesel plant at each district, dependence on diesel fuel for farm operations can be reduced. It offers business possibility to agricultural enterprises and rural employment.

