RENEWABLE ENERGY TECHNOLOGIES FOR ENERGY GENERATION FROM *JATROPHA CURCAS*

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Introduction

Oil is the major source (about 40%) of the world's primary energy consumption. India is currently the world's eighth largest consumer of oil and is expected to rise to fifth place in the next 20 years. The consumption and demand for the petroleum products are increasing every year due to increase in population, standard of living and urbanization. The petroleum products continue to be the backbone of Indian economy with a share of 33 per cent of the energy basket. In India, there is a deficit of 40 per cent in supply of petroleum products and our petroleum reserves are limited to 6 to 7 years only. The increase in crude oil import affects the country's economy and its development. In India, the expenditure on crude oil imports has increased sharply from Rs.6,118 crores in 1991 to Rs.90,000 crores in 2002, which is 14.7 times higher than what it was before. This is also expected to rise continuously.

Biodiesel - solution for the future

Apart from increase in fuel demands and limited petroleum reserves, diesel and other petroleum products are always under threat of supply instabilities and rise in oil prices in developing countries like India. The acid rain, global warming and health hazards are the results of ill effects of increased polluted gases like SOx, CO and particulate matter in atmosphere. The aforementioned issue really worries the planners and policy makers and there is urgent need to search for suitable alternate diesel fuel from renewable sources. Among the various renewable energy sources, seed oil-bearing crops have a potential as supplement for meeting the increasing requirements of petroleum and its products. Biodiesel crops have lot of scope to be planted in wasteland to

meet out the increasing diesel demand apart from helping the farming community by creating rural employment and reducing the oil imports and air pollution.

Jatropha plant

The oil plant, *Jatropha curcas* (L) is a multipurpose drought resistant large shrub or small tree. The biodiesel from jatropha oil has now become more economical as a diesel substitute. *Jatropha curcas* is a large shrub/small tree able to thrive in a number of climatic zones with rainfall of 250–1200 mm. It is well adapted in arid and semi-arid conditions and has low fertility and moisture demand. It can also grow on moderately sodic and saline, degraded and eroded soil. It can be raised by seeds or cuttings. It reaches its maximum productivity by five years and can live up to 50 years. One hectare jatropha plantation with 4400 plants per hectare under rain fed conditions can yield about 1500 litres of oil. It is estimated that about 3 million hectares plantation is required to produce oil for 10% replacement of diesel.

Jatropha byproducts

Transesterification technology is used to produce the biodiesel from the jatropha oil, which separates the glycerol from the raw jatropha oil. Glycerol is a raw material for different chemical products. Nowadays the people are interested to develop the jatropha plantations for biodiesel production. The cost of the jatropha biodiesel is depending on its byproduct costs. The oilcake cannot be used as animal feed due to its toxins *viz.,* curcasin and cursin. The detoxified oilcake can be used as animal feed, which increase the additional cost for detoxification. So the oilcake can be used as fertilizer and the cost of the oilcake is sold at lower price in the market at time of the peak oilcake production. The energy recovery from the other jatropha materials is remains untapped. This leads to less profit for jatropha plant growers.

Renewable energy technologies for energy generation

The biomass and other products generated from the jatropha plantations is shown in figure 1. The generation of huge quantity of these materials leads disposal problems and environmental pollutions. No attention has to be given for effective utilization of all products from the jatropha plantations. The renewable energy technologies are well proven technologies for generation of energy from different wastes and biomass materials. The path ways for energy generation from the jatropha plant materials is presented in this article to create the awareness of these technologies among the jatropha plant growers, researchers and people (table 1). These technologies are giving the solution to disposal problems and different kinds of energy fuels, extra income to jatropha growers. These technologies are helping the farming community by creating rural employment for unemployed youth and reducing the oil imports and air pollution.

Fig. 1. Biomass and other products generated from jatropha plantations

Table 1. Renewable energy technologies suitable for jatropha materials

S. No.	Jatropha biomaterials	Conversion technogies	Unit	Energy fuels
I. Thermo chemical conversion technologies				
1	Leaves	Extraction	Extraction unit	Biocrude
2	Biomass materials - Stems/wood	Combustion	Improved chulahs	Heat energy
		Pyrolysis	Pyrolyzer	Charcoal
		Gasfication	Gasifier	Producer gas
		Gasfication and fermentation	Gasifier and biorector	Ethanol
		Gasification	Gasifier	Producer gas
		Gasification	Gasifier	Hydrogen gas
		Briqueting	Briqueting machine	High calorific fuels
3	Shell	Briqueting	Briqueting machine	High calorific fuels
		Gasification	Gasifier	Producer gas
4	Oil seeds	Fast pyrolysis	Pyrolyzer	Biochar
5	Oil	Pyrolysis	Pyrolyzer	Biochar
6	Oilcake	Fast pyrolysis	Pyrolyzer	Biochar
II. Biochemical conversion technologies				
7	Oilcake	Biomethanation	Biogas plant	Biogas
		Pyrolysis	Pyrolyzer	Biooil
8	Oil	Enzymatic transesterification	Biodisel plant	Biodiesel
		Steam reforming	Steam reforming	Hydrogen
		Thermal cracking	Pyrolyszer	Hydrocarbon fuels
III. Chemical conversion technologies				
10	Oil	Transesterification	Biodiesel plant	Biodiesel
11	Biochar from Oilseed/oilcake	Distillation	Refinery units	Biofuels

SWOT analysis of jatropha plantation

a. STRENGTH

1 Promotion of barren lands cultivation
2 Renewable biological source.
3 Maintain carbon cycle.
4 Sustainable solution / Ideal solution for fossil fuels.
5 Reduce the oil imports.
6 Eco-friendly fuels.
7 Pay back period from plantations is nearly 40 years.
8 Erosion control and soil improvement.

b. WEAK

1 Energy recovery rate per unit area of jatropha plantations is low.
2 Production cost of biofuels is high.
3 Lacking of established standard protocol.
4 Unawareness of biofuel production technologies.

c. OPPORTUNITIES

1 Employment opportunities in production catchments and technological process.
2 Reduction in health hazards over existing fossil fuel emissions.

d. THREATS

1 Lacking in safe disposal methods for jatropha oilcake.
2 Encroachment of jatropha plantations in stable crop cultivation land.
3 Localized technology is not standardized.

Conclusions

Today India, a country with more than a billion people, faces the challenge of achieving growth and development in a sustained manner. Economic growth and development call for huge capacity additions in the energy infrastructure of the country. The challenge is in achieving the developmental objectives without adversely impacting the environment, natural resources, wild life and climatic conditions. Renewable energy technologies are useful for tapping energy from jatropha materials. These technologies show the production of energy fuels from jatropha materials, which plays vital role in the generation of energy for the future. The energy fuels from the jatropha can be used for electricity generation, engine running, thermal applications, fuel cell, cooking, lighting and etc. The application of these technologies is dependent on the degree of Research and development as well as their commercialization.

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