Jatropha Bio-diesel : An Alternative to Conventional Fuel -A Review

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ABSTRACT

Diesel engines have proved its utility in transportation, agriculture and power sector of India. The demand for diesel has risen rapidly due to increasing industrialisation and modernisation of the world. The economic development has led to a huge demand for energy, where the major part of that energy is derived from fossil sources such as petroleum, coal and natural gas. However the limited reserves of fossil fuels has drawn the attention of many researchers to look for an alternative fuels which can be produced from renewable feedstock.

In this paper, an attempt has been made to review the techniques used to generate biodiesel from Jatropha curcas oil. The results from the various experiments conducted by various scientist in different journals suggests that Jatropha oil and diesel blend with the engine exhaust gases could be a good substitute fuel for diesel engine in the near future.

Keywords: *Biodiesel; Jatropha curcas; Renewable sources; Trans-esterification; Catalyst.*

1. INTRODUCTION

Biodiesel, an alternative diesel fuel, is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable and non toxic, has low emission profiles and so is environmentally beneficial.

One hundred years ago, Rudolf Diesel tested vegetable oil as fuel for his engine. With the advent of cheap petroleum, appropriate crude oil fractions were refined to serve as fuel and diesel fuels and diesel engines evolved together. In the 1930s and 1940s vegetable oils were used as diesel fuels from time to time, but usually only in emergency situations. Recently, because of increases in crude oil prices, limited resources of fossil oil and environmental concerns there has been a renewed focus on vegetable oils and animal fats to make biodiesel fuels. Continued and increasing use of petroleum will intensify local air pollution and magnify the global warming problems caused by CO_2.

Natural vegetable oils and animal fats are extracted or pressed to obtain crude oil or fat. These usually contain free fatty acids, phospholipids, water and other impurities. Even refined oils and fats contain small amounts of free fatty acids and water. The free fatty acid and water contents have significant € effects on the trans-esterification of glycerides with alcohols using alkaline or acid catalysts. They also interfere with the separation of fatty acid esters and glycerol [1].

Energy is one of the most important resources for mankind and its sustainable development. Today the energy crises becomes one of the global issues confronting us. Fuels are of great importance because they can be burned to produce significant amounts of energy. Many aspects of everyday life rely on fuels, in particular the transport of goods and people. Main energy resources come from fossil fuels such as petrol oil and natural gas.

1.1 JATROPHA (JATROPHA CURCAS)

Jatropha curcas is a drought-resistant perennial, growing well in marginal/poor soil. It produces seeds with an oil content of around 37% [2]. The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The by-products are press cake a good organic fertilizer, oil contains also insecticide. It is found to be growing in many parts of the country, rugged in nature and can survive with minimum inputs and easy to propagate .Medically it is used for diseases like cancer, piles, snakebite, paralysis, dropsy etc. Depending on soil quality and rainfall, oil can be extracted from the Jatropha nuts after two to five years. It grows on well drained soils with good aeration and is well adapted to marginal soils with low nutrient content. Jatropha curcas grows almost anywhere, even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. The leaves shed during the winter months form mulch around the base of the plant. Its water requirement is extremely low and it can stand long periods of drought by shedding most of its leaves to reduce transpiration loss. Jatropha is also suitable for preventing soil erosion and shifting of sand dunes.

Fig1. Jatropha curcas seeds

1.2 TRANSESTERIFICATION

Trans esterification also called alcoholises, is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. This process has been widely used to reduce the viscosity of triglycerides. The trans esterification reaction is represented by the general equation.

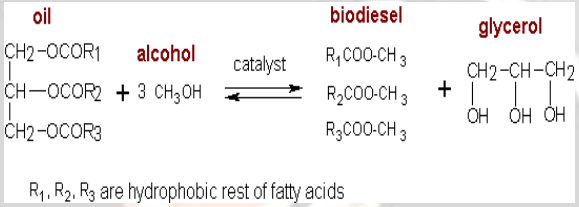

Fig2. Trans-esterification reaction

2. CHEMICAL PROPERTIES

There are various chemical properties of bio- diesel like density, viscosity, acid value, calorific value, flash point, and fire point, which can be obtained using several formulas, methods and apparatus.

2.1 Density

Volumetric mass density of a substance is its mass per unit volume.
Formula- Mass/Volume,
The density obtained is 0.86 Kg/l.

2.2 Viscosity

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress.
It is calculated with the help of equipment name Ostwald's viscometer. This is first done for water and then for oil. Avg. time for water is calculated and Avg. time for oil is calculated.

Formula: - Viscosity of water = d1*t1
Viscosity of oil d2*t2
Where,
d1, d2 =Density of water and oil.
t1, t2 = Average time of water and oil
Viscosity obtained =5.7* 10^{-3} mm^2 / s.

2.3 Acid Value

It is the actual mass of Sodium Hydroxide (NaOH) in milligrams that is required to neutralize one gram of chemical substance.
It is calculated with the help of titration using the below mention formula

Formula: – 56.1 * 1* Vol. of NaOH used
10*wt. of oil used
Result: 0.374 (acid value).

2.4 Flash Point and Fire Point

Flash point is the temperature at which first flame is obtained of the bio- diesel. And the *fire point* is the temperature at which it begins to fire or at which it gives continuous flame. These both can be determined with the help of **Pensky Martens apparatus.** The flash point calculated of oil is 99^{o}Cand fire point of bio-diesel is 120^{o}C.

2.5 Calorific Value

Defined in terms of the number of heat units liberated when unit mass of fuel is completely burnt in a calorimeter under specified conditions. Higher calorific value of fuel is the total heat liberated in kJ per kg .The calorific value of the fuel was determined with the Isothermal **Bomb Calorimeter.** The sample of fuel was ignited electrically. The water equivalent of bomb calorimeter was determined by burning a known quantity of benzoic acid and heat liberated is absorbed by a known mass of water. Then the fuel samples were burnt in bomb calorimeter and the calorific value of all samples were calculated. The heat of combustion can be calculated with the help of

Formula: $-H_c = W_c T / M_c$

Where,

H_c= Heat of combustion of the fuel sample, kJ/kg
W_c= Water equivalent of the calorimeter assembly, kJ/ ^{o}C
T = Rise in temperature, ^{o}C
M_c= Mass of sample burnt, kg

Table 1: Comparison of experimental and theoretical values of different of vegetables oil.

Vegetable oil	Experimental Sponification Value	Theoretical sponification value	Experimental Iodine Value	Theoretical Iodine Value	Experimental acid value	Theoretical acid value
Palm oil	105-110	106	97	95	190	218
Rapeseed oil	315.2	298	94.2	98	180	215
Linseed oil	189-195	188	165	170	197	181
Jatropha oil	196-200	199	96	101	5.31	8
Karanja oil	186-196	190	80	96	20	24
Mahua oil	190-195	191	60	63	18.38	27

Table 2: comparison of chemical properties of Diesel and Biodiesel

Properties	Biodiesel	Diesel
Density(kg/L)	0.864	0.838
Viscosity(mm^2/s) at 40 C	5.2	1.9-4.1
Flash Point	115	75
Acid Value(mgNaOH/g)	0.374	Max 0.5
Solidifying point	-12	-50 to 10
Fire Point	120	90-95
Heating Value(Mj/kg)	41	40-45

3. EMISSIONS PRODUCED BY BIODIESEL

Biodiesel can replace fossil fuel as a clean energy source. It can protect the environment by reducing CO_2, SO_2, CO, HC.

The carbon cycle of biodiesel is a dynamic through the photosynthesis process. Plants absorb CO2, which is more than those discharged by the biodiesel combustion process. Thus, using biodiesel can more effectively reduce the emission of CO2, protect the natural environment and maintain the ecological balance, compared to the use of fossil fuel [5].

Using biodiesel can also reduce air pollution. The use of biodiesel in a conventional diesel engine results in a substantial reduction of hydrocarbons, aromatic hydrocarbons, carbon monoxide, alkenes, aldehydes, ketones and particulate matter [2]. Nitrogen oxide emissions are slightly increased if the engine management remains unchanged [2]. However, this can be optimized using special software and biodiesel sensors. Using biodiesel decreases solid carbon fraction particulate matter and eliminates the sulphate fraction. Biodiesel from jatropha works well with new technologies such as catalysts, particulate traps and exhaust gas recirculation.

4. CHALLENGES

At the present time there are multiple obstacles that are need to be overcome as soon as possible so that biodiesel can become a main stream energy source. These issues range from feedstock costs and availability of feedstock to fuel quality and the international compatibility of biodiesel testing standard [4].

i. Currently the cost of a variety of feedstock used to make biodiesel is very high. This is due to the availability of this feedstock in that they will always have other uses besides being an energy source.
ii. Another challenge which the biodiesel industries are facing is quality control. One major difference that separates biodiesel from petro-diesel is how biodiesel behaves under extreme temperature conditions.
iii. The diversity of the biodiesel testing standards around the world is a major issue in the effort to make biodiesel a main stream energy source.

5. RESULT AND DISCUSSION

There are significant advantages using of biodiesel as a replacement of diesel fuel and its blends.

The vegetable oils use as raw material can be obtained from different oil crops that may be grown in a wide variety of environments, some of which are not adequate for traditional agricultural production. Moreover, used cooking oils and fat residues from the meat processing industry may also be employed in biodiesel production.

Biofuel is a new form of energy provides a greener and cost effective solution to the problem of depleting fuels. Efforts are needed to increase the cost effectiveness of its production. Advancement in technology is needed to improve the competitiveness of biofuels.

In large scale production plants, glycerine is usually recovered and purified since it is a valuable substance, with many applications in the pharmaceutical, cosmetics and chemical industries.

6. CONCLUSION

From above results and discussion it is quite clear that, biodiesel is a better replacement for diesel fuel used in CI engines.. As we know, diesel is non-renewable resource and will certainly vanish from the earth one day.

So we conclude that diesel can be replaced by biodiesel and it is best alternative conventional fuel and a true future of automobile.

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