Chemical Properties of Diesel and Bio-diesel from Jatropha oil Produced from Bio-reactor Plant

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Abstract— Diesel fuel is a petroleum distillate rich in paraffinic hydrocarbons. It is one of the greatest fuel invention ever in Automobile history. Diesel fuel particularly for diesel engines have certainly helped a lot. Their higher thermodynamics and fuel efficiencies is quite impressive.Petro-diesel is produced from frictional diatillation of crude oil between 392F and 662F at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule. But diesel fuel are one of the non-renewable resources, which can be replaced by biodiesel fuels. Biodiesel also called as fatty acid methyl ester (FAME) and can be obtained from any vegetable oil, animal oil, and other seed oils using some specific methods. The objective of this paper is to study the chemical properties of jatropha oil, so as get the clarity upto which extent diesel can be replaced by biodiesel... A study of various characteristics and chemical properties have been shown using both manual and bio-reactor methods. From our experiments, we have come to know that the various chemical properties are in comparison with the diesel fuel and can easily be replaced.

Key words: Jatropha Bio-Diesel, Energy Crisis, Biodiesel, FAME, Bio-Reactor plant

I. INTRODUCTION

Jatropha is a genus of flowering plants in the spurge family, Euphorbiaceae. It contains approximately 170 species of succulent plants, shrubs and trees (some are deciduous, like *Jatropha curcas*). Plants produce separate male and female flowers. As with many members of the family Euphorbiaceae, *Jatropha* contains compounds that are highly toxic. Jatropha species have traditionally been used in basketmaking, tanning and dye production. In the 2000s, one species, *Jatropha curcas*, generated interest as an oil crop for biodiesel production. Jatropha Curas is multipurpose small shrub, also known as physic nut or purging nut.[10]. It is drought resistant shrub belonging to tribe joannesieae in the family Euphrobiaceae which is mostly cultivated in Africa, India, some regions of central and South American [1].Jatropha is a poisonous, semi green shrub of 4-6m height. Moreover it is resistant to high industries. Also oil of the plant works as potential renewable resources, for various purposes, like lighting, cooking and substitute for diesel fuel [5], also for making soap, cosmetic and dye too. Jatropha curcas plants can also be used bio-insecticides or pesticides since extracts from the plant exhibit molluscicidal properties [6]. Byproduct of this plant cannot be used to feed animal as it has phorbol ester, responsible for its toxicity [7]. For the better utilization of jatropha curcas seeds and byproducts its all characteristics and properties should be known.

Biodiesel is a fuel that can be a direct replacement for petroleum-based diesel in diesel engines. Biodiesel is produced using a transesterification process, reacting vegetable oils or animal fats catalytically with a short chained aliphatic alcohol. Glycerol is a by-product of this transesterification process. Trans-esterification is the process in which biodiesel is produced by reacting alcohol, methanol or ethanol, with oil or fat in the presence of a catalyst. After the trans-esterification the liquid needs to settle and separates into glycerin and biodiesel. The glycerin is drained; the biodiesel washed with water to filter out any remaining glycerin or other impurities and then allowed to dry in an open container placed in a well-ventilated area. The end results are biodiesel, glycerin, wastewater, oil and alcohol (the latter two can be recycled or discarded depending upon the quantity and its capabilities).

II. MATERIALS AND METHODS

The materials for making biodiesel are *Jatropha* oil which is obtained from the *Jatropha* plant (which was directly purchased from the market), KOH, Methanol. The production of bio-diesel was done by using a Bio-reactor plant [10].

The below reaction is the transesterification process:

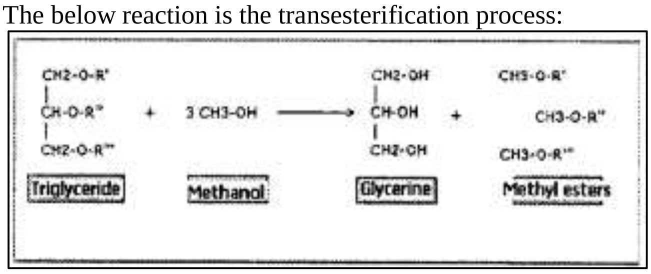

Fig. 1: Chemical reaction of biodiesel

The bio- reactor is basically an automated machine to produce the bio-diesel. The procedure involved in this case is as following-

a) Set the temperature of the reactor at 60^{o}C. Pour the Jatropha oil (2lt), maintaining the temperature at 60^{o}C and then add the mixture of methanol (400 ml) and KOH (10 gm.).
b) In this stirrer is already there which will rotate and mix the whole mixture for 2-3 hours and the speed of stirrer should not exceed the value 100rpm. It should be maintained between 80-100 rpm. During the process, there is continuous supply of water to the condenser of the main chamber so that the evaporated methanol can be poured back to the main chamber.
c) After completion of the mixing process, take about 500 ml of the mixture from the outlet nozzle at the bottom of the reactor drum, to check whether the reaction is completed or not. The colour changes from dark yellow to transparent yellow. If yes, then the mixture is kept for some time until the glycerol settles down and bio- diesel with impurities is obtained. Then again the washing is done of this impure bio-diesel to obtain the pure biodiesel.

Fig. 2: Bio-rector machine [8]

III. CHEMICAL ANALYSIS OR 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 methods and different apparatus.

A. Density

- Mass per unit volume.
- *Formula*- Mass/Volume
- *It was calculated manually.*
- The density obtained is 0.86 Kg/l.

B. 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 (water being the standard fluid) 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.

C. 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 mentioned formula *Formula*: – 56.1 * 1 * Vol. of NaOH used

10 * wt. of oil used Result: 0.374 (acid value).

D. 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^oC . Fire point of bio-diesel is 120^oC.

E. Calorific Value

It is 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 bio-diesel was determined with the Isothermal **Bomb Calorimeter** [8]. The sample of fuel was ignited electrically. The water equivalent of bomb calorimeter was determined by burning a known quantity of bio-diesel and heat liberated was absorbed by a known mass of water. 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/ ^oC T = Rise in temperature, $_oC$ M_c = Mass of sample burnt, kg.

Chemical Properties	Biodiesel	Diesel
Density(Kg/L)	0.86	0.838
Viscosity(mm^2/s)	$5.7*10^{-3}$	$5.2*10^{-3}$
Acid value	0.374	Max-0.5
Flash Point (^oC)	99	75
Fire Point(^oC)	120	120-130
Calorific Value(Kj/Kg)	40	40-45

Table 1: Desirable Chemical Properties of Biodiesel and Diesel

IV. RESULT AND DISCUSSION

Jatropha curcas oil is successfully converted into Jatropha biodiesel using both manual and bioreactor method.

All the desirable chemical properties of Biodiesel are in comparison with the diesel. Bio- diesel is a viable substitute for our future needs in automotive industry [11].

V. CONCLUSION

Production of bio-fuel from plant materials is a major step toward harnessing one of the world's most-prevalent, yet least-utilized renewable energy resources.[10] The main aim of the present investigation was to produce bio-diesel from jatropha oil by using different methods. The resulting biodiesel has almost the same chemical structure as traditional diesel and burns the same way in diesel engines. This comparison helped us to figure out that with certain modifications in the chemical properties of the bio-diesel, it can replace the existing endangered diesel fuel completely so as to use it as 100% in CI engines.

India, with its huge waste/non-fertile lands, has taken a well noted lead in the cultivation. Since the knowledge-base/expertise for jatropha has been inadequate in India, there is an ardent need for setting up specialized extension service centres for its cultivation and propagation.

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