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# Characterization of Jatropha Oil, An Alternative Fuel

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## ABSTRACT

There has been greater awareness on biodiesel in developing countries in the recent time and significant activities have picked up for its production especially with a view to boost the rural economy. Biodiesel, a promising substitute as an alternative fuel for diesel has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. The utilization of liquid fuels such as biodiesel produced from Jatropha oil by trans-esterification process represents one of the most promising options for the use of conventional fossil fuels. The Jatropha oil is converted into Jatropha oil methyl ester known as biodiesel prepared in the presence of homogeneous acid catalyst. The physical properties such as Calorific value, density, flash point, kinematic viscosity, Cloud point and Pour point were studied out for Jatropha oil methyl ester. The same characteristics study was also carried out for the diesel fuel for obtaining the base line data for analysis. The study reveals that the values of properties obtained from the study of Jatropha methyl ester is closely matched with the values of conventional diesel and can be used in the existing diesel engine without any modification.

## I. INTRODUCTION

As civilization is growing, transport becomes essential part of life. The biggest problem is the growing population & depletion of fossil fuel. About 100 years ago, the major source of energy shifted from recent solar to fossil fuel (hydrocarbons). Technology has generally led to a greater use of hydrocarbon fuels, making civilization vulnerable to decrease in supply. This necessitates the search for alternative of oil as energy source.

Biodiesel is an alternative fuel for diesel engine. The esters of vegetable oils and animal fats are known collectively as biodiesel. It is a domestic, renewable fuel for diesel engine derived from natural oil like Jatropha oil. Biodiesel has an energy content of about 12% less than petroleum-based diesel fuel on a mass basis. It has a higher molecular weight, viscosity, density, and flash point than diesel fuel. Jatropha curcas is unusual among tree crops is a renewable non-edible plant. From jatropha seeds jatropha oil can be extracted which have similar properties as diesel but some properties such as kinematic viscosity, solidifying point, flashpoint and ignition point is very high in jatropha oil. By some chemical reactions, jatropha oil can be converted into biodiesel. Jatropha oil can also be used directly by blending with diesel.
Practically high viscosity of vegetable oil (30-200 centistokes) as compared to that of diesel. (5.8-6.4 centistokes) leads to unfavorable pumping; inefficient mixing of fuel with air contributes to incomplete combustion, high flash point results in increase carbon deposit Formation and inferior cooking. Due to these problems, vegetable oil needs to be modified to bring the combustion related properties closer to those of diesel oil. The fuel modification is mainly aim at reducing the viscosity and increasing the volatility.

One of the most promising processes to convert vegetable oil into methyl ester is the trans-esterification, in which alcohol reacts with triglycerides of fatty acids (vegetable oil) in the presence of catalyst. Jatropha vegetable oil is one of the prime non edible sources available in India. The vegetable oil used for biodiesel production might contain free fatty acids which will enhance saponification reaction as side reaction during the trans-esterification process. Vegetable oil has the characteristics compatible with the CI engine systems. Vegetable oils are also miscible with diesel fuel in any proportion and can be used as extenders. India highly depends on import of petroleum crude and nearly two third of its requirement is met through imports. Moreover the gases emitted by petrol, diesel driven vehicles have an adverse effect on the environment and human health. Jatropha oil has potential as an alternative energy source. This will enable our country to become independent in the fuel sector by promoting and adopting biofuel as an alternative to petroleum fuels. The oil extracted from jatropha seeds can be used as a substitute for kerosene without any further processing. This is more economical compared to kerosene crude oil, which are used for electrification. It is found from researches that the neat jatropha oil can be used run engines in mini-vans for rural transportation ,haulage trucks, farm tractors and other agricultural machinery, but may requires little modification. Show the alternative society has to choose from, altogether with the advantages and disadvantages of each of them.

**Source of Jatropha oil:-**

The plant that is generally cultivated for the purpose of extracting jatropha oil is Jatropha curcas. Owing to the toxicity of jatropha seeds, they are not used by humans. The major goal of jatropha cultivation therefore is performed for the sake of extracting jatropha oil. Oil that is produced from the seeds of Jatropha plant that grows in all the common and marginal lands is called as jatropha oil. The main goal of cultivating jatropha all over the world is to extract oil from the seeds which is used as an alternative energy source. Jatropha oil extraction methods have also gained the same importance like jatropha cultivation. Since the oil extracted from jatropha seeds is the primary source for bio-fuel, the process of extraction methods have also become significant.

The oil extracted from the seeds is processed to prepare high quality bio-fuel an alternative source that can be used in diesel car. While the residue that remains after extracting oil is also processed and used a biomass feedstock to produce electricity and is also used as a fertilizer. Jatropha oil is non edible and is also poisonous. Jatropha has to be made with two process to get a better yield of 92% otherwise a yield of less the 85% only will be got. Analysis of Jatropha curcas seed shows the following chemical compositions

| | |
|---|---|
| Moisture | : 6.20% |
| Protein | : 18.00% |
| Fat | : 38.00% |
| Carbohydrates | : 17.00% |
| Fibre | : 15.50% |
| Ash | : 5.30% |

The oil contain is 50-60% in the seed. The oil contains 21% saturated fatty acid and 79% unsaturated fatty acid. These are some of the chemical element in the seed, cursine, which is poisonous and render the oil not appropriate for human consumption.

**As an energy source:-**

Oil from jatropha curcas: There are number of variety of jatropha. Best among these are jatropha curcas. Jatropha oil is an important product from the plant for meeting the cooking and lighting needs of the rural population, boiler fuel for industrial purpose or as a viable substitute for Diesel. About one- third of the energy in the fruit of jatropha can be extracted as oil that has a similar energy value to Diesel fuel. Jatropha oil can be used directly in Diesel engines added to Diesel fuel as an extender or trans esterified to a bio-diesel fuel. There are some technical problems to use

jatropha oil directly in Diesel engines that have yet to be completely overcome. Moreover, the cost of producing jatropha oil as a Diesel substitute is currently higher than the cost of Diesel itself. It is significant to point out that, the non edible vegetable oil of jatropha curcas has the requisite potential providing a promising and commercially viable alternative to diesel oil since it has desirable physical chemical and performance characteristics comparable to diesel. Cars could be run with jatropha oil without requiring much change in design. Jatropha oil expelled from seeds and filtered through filter press can replace kerosene or oil lamp.

Jatropha oil can be used as liquid fuel for lighting and cooking. It will also be used in big Diesel engine based electricity generating sets, pump sets, heavy farm machinery, where the viscosity of oil is not an issue. The seeds of jatropha contain (50% by weight) viscous oil which can be used for manufacture of candles and soap, in the cosmetic industry, for cooking and lighting by itself or as a Diesel /paraffin substitute or extender.

**Other products of Jatropha curcas:**

The jatropha oil can be used for soap production and cosmetics production in rural areas. The oil is a strong purgative, widely used as an antiseptic for cough, skin diseases and as a pain reliever from rheumatism. Jatropha oil has been used commercially as a raw material for soap manufacture for decades, both by large and small industrial producers.

When jatropha seeds are crushed, the resulting jatropha oil can be processed to produce a high quality biodiesel that can be used in a standard diesel car, while the residue (press cake) can also be processed and used as biomass feedstock to power electricity plants or used as fertilizer (it contains nitrogen, phosphorous and potassium).

**Yield of Jatropha oil:-**

It is often considered that a more effective extraction technique would yield greater quantities of oil. This is partly inaccurate, since an effective extraction method would only yield the optimum quantity and not more than that. The optimum oil content in jatropha plant varies between species and genetic variants.

Climatic and soil condition generally affects the yield of the oil as well. However, improper processing technique such as prolonged exposure of the harvested seeds to direct sunlight can impair the oil yield considerably. The maximum oil content that has been reported in jatropha seeds has been close to 50-60%. However, the accepted average is 40%, and the fraction that can be extracted is taken to be around 91%.

Below are some of the methods that are usually followed to extracts the oils from jatropha seeds.

**Oil Presses: -**

Oil presses method is used to extract the oil using simple mechanical devices. It is also done manually. The most commonly used oil presses method is the Bielenberg ram press method. Bielenberg ram press method is a simple traditional method that uses simple devices to extract the oils. With the help of this method 3 liters of oil can be obtained with 12 kg of seeds.

**OilExpellers:-**

Oil expeller's method is also use for jatropha oil extraction. The most commonly used method is the Sayari oil expeller method. This method is also called as Sundhara oil expeller. Komet oil expellers are also used. These sayari oil expellers was developed in Nepal and is a diesel operated one. Now it is developed in Tanzania and Zimbabwe mainly for the production jatropha oil. Heavy oil expellers are made of heavy cast iron and the light ones are made up of iron sheets. Electricity driven models are also available. Komet oil expeller is a single oil expeller

machine that is used not only to extract the jatropha oil as well for the preparation of the oil cakes.

Traditional Methods:-Traditional methods are used in the rural and developing areas for extracting the oils. Traditional methods are simple and the oil is extracted by hand using simple equipment.

**Hot oil extraction:-**

The process of extracting the oil at high pressure is called as hot oil extraction method. Since jatropha oil can regulate the operating temperature it is extracted using the hot oil extraction method.

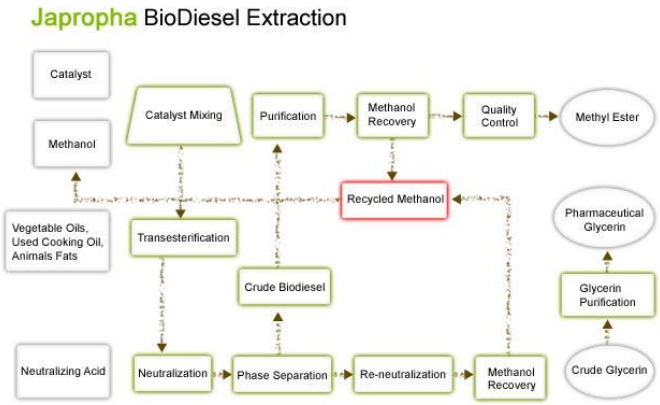
Then the cold oil extraction method it is easy to extract the oil from the hot oil extraction since the oil flows more easily due to higher viscosity. And the press cake that remains after extracting the oil also have less oil content which might be 3 to 7 % approximately. These two reasons make the oil press method very interesting. During the oil extraction method many stuffing of the seeds are converted into gum like substances and some non organic substances. These are unwanted products and so they have to be refined.

**Modern Concepts:-**

Modern methods are followed to extract more oils from the jatropha seeds. In these modern concepts chemical methods like aqueous enzymatic treatment is used. The maximum yield by following this modern method is said to be about 74/5. The main idea in researching the modern concepts is to extract a greater percentage of oil from the jatropha seeds

**Jatropha Biodiesel Process:-**

Trans-esterification is the process of converting the oil produced from vegetables into biodiesel. The process is less complex and it is quite easy. Trans-esterification is a chemical based production of biodiesel from jatropha oil. In this process a complex fatty acids like triglyceride molecule is taken and it is neutralized. The glycerin is removed and an alcohol ester is created. This process is completed when methanol is mixed with sodium hydroxide. This result in the production of sodium methoxide which is then mixed with oil produced from the jatropha seeds. When the mixture settles glycerin is left at the bottom and the biodiesel (methyl esters) remains on the top. This methyl ester is washed and then filtered




**Trans-esterification Biodiesel Process**

Raw materials required

- Jatropha oil
- Methanol
- Potassium hydroxide
- Isopropyl alcohol
- Distilled water
- Phenolphthalein solution
- Vinegar
- Water

**Manufacturing Process**

First jatropha oil is filtered to remove the solid particles present in it. Then it is heated to remove the water contents if any present in it. Biodiesel is now been used as a diesel engine in number of agencies. The results are said to be comparable with petroleum in all the areas like power, efficiency, climbing, hauling etc. To determine the amount of catalyst that is required for catalyst. The accurate amount of potassium hydroxide is mixed with methanol till the methanol completely dissolves to get potassium methoxide. In the winter season additional jatropha

oil is heated and is mixed with the potassium methoxide. The mixture is allowed to settle. In this process glycerin settles at the bottom and the biodiesel at the top. The glycerin is then removed and the biodiesel is washed and dried. The biodiesel that is obtained is then checked for quality

**Note:** In this process when methanol and potassium hydroxide to produce potassium methoxide which when mixed with oil produces strong polar bond. This breaks the fatty acids into glycerin and biodiesel (esters).

**Biodiesel Characterization:-**

The specific gravity reduces after trans-esterification, viscosity from 57 to 4.73 centistokes, which is acceptable as per ASTM norms for biodiesel. Flash point and fire point are important temperatures specified for safety during transport, storage and handling. The flash point and fire point of biodiesel was found to be 128°C and 136°C respectively. Flash point of jatropha oil decreases after trans-esterification, which shows that its volatile characteristics had improved and it is also safe to handle.

Higher density means more mass of fuel per unit volume for vegetable compared to diesel oil. The higher mass of fuel would give higher energy available for work output per unit volume. Higher viscosity is a major problem in using vegetable oil as fuel for diesel engines.

**Table 1.** The properties, Diesel, Jatropha Oil and biodiesel

| Property | Diesel | Jatropha oil | Biodiesel |
|---|---|---|---|
| Flash Point °C | 65 | 214 | 128 |
| Fire point °C | 78 | 256 | 136 |
| Pour Point °C | -6 | 6 | -2 |
| Cloud Point °C | 5 | 11 | 8 |
| Viscosity at 40°C | 2.86 | 36.92 | 4.82 |
| Viscosity Index | 98 | 181 | 154 |
| Specific Gravity (29°C) | 0.792 | 0.944 | 0.84 |
| Refractive Index at 40°C | 1.32 | 1.61 | 1.46 |
| Calorific Value (MJ/kg) | 44.34 | 39.76 | 42.80 |

## II. CONCLUSION

In the current investigation, it has confirmed that jatropha oil may be used as resource to obtain biodiesel. The viscosity of jatropha oil reduces substantially after trans-esterfication and is comparable to diesel. Biodiesel characteristics like density, viscosity, flash point, cloud point and pour point are comparable to diesel. Biodiesel is a viable substitute for petroleum based diesel fuel. Its advantages are improved lubricity, higher cetane number, cleaner emission (except for NOx), reduced global warming, and enhanced rural development. Jatropha oil has potential as an alternative energy source. This will enable our country to become independent in the fuel sector by promoting and adopting biofuel as an alternative to petroleum fuels.

## III. REFERENCES


[1]. Ofori-Boateng Cynthia, Feasibility of Jatropha oil for Biodiesel: Economic Analysis, World Renewable energy Congress 2011 Sweden.

[2]. Kazi Mostafiejur Rehaman, Biodisel from Jatropha oil as an alternative fuel for Diesel engine, International journal of Mechanical & Mechatronics IJMME-IJENS.

[3]. S. Antony Raja, Biodisel production from Jatropha oil & its characterization, Research Journal of Chemical Science Vol. 1(1) April (2011

[4]. S. Antony Raja, Biodiesel production from Jatropha oil & its charecterisation, Research Journal of Chemical Science Vol. 1(1) April (2011)