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Experimental Studies on Production of Biodiesel from Thevetia Peruviana Feedstock

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ABSTRACT

Biodiesel, an alternative and renewable fuel for diesel engines, consists of alkyl esters of long chain fatty acids, more commonly methyl esters and is typically made from nontoxic, biological resources such as edible and non-edible vegetable oils, animal fats, waste cooking oils etc. by transesterification with methanol. Despite many processes of biodiesel production, transesterification method is successfully employed to reduce the high viscosity of triglycerides and improve other characteristics of biodiesel fuel.In this study the production of biodiesel from Thevetia Peruviana has been carried out.

Keywords–Biodiesel, Production, Seeds, Thevetia Peruviana, Transesterification

I. INTRODUCTION

Under Indian conditions plant varieties, which are non-edible and which can be grown abundantly in large-scale on waste lands, can be considered for biodiesel production. Some of the prominent non-edible oil seed producing plants include Jatropha curcas, Pongamia pinnata, Neem and Rubber seed etc. In this research work, biodiesel production from a new plant source called Thevetia Peruvianahas been investigated. Due to rapid population growth and economic development, the worldwide energy demand is constantly increasing. The energy demand is fulfilled mainly from the conventional energy resources like coal, petroleum and natural gas. But, the petroleum reserves concentrated in certain regions of the world are fast depleting day by day and at the current usage rate, these sources will soon be exhausted. Recently, due to the shortage of fossil fuels throughout the world, crude oil price increase and contribution of these fuels to pollute the environment, biodiesel is being attracting increasing attention worldwide as a potential alternative and renewable fuel for diesel engines.

II. PLANT DETAILS

Thevetia Peruviana, called Bitti or Kaner in Marathi, is a small evergreen tree (3-4 m high) cultivated as an ornamental plant in tropical and subtropical regions of the world, including India. Fruit contains 1 flat gray colored seed, which yield about half a liter of oil from one kg of dry kernel. ThevetiaPeruviana plant and flower are shown in Figures 1 and 2 respectively. This plant can be cultivated in wastelands. It requires minimum water when it is in growing stage. It starts flowering after one and a half year. After that, it blooms thrice every year.

Fig 1. Thevetia Peruviana Plant

Fig 2. Thevetia Peruviana Flower

Considering all options available among non-edible tree-bearing oil seeds, Thevetia Peruviana has been identified as one of the most suitable seeds. It grows practically all over India under a variety of agro-climatic conditions. Thus it ensures a reasonable production of seeds with very little inputs. Figures 3 show the Thevetia Peruviana fruit and seed as well as kernels.

Fig 3. Thevetia Peruviana fruits with seeds and kernels

III. METHODOLOGY

Fig 4. shows the operations involved in preparation of biodiesel from Thevetia Peruviana Seed Oil. While collection of fruits and removing flesh from the fruit for collection of seed, wearing gloves is essential; because the entire parts of the plan is milky nature.

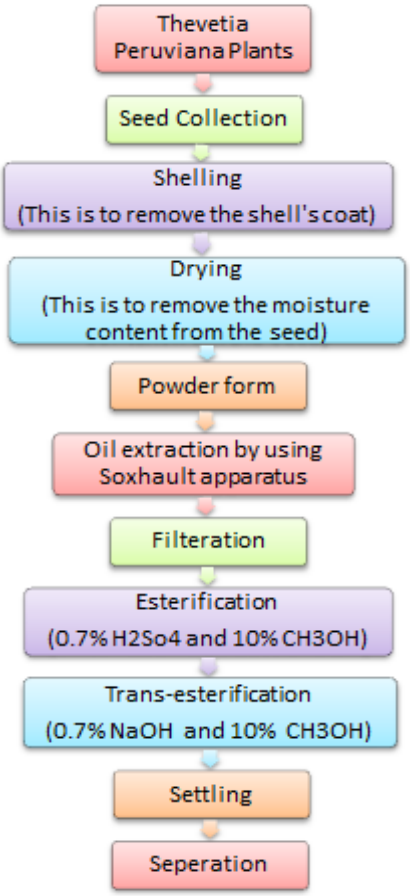

Fig 4. Flow chart of TPSO Extraction Process

IV. TRANSESTERIFICATION REACTION

Transesterification is a most commonly used and an important method to reduce the viscosity of vegetable oils. In this process triglyceride reacts with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acids, alkyl ester and glycerol. The process of removal of all the glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called esterification

This esterified vegetable oil is called bio-diesel. Biodiesel properties are similar to diesel fuel. It is renewable, non-toxic, biodegradable and environment friendly transportation fuel. After esterification of the vegetable oil its density, viscosity, cetane number, calorific value, atomization and vaporization rate, molecular weight, and fuel spray penetration distance are improved more. So these improved properties give good performance in CI engine.

Physical and chemical properties are improved in esterified vegetable oil because esterified vegetable oil has a higher cetane number than straight vegetable oil. These parameters induce good combustion characteristics in vegetable oil esters. So unburnt hydrocarbon level is decreased in the exhaust. It results in lower generation of hydrocarbon and carbon monoxide in the exhaust than diesel fuel. The vegetable oil esters contain more oxygen and lower calorific value than diesel. So, it enhances the combustion process and generates lower nitric oxide formation in the exhaust than diesel fuel.

The step by step procedure to carry out ransesterification is as follows:

- Prepare standard solution of 1000ml of distilled water + 4 gms of NaOH.
- In burette take this standard solution.
- In another conical flask take 50 ml of Isopropyl alcohol.
- Neutralize it by using 3 to 4 drops of burette solution.
- Now add 10 gms of raw oil to the conical flask.
- Heat up to 60˚C in heating oven.
- Cool the flask.
- Add 3 to 4 drops of Phenophtlene indicator.
- Titrate against burette solution until pink colour appears.
- FFA = 28.2 × Normality of NaOH ×titration value/ Weight of oil

Chemistry of Transesterification

Transesterification is the process of using an alcohol (methanol or ethanol) in the presence of catalyst, such as sodium hydroxide (NaOH) to chemically break the molecule of the raw renewable oil into methyl or ethyl esters with glycerol as a byproduct.

Benefits of Transesterification

- Reduces viscosity of the oil
- Improves lubricity
- Improves cetane number

- Improves emission with oxidation catalysts
- Increases the volatility

Transesterification Setup

The setup (Fig 5) in which the methyl ester of TPSO was prepared consists of the following components.

- Round bottle flask
- Condenser
- Mechanical stirrer
- Dimmer start
- Thermometer
- Measuring jars
- Separating funnel

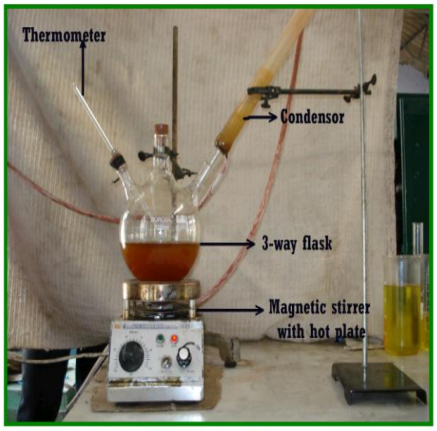

Fig 5. Transesterification Setup

Openings are provided in the round bottom flask for connecting condenser and temperature sensor. The heater coil surrounds the reactor vessel and it provides uniform heating all-round the flask. The magnetic stirrer enables proper mixing of the TPSO and methanol. The speed of the stirrer is adjustable. Dimmer start is used to control the voltage so that constant temperature can be maintained. Condenser is used to condense alcohol if it vaporizes from the mixture. Separating funnel helps to separate biodiesel from glycerol.

V. CONCLUSION

The transesterification of Thevetia Peruviana biodiesel has been successfully carried out. The properties of Thevetia Peruviana biodiesel are closely related with diesel.

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