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Experimental Transesterification Process, Properties Assessment of Neem, Safflower, Corn Oil for CI Engine Application

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Abstract:

Environmental concern and fossil fuel depletion have forced the researchers to concentrate on finding for alternate source of energy. Biodiesel is a renewable, clean-burning fuel which can be produced from vegetable oils. These oils cannot be used directly in to the engine due their higher viscosity. Hence, fuel and engine-based modifications is required to improve the performance, emission and combustion parameters of the CI engines. Some issues related to the use of biodiesel as working fuel are its oxidation stability and performance. Different types of catalyst have been considered for transesterification process by various researchers all over the world. The method of transesterification processes is based on free fatty acid (FFA) content in the vegetable oil. If the FFA value is less than 2% used alkaline transesterification more than that acid esterification. In this study, the various vegetable oils such as neem, safflower and corn oil undergo alkaline transesterification process by using potassium hydroxide (KOH) as a catalyst with methanol, to convert into biodiesels. Their Properties have analyzed for these fuels used in a CI engine.

Keywords: Safflower oil, Neem oil, Corn oil, biodiesel, transesterification, catalyst.

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I. INTRODUCTION

In the past few decades extensive use of petroleum has led to depletion of fossil fuel. Increasing human population and industrialisation has led to scarcity of petroleum reserves. Particularly, in developing country like India, fuel imports cause serious economic consequences in the form of budget deficits (accounting for 70% of total import expenditure). However, the demand of fossil fuel is rising day by day and hence the major fuel source of diesel engine, the petroleum based fuel, is depleting rapidly. Many countries depend mainly on imported fossil fuels due to lack of fuel reserves and it has great impact on the economy. This has made alternate energy resources more attractive. The alternative energy resources should be renewable, sustainable, efficient and cost effective. Biodiesel is considered as one of the Promising alternative resources for CI engine. In this present study we are selected three vegetable oils namely Neem, Safflower, and corn oil to reduce the viscosity by suitable method and improve the fuel properties significantly. The availability of each vegetable oil is discussed below.

1.1 Safflower oil

Safflower, botanically known as *Carthamus tinctorius L*. India is the largest producer of safflower in the world
with the production hovering around 0.2 million tonnes. Safflower seeds are primarily used for oil

production for domestic consumption in India. Safflower is a highly branched, herbaceous, thistle-like annual plant. It is commercially cultivated for vegetable oil extracted from the seeds. The seed of safflower oil is white in color and has lot of proteins and fats. The extracted oil from these safflower seeds is colorless and flavorless. It is basically same as sunflower oil but safflower oil is more nutritious. It has less fatty acid than olive oil. Safflower seeds usually have 40% of oil by weight. It has yellow, orange or red flowers. Each branch will usually have from one to five flower heads containing 15 to 20 seeds per head. Safflower is native to arid environments having seasonal rain. It grows a deep taproot which enables it to thrive in such environments.

1.2. NEEM OIL

Neem, botanically known as *Azadirachta indica.* Neem essential oil is usually prepared from the seed kernels and is well known for its high insecticidal and medicinal value. The fruit, flower, and leaves are minor sources of neem essential oil. According to a survey, only 20% of the seeds are being harvested due to scattered growth of neem trees in India. Out of it, India produces approximately 8300 tonnes of neem oil annually. India is a largely agrarian society with more than hundred million families dependent on farming for a living. The liberalized Indian economy still depends on the success of agricultural production and 35 - 40% of India's National Income comes from agricultural sources. It is indigenous to India and found in tropical and subtropical regions like Pakistan, Bangladesh, Sri Lanka, and Mayanmar. The Siwalik hills, dry forests of Andhra Pradesh, Karnataka, and Tamil Nadu (India) are the main habitat of the wild population. Neem is a renewable source of various useful products-seeds and leaves being of particular interest. A fully-grown tree yields about 50 kg fruits and about 350 kg leaves annually. From about 14 millions neem trees that grow in India, 0.7 million metric tonnes of fruits and about 5 million metric tonnes of leaves, besides, 83,000 tonnes of Neem oil and 3,30,000 tonnes of Neem cake are expected to be produced annually.

1.3 CORN OIL

Corn, botanically known as (maize).Corn oil belongs to the group of vegetable oils with high levels of linoleic and oleic acids. In India nearly 2.6 thousand quintals of corn oil is produced corn based factories. Average cumulative extraction capacity of these factories is 2.41 thousand tonnes /day. On an average these factories can extract 3.0-3.5% oil from corn, which contains 5-6% of oil. Thus there is immense scope to increase the production of corn oil only by improving the efficiency of oil extraction from corn germs.

2. Various methods are used to reduce the high viscous vegetable oil such as blending, emulsification, pyrolysis, and transesterification. Among these, transesterification is an attractive and widely accepted technique. The different methods of production were discussed below.

2.1 Blending: In this method, vegetable oils are directly mixed with the diesel / secondary fuels like alcohols (ethanol,methanol, butanol, pentanol etc..). The blending fuel percentage of diesel/alcohol is limited to 30% by volume or up to the knocking limit of the engine.

2.2 Emulsification: This process is used mixed with two different fuels uniformly. The breakdown of fat globules in the duodenum into tiny droplets, which
provides a larger surface area on which the enzyme pancreatic lipase can act to digest the fats into fatty acids and glycerol.

2.3. Pyrolysis: It is the process that causes the break of the molecules by heating at high temperatures that is, by the heating of the substance in the absence of air or oxygen in temperatures superior to 450°C forming a mixture of chemical compounds with properties very similar to those of petro diesel. It is the chemical process which converts the vegetable oils into alkanes, alkenes, carboxylic acids and aromatics in the absence of oxygen by applying heat at various higher temperatures. Several vegetable oils like Palm oil, soybean oil, castor oil, sunflower oil were used successfully for pyrolysis technique in the past.

The demerits are the equipment for the pyrolysis is expensive.

2.4. Transesterification: It is the chemical process in which all glycerol and the fatty acids are removed from the vegetable oil in the presence of catalyst. In these process large and branched triglycerides molecules of vegetable oil and animal fats are converted into smaller and straight chain

molecules that is similar to diesel fuel molecules. It is the best, cheap, simple method used so far commercial application and the physical and chemical properties are much close to diesel fuel. Table.1.Shows the properties of neat safflower, neem and corn oil

Table 1. Properties of neat vegetable oil

PROPERTIES	SAFFLOWER OIL	NEEM OIL	CORN OIL
Density @15˚C (g/cc)	0.930	0.965	0.915
Kin. Viscosity @40˚C (cSt)	28.3	28.5	65.1
Lower Calorific Value (kJ/kg)	39,000	40,000	41,200
Cetane Index	-	40	37.6

3. Transesterification Process

Fig.1 shows the esterification test setup employed for transesterification process. Neat safflower, neem and corn oil was converted into biodiesel through the alkaline transesterification reaction for which sodium hydroxide / potassium hydroxide (NaOH/ KOH) was used as a catalyst with methanol. One percent of sodium hydroxide catalyst was dissolved in methanol by 50% in volume and mixture was added to the safflower oil. Then the prepared mixture was stirred at 60ºC for 30 minutes. After that, the reactant material was poured into a transparent vessel and allowed for cooling at room temperature for 8 hrs. It was allowed to settle for separation of glycerol as the bottom layer. The upper layer of biodiesel was put into another transparent vessel for washing with an equal amount of water. The respective biodiesel was heated above 100ºC for 10- 20 minutes to remove excess water. Then the biodiesel was cooled down to room temperature before use. The Schematic diagram of esterification test setup is shown in fig 1.

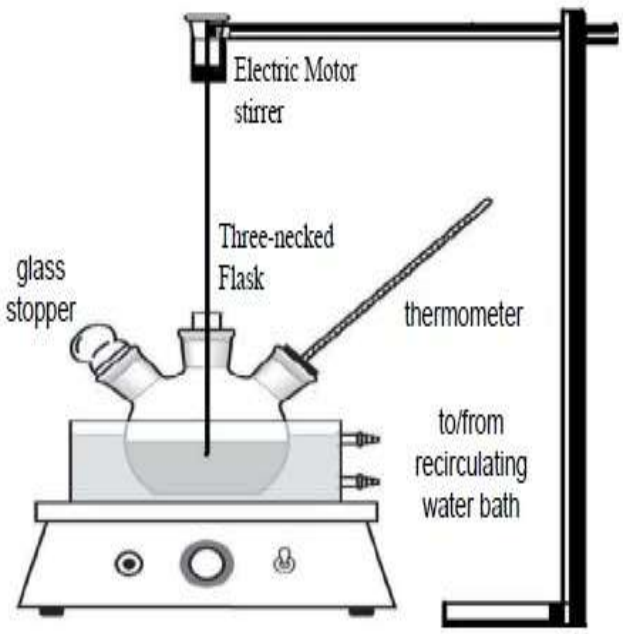

Fig. 1 Schematic diagram of esterification test setup.

Table.2. Shows the properties of safflower, neem and corn oil methyl esters.

Table.2 Properties of biodiesel

PROPERTIES	SME	NOME	COME
Density @15˚C (g/cc)	0.8929	0.910	0.876
Kin. Viscosity @40˚C (cSt)	6.61	4.2	4
Lower Calorific Value (kJ/kg)	38,646	39,820	39,930
Cetane Index	34	55	54

4. Conclusion:

In this research the three vegetable oils such as Neem, safflower and corn oil undergo transesterification process to reduce the viscosity of the oil and converted into SME, NOME and COME. The various properties were analyzed by this

transesterification process and these methyl esters can be effectively utilized in CI engine for obtaining the performance characteristics.

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