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Production of Hybrid Oil Biodiesel (Nahar Oil and Waste Cooking Oil) and Quality Testing

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Abstract: *The need to search for alternative sources of energy which are renewable, safe and non- polluting frequent price hikes of fossil fuels in the international market assumes top priority in view of the uncertain supplies. Biodiesel (fatty acid methyl ester) which is derived from triglycerides by trans-esterification has attracted considerable attention as well as highly discussed topic during the past decade as a renewable, biodegradable and nontoxic fuel. Several processes of biodiesel fuel production have been developed, the present work deals with the property, performance & emission characteristics of biodiesel obtain by mixing Nahar oil methyl ester with waste cooking oil methyl ester Nahar seed oil. The kinematic viscosity, density and pour point were found to be higher than that of neat diesel and waste cooking methyl ester. The results indicates that the waste cooking oil shows better performance and reduced smoke emission as compare to Nahar oil methyl ester. I found that the mixing of waste cooking oil methyl ester with Nahar oil methyl ester significantly improves fuel properties, engine performance. I observed that 60 to 80 percentage of waste cooking methyl ester blend with Nahar oil methyl ester is the optimum blend for engine application.*

Keywords: *fatty acid methyl ester, triglycerides, trans-esterification.*

I. Introduction

Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil dates back to 1895. Rudolf Diesel Sated: "the use of vegetable oil for engine fuels may seem insignificant today". Oil like this which is to be obtained by means of chemical process called esterification and trans-esterification may become in source of time is important as petroleum as the coal tar products of the current time. Biodiesel is a non-petroleum fuel defined as fatty acid methyl or ethyl esters derived from vegetable oil like Karanja, Jatropha etc. or animal fats and it is used in diesel engines and heating systems. Biodiesel Fuels derived from renewable biological resources for use in diesel engines. This is to be environmentally friendly liquid fuel similar to petrol-diesel in combustion properties. Due to few strategies like, as we know very well the rising population is very serious issue in current scenario, and the growing energy demand from the transport sector, bio fuels can be assured of a significant market in India [1].

Biodiesel is rapidly replacing both kerosene and diesel as a more efficient, cheap, and clean alternative for large engines, reason behind to replace this kind of fuel is only harmful emission and toxic in nature of liquid diesel during combustion. Biodiesel is a biodegradable and nontoxic diesel fuel consisting of long polymeric chains of alkyl esters. Biodiesel contains absolutely non petroleum, but it will be blended at any proportion diesel fuel to be used in diesel engines with no modification. Fuel grade biodiesels are produced through the trans-esterification process conforming to strict specifications such as ASTM D6751 in order to ensure proper performance and quality. 20% of India's diesel demand meets by 'National Bio fuel Policy'. Over last few years, Biodiesel (fatty acid methyl esters) has become the part of the equation and life of transportation in the 1990's the effects of global warming started to get political acknowledgement, the reason behind that of its benefits again petroleum diesel like significant reduction in greenhouse gas emissions, non-sulfur emissions and non-particulate matter pollutants, biodegradable, low toxicity and is obtained from renewable source like we have vegetable oils, animal fat etc. Biodiesel is superior to fossil diesel fuel in terms of exhaust emissions, cetane number, and flash point and lubricity characteristics, without any significant difference in heat of combustion of these fuels. Moreover, biodiesel returns about 90% more energy than the energy that is utilized to produce it [2].

For the production of biodiesel is very important to avoid the harmful impact of petro fuel, present study based on Nahar oil. This is found to be in a medium-sized to a large evergreen tree with short trunk, found in the Himalayas region from Nepal eastward, in North-Eastern India, Deccan Peninsula and the Andaman Island, ascending to an altitude of 1500m to 2000m. It is estimated that 5500-6000 tons of nahar seeds are annually available from lakhimpur and sibsagar districts of Assam. Nahar oil (mol wt 900) mainly contains mesuol ($C_{22}H_{22}O_5$) and meuone ($C_{29}H_{42}O_4$). For the production of nahar oil biodiesel in every liter of nahar oil requires 500 ml to 550 ml of methanol (density 0.8, mol wt. 32) to achieve satisfactory esterification [3].

Cooking food is the main source of waste cooking oil refers to the used vegetable oil obtained from it. Waste oil contain very high amount of acids which is does not used directly as a biofuel. The edible vegetable oil no longer suitable for consumption due to high free fatty acid (FFA) content for that repeated frying for preparation of food. Waste oil has many disposal problems like soil pollution, water and human health concern due that disturbance to the aquatic ecosystem will happen, so rather than disposing it and harming the environment, it can be used as an effective and cost efficient feedstock for Biodiesel production as it is readily available [4].

Fig.1 Nahar (Mesua ferrea) seed

Fig.2 Waste cooking oil

II. Material and methods

As we know that available source of energy like petrol, diesel, coal limited in stock hope so in next 50 to 60 years it will be diminished completely that's why we need to search alternative source of energy one of them Biodiesel. It is a renewable alternative fuel created by means of various source browsed by the researcher and chemist. Biodiesel Production done by the vegetable oils, animal fats and grease by means of chemical process. Alcohol is the main source of production of biodiesel which is to be take part with natural oil and reaction between both of them is takes place in presence of suitable catalyst (usually sodium hydroxide [NaOH] or potassium hydroxide [KOH] and then refining the mixture to create molecules which can be easily burned in a diesel engine [4,5]. With proper selection Blend of 20% to 80 % with petroleum diesel significantly reduces carcinogenic emissions and gases that contribute to global warming. Glycerin is the main byproduct of the biodiesel production process which can be used for personal care products, cosmetic product and variety of chemical applications [5].

Biodiesel production reaches in two steps chemical process called esterification and trans-esterification, in trans-esterification which is contain various oils (triglycerides) are converted into methyl esters through a chemical reaction with methanol (FAME) or ethanol (FAEE) in the presence of a catalyst, such as sodium or potassium hydroxide. By-product of the trans-esterification process includes glycerol which needs to be removed from the finished product along with traces of the methanol or ethanol, un-reacted triglycerides, and the catalyst. Obtained byproduct which is to be highly viscous and dense in nature, during biodiesel production they contain three layer of liquid upper layer is non-dissolved alcohol middle layer is obtained biodiesel and last layer is our glycerol [5, 6].

III. Experimental setup

A) ETHERIFICATION PROCESS

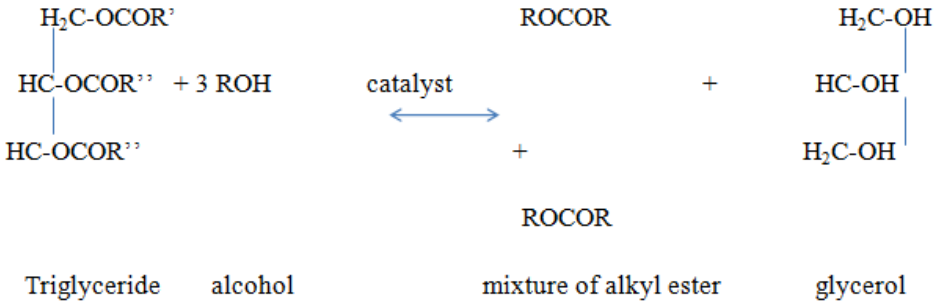
The process in which first we have to collect the filtered and moisture free oil kept into the flask having capacity up to 1000 ml to 3000 ml. Whole flask kept into the heater having heating coils with temperature controlled unit where coil is closed to the flask due to conduction rate of heat transfer heating will be carried out. During esterification process first of all we have taken 1000 ml of waste oil into the flask at room temp 25ºC-30ºC. One mechanical stirrer is kept into the flask which is continues stirrer the oil, which is to be operated by means electrical unit having rotation 1500-1700 rpm speed controller unit is there due that we have manage the speed as per our requirement. After 10-15 min we have to add (0.4 % by wt.) of H_2SO_4 act as catalyst with 7% of ethanol into it which is to be play the role of solvent .Whole reaction will be carried out continuously up to 45-50 min, during esterification process stirrer speed kept 600-650 rpm [6].

B) TRANS-ESTERIFICATION PROCESS

In trans-esterification reaction, the triglyceride component of oil sample reacts with the alcohol either ethanol or methanol in the presence of [KOH] or any other catalyst to give ester and glycerol as shown in the scheme In general, there are three systems of trans-esterification with vegetable oil or an animal fat which is to be act as a starting material of biodiesel production, they are homogeneous, heterogeneous nature of systems. It has been found that, trans-esterification process depends on several parameters which is to be reaction temperature and pressure, reaction time, rate of agitation, type and concentration of catalyst used and concentration of moisture and FFA in the feed oil [7].

Biodiesel is produced by a process called trans-esterification, in which various oils are converted into methyl esters or ethyl through a chemical reaction with methanol (FAME) or ethanol (FAEE) in the presence of various different kind of catalyst, such as sodium or potassium hydroxide. By-product of the trans-esterification process includes glycerol which is highly viscous in nature needs to be removed from the finished product along with traces of the methanol or ethanol, un-reacted triglycerides, and the catalyst.

Esterified oil obtained after esterification then after we have taken 0.4 % [KOH] with 7% ethanol. During trans-esterification of waste cooking, reaction between oil and fats will be takes place and water contained into the oil removed because if the oil contained water saponification reaction will be carried out and it is very harmful for the production of biodiesel. Obtained biodiesel is free from water which improves the oil quality and very effective for the C.I engine. Trans-esterification needs 8-10 hours for complete settling of the by-product from the biodiesel i.e. glycerol. Finally we have produce biodiesel but it is not used directly as a biofuel the reason is that some impurities in the mixture of alcohol and catalyst which is increase the rate of reaction it is necessary to remove, hence obtained biodiesel washed with hot distilled water and purification will be done. After that demoisturizaion process takes place at the temperature of 110 ºC [7, 8].



C) HYBRID OIL BLENDS PREPARATION:

After complete production of nahar oil biodiesel and waste cooking biodiesel, collect both oil in appropriate proportion for example we have 1000 ml beaker in which we have to mixed the both the oil to form hybrid oil biodiesel whose having blend proportion is about HB 5%, HB 10%, HB 15%, HB 20% its mean that we have 95% diesel oil with 5% hybrid oil similarly for 90% diesel having 10% hybrid oil respectively.

First the oil is heated to remove the water content. Vegetable oil may contain water, which can slow down the reaction and causes saponification (soap formation). Then the temperature is raised to 100°C, holding it and allows water contents to boil off. Run the agitator to avoid steam pockets forming below the oil and exploding, splashing hot oil puddles out from the bottom. When boiling slows, the temperature is raised to 130°C for 10 minutes and allow cool to it.

With the help of trans-esterification process various blends of biodiesel are prepared. The biodiesel blended with diesel by volume as HB 5(5% H biodiesel and 95% diesel fuel), B10 (10% H biodiesel and 88% diesel fuel),B15 (15% H biodiesel and 85% diesel fuel), B20 (20% H biodiesel and 80% diesel fuel), B25 (25% H biodiesel and 75% diesel fuel), B30 (30% H biodiesel and 76% diesel fuel), B35 (35% H biodiesel and 70% diesel fuel), B35 (35% H biodiesel and 64% diesel fuel).Then the samples were proceeding for their property [8].

IV. Result and discussion

Table-1 shows the fuel properties of biodiesel determined as per ASTM standards. Among the general parameters for biodiesel, the viscosity controls the characteristics of the injection from the diesel injector. We are to predict the final value of flash point and fire point and compared their value the available fuel and which is highly suitable for the diesel engine combustion. Obtained biodiesel is light brown in color which is to be little bit similar to the diesel but they have small amount of sweet smell during production.

Table 1 Properties of Nahar oil, NOME, And Diesel

Properties	Diesel	Nahar oil	NOME
Specific gravity	0.869	0.955	0.891
Kinematic viscosity	2.288	20.586	5.834
Flash point ºC	83.5	--	1.55
Cloud point ºC	-1	8	6.1
Pour point ºC	-6	--	-1.2
Cetane index	52.55	--	54.678
Color	Light brown	brown	Light brown

Table 2 shows Frying conditions decide the properties of WCO and their changes depend on it and performance gets varied, such as temperature and cooking time. Thermal stress subjected on vegetable oil such as during frying can completely vary its chemical and physical original characteristics of that fuel. The cooking process causes the vegetable oil, Triglyceride to break-down to form, Diglycerides, Monoglycerides, and free fatty acids (FFAs). hydrolysis of triglycerides increases by means of amount of heat and water, therefore it causes a growth of the Free Fatty Acids (FFAs) in the WCO.

Table-2 Properties of Waste cooking oil

property	Units	Value
Density	g/cm^3	0.9-0.9435
Kinematic viscosity	Mm^2/s	36.67-42.0
Saponification value	mgKOH/g	188.23-205.97
Acid value	mgKOH/g	1.3-3.589

Table-3 shows the properties of hybrid oil biodiesel and after combination of both nahar oil and waste cooking to form hybrid oil with suitable proportion of blends like HB 5%, HB 10% HB 20% etc. we predict following result as follows.

Table 3 Properties of hybrid oil biodiesel

Properties	Hybrid oil biodiesel	Protocol
Viscosity at 40ºC	4.1-4.2	ASTMD445
Specific gravity	0.89	ASTM6751
Calorific value (kj/kg)	39.50	IS:1448(P6)
Flash point (ºC)	110	IS:1448
Pour point	7-8	IS:1448(P10)
Cloud point	14	IS:1448(P10)

Above properties of hybrid oil biodiesel is specified and compared with the different kind of protocol on that standard we have decide the specific value of that fuel. This standard fixed and provides the limit of that quantity, after various result and prediction best and suitable for diesel engine that is HB 20% (20% hybrid oil biodiesel and 80% diesel fuel).

V. Conclision

The following are the conclusions drawn from the above work which is to be deals with the production of hybrid oil biodiesel produced by the nahar oil and waste cooking oil.

- Biodiesel is produced from hybrid oil (Nahar oil and waste cooking oil). Some important properties like flash point, fire point, density, calorific value, kinematic viscosity, are determined as per the Indian standards and were found to be within the limits of biodiesel standards.
- Engine working performance with hybrid oil biodiesel and its blends does not differ greatly from that of diesel fuel whose performance value have little bit in different due to mixing of two fuel.
- Cost of biodiesel can be reduced by using low cost raw material like waste cooking oil, and can be further reduced by adopting mass production.
- Most of the major exhaust pollutants which are very harmful in our environmental condition such as HC, CO and CO2 are reduced with the use of biodiesel and its blends with diesel fuel compared to that of neat diesel fuel at full load except NOX.

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