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Biodiesel Production from Mahua oil via Catalytic transesterification method

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Abstract: Biodiesel, which is derived from vegetable oil (triglycerides) by transesterification with ethanol, has the significant notice during the past decade as a nontoxic, biodegradable, and renewable fuel. Several processes for biodiesel fuel production have been developed, amongst which transesterification by alkali catalysis gives high levels of conversion of triglycerides to their corresponding ethyl esters. In this paper, biodiesel produced from Mahua vegetable oil through catalytic transesterification using ethanol and potassium hydroxide as catalyst. The properties of biodiesel were analyzed using ASTM standard methods. From the tests it is clear that the, properties of Mahua biodiesel are similar to diesel fuel.

Key words: Biodiesel fuel, Catalytic transesterification, Vegetable oil, Mahau, Ethanol, Performance, Emission.

1. Introduction

The economic growth is mainly depends on a commensurate increase in the transport. The high energy require in the global market and pollution troubles caused due to the extensive use of fossil fuels create it more and more necessary to develop the renewable sources [1]. Biodiesel fuel has superior properties than that of Petro-diesel fuel such as non-toxic, renewable and biodegradable. There are more than 300 oil behavior crops recognized, among which only pungamia, sunflower, Mahua, cottonseed, rapeseed, soybean, peanut and coconut oils are considered as possible alternative fuels for DI diesel engines [2,3]. Continuous and ever-increasing use of Petro-fuels will increase the air pollution and the global warming problems. The problem associated with the use of direct vegetable oils as fuels is caused by high viscosity during combustion. Blend, micro-emulsification, transesterification and pyrolysis are the four main techniques applied to resolve the problems produced by the high viscosity [4]. The blending of oils with solvents or diesel fuel and microemulsions of direct vegetable oils reduces the viscosity and it will produce several engine performance problems. Considerable research has been completed on vegetable oils as diesel fuel. Natural vegetable oils are extracted or pressed to obtain crude oil. These usually contain free fatty acids, phospholipids, sterols, water, and other impurities. Even refined oils small amounts of free fatty acids and water. The free fatty acid and water contents have significant effects on the transesterification of glycerides with alcohols using alkaline or acid catalysts. They also interfere with the separation of fatty acid esters and glycerol [5]. Chemically, biodiesel is referred to as the mono-alkyl esters of long chain fatty acids derived from renewable biological sources. Biodiesel is the name for a range of ester based oxygenated fuel from renewable lipid sources. It can be used in diesel engines with small or no modifications [6]. Several methods exist to blend vegetable oil with diesel and make a low viscosity fuel oil with alike properties to diesel fuel. Benefits are considerably reduced engine emissions, even with as little a blend as 20% biodiesel with 80% Petro-diesel. Using biodiesel fuel results in big reductions in overall carbon dioxide (CO) emissions and it is carbon dioxide that is a major contributor to climate change [7].

2. Transesterification

Most of the biodiesel is currently prepared from non-edible oils by using methanol and an alkaline catalyst (KOH or NaOH) [8]. However, there is a huge quantity of low cost oils and animal fats that could be converted into biodiesel. The troubles with processing these low cost oils and animal fats is that they frequently contain huge amounts of free fatty acids (FFA) that is not possible to convert into biodiesel. At first the free fatty acids can be converted into fatty acid methyl esters by an acid catalyzed treatment and in the second step transesterification is done by using an alkaline catalyst to reduce the amount of free fatty acids [9]. Transesterification process has been generally used to decrease the high viscosity of triglycerides. The mechanism of the transesterification process is represented by the general equation as figure 1. Methanol is used in this process, so this process is called methanolysis. Transesterification is the reverse reaction and proceeds by addition of reactants. However, the presence of a catalyst (KOH or NaOH) accelerates the conversion [10].

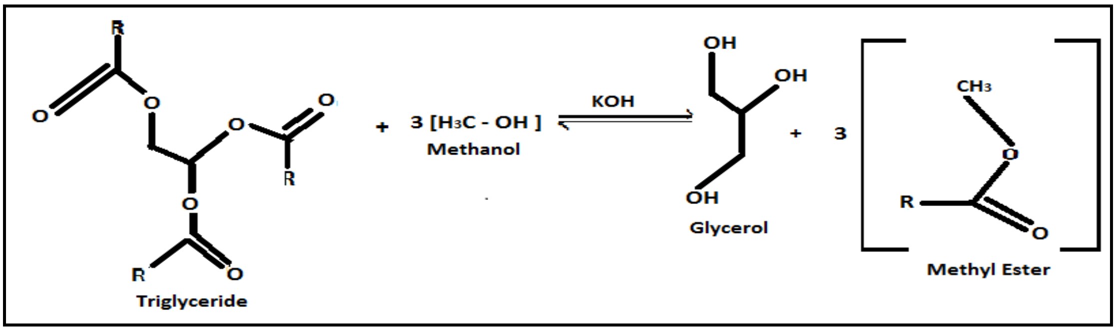

Figure 1. Mechanism of transesterification process

Transesterification is the process of by means of an alcohol (e.g. ethanol or methanol), in the presence of a catalyst to chemically break the triglyceride molecules of the raw vegetable oil into ethyl or methyl esters (fatty acid alkyl esters) of the vegetable oil with glycerol as a byproduct [11]. Methanol is a preferred chemical for transesterification process because it is derived from renewable sources (agricultural waste) and is biologically a non horrible for the environment. Methanol is the widely used alcohol in transesterification process, due in part to its low cost [12]. Scheme of the transesterification process is shown in figure 2.

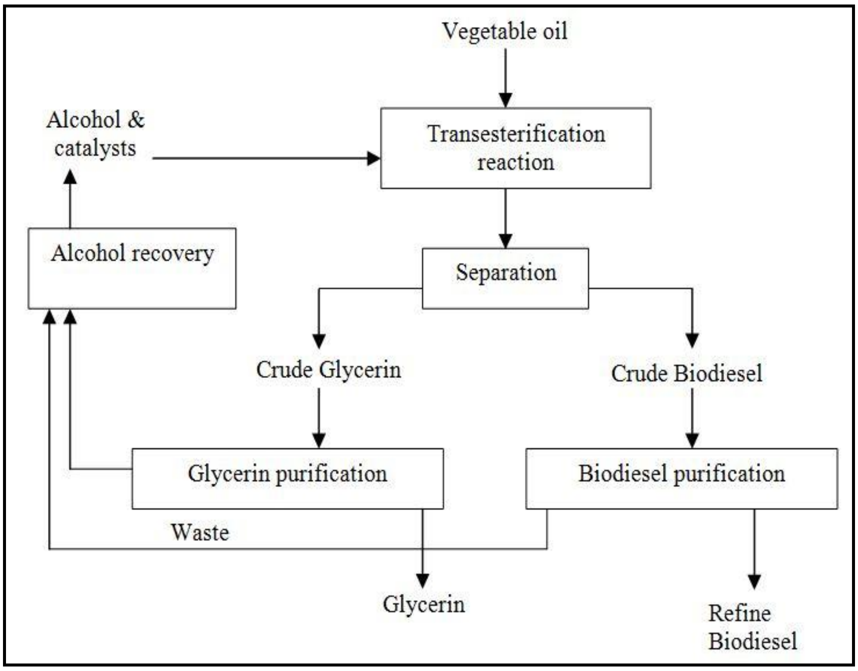

Figure 2. Scheme of transesterification process

2.1 Catalytic transesterification process

One liter of Mahua oil is heated in an open beaker to a temperature of 100-120ºC to remove water contends present in vegetable oil followed by filtration of raw vegetable oil. The raw oil is processed under base catalyzed transesterification method where it is mixed with 200 ml of methanol and 7gms of sodium hydroxide (NaOH) pellets. The mixer is kept on a hot plate magnetic stirring arrangement for 1-1.5 hours up to 60ºC and then it is allowed to settle down for about 5-6 hours to obtain methyl ester and glycerol. The methyl ester obtained in the process is further washed with distilled water for 2-3 times for the removal of acids and heated above 100ºC to separate the moisture content present in the methyl ester. Hence, pure Mahua methyl ester is obtained.

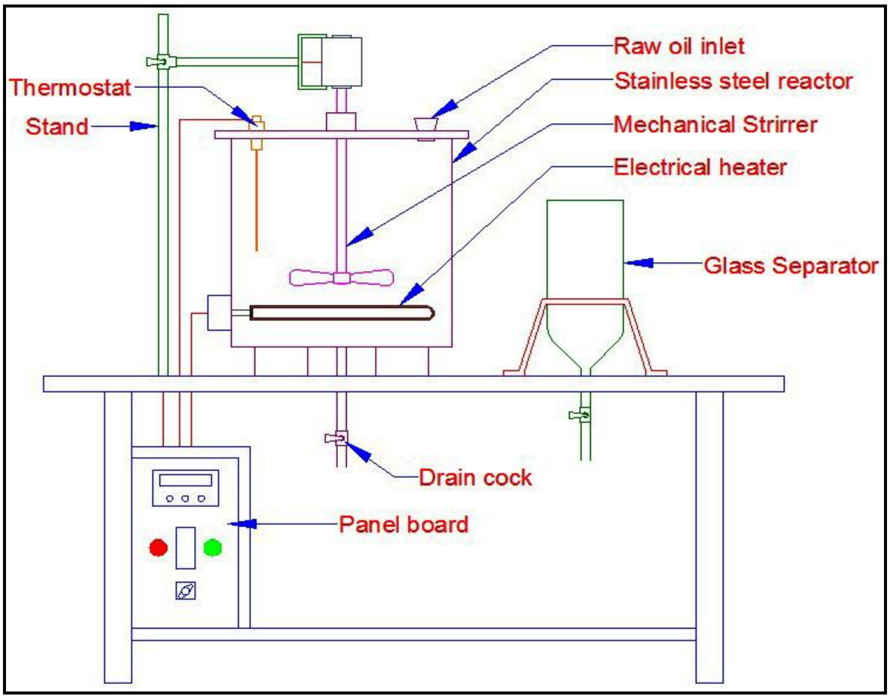

Figure 2 Schematic diagram of Biodiesel Plant

3. Properties of biodiesel

The physical and chemical properties of biodiesel were determined by standard methods and shown in Table 1. In order to measure the properties of the biodiesel and the blends, the test methods were used as follows. Density is an important property of biodiesel. Density is mass per unit volume of any liquid at a given temperature. Density measurement was carried out using a hydrometer at a temperature of 312 K. The flash point temperature of biodiesel fuel is the minimum temperature at which the fuel will ignite on application of an ignition source. Flash point varies inversely with the fuel's volatility. Fire point is the lowest temperature at which a sample will continue burning for 5 s. Flash points of the samples were measured in the temperature range of 50-190ºC by an automated Pensky–Martens closed-cup apparatus. The calorific value of a fuel is the thermal energy released per unit quantity of fuel when the fuel is burned completely and the products of combustion are cooled back to the initial temperature of the combustible mixture. It measures the energy content in a fuel. The calorific value of biodiesel and its blends was measured in a bomb calorimeter according to ASTM D240 standard method. Viscosity is a measurement of the internal fluid friction of oil to flow, which tends to resist any dynamic change in the fluid motion. Viscosity is measured by using Redwood Viscometer. The Redwood viscosity value is the number of seconds required for 50 ml of oil to flow out of a standard Viscometer at a definite temperature. The cetane number of the fuel is one such important parameter which is responsible for the delay period. Cetane number is defined as the percentage by volume of normal cetane in a mixture of normal cetane and a-methyl naphthalene, which has the same ignition characteristics as the test fuel, when combustion is carried out in a standard engine under particular operating conditions. A fuel with higher cetane number gives a lower delay period and provides smoother engine operation. Biodiesel has a higher cetane number than diesel because of its higher oxygen content.

Table 1 Properties of biodiesel sample

Description	Viscosity @40°C (cSt)	Density @ 15°C (kg/m3)	Flash Point (°C)	Calorific value, (kJ/kg)	Cetane number
Diesel fuel	3	815	56	42,000	47
Biodiesel standards (ASTM)	1.9-6	850-900	>130	≥36000	47 to 65
Mahua methyl ester (MME)	4.9	869.8	136	39950	58

4. Conclusion

Methyl esters of vegetable oils have many terrific advantages amongst other renewable and alternative fuel. In this investigation Mahua methyl ester derived from Mahua vegetable oil through catalytic transesterification using NaOH as catalyst. The viscosity of the Mahua methyl ester was slightly higher than that of neat diesel fuel. The calorific value of Mahua methyl ester was nearer to the neat diesel and cetene number was slightly higher. The Mahua methyl ester was more expensive than Petro-diesel fuel. With the recent hike in petroleum prices and uncertainties regarding petroleum fuel availability, there is rehabilitated interest in biodiesel for Diesel engines.

References

1. Demirbas A. Biodiesel fuels from vegetable oils via catalytic and non-catalytic supercritical alcohol transesterifications and other methods: a survey. Energy Convers Manage 2003;44: 2093–109.
2. Demirbas A. Biodiesel from vegetable oils via transesterification in supercritical methanol. Energy Convers Manage 2002; 43:2349–56.
3. Goodrum JW. Volatility and boiling points of biodiesel from from vegetable oils and tallow. Biomass Bioenergy 2002;22: 205–11.
4. Acaroglu M, Oguz H, Ogut H. An investigation of the use of rapeseed oil in agricultural tractors as engine oil. Energy Sources 2001;23:823–30.
5. Diasakou M, Louloudi A, Papayannakos N. Kinetics of the noncatalytic transesterification of soybean oil. Fuel 1998;77: 1297–302.
6. Kaya C, Hamamci C, Baysal A, Akba O, Erdogan S, Saydut A. Methyl ester of peanut (Arachis hypogea L.) seed oil as a potential feedstock for biodiesel production. Renew Energy 2009;34:1257–60.
7. C.S. Aalam et al., Experimental investigations on a CRDI system assisted diesel engine fuelled with aluminium oxide nanoparticles blended biodiesel, Alexandria Eng. J. (2015), http://dx.doi.org/10.1016/j.aej.2015.04.009.
8. Sahoo PK, Das LM. Process optimization for biodiesel production from Jatropha, Karanja and Polanga oils. Fuel 2009;88:1588–94.
9. Srivastava A, Prasad R. Triglycerides-based diesel fuels. Renew Sustain Energy Rev 2000;4:111–33.
10. Patil PD, Deng S. Optimization of biodiesel production from edible and nonedible vegetable oils. Fuel 2009;88:1302–6.
11. Ramadhas AS, Jayaraj S, Muraleedharan C. Biodiesel production from high FFA rubber seed oil. Fuel 2005;84:335–40.
12. Rashid U, Anwar F, Knothe G. Evaluation of biodiesel obtained from cottonseed oil. Fuel Process Technol 2009;90:1157–63.

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