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AN EXHAUSTIVE STUDY ON THE PERFORMANCE AND QUALITY ASSESSMENT OF BIODIESEL PRODUCED FROM LOW CATALYTIC ACTIVITY CATALYST

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ABSTRACT - *Biodiesel has been receiving a lot of concern throughout the world due to energy needs and environmental awareness. It is an eco- friendly, renewable and alternative diesel fuel. Of late, it is not economically feasible since the cost of biodiesel is high when compared to conventional diesel oil as it is produced from pure vegetable oil. Hence, more attention has been devoted to identify the low-cost feedstock such as animal fat, non edible oil and used cooking oil to produce biodiesel. The present study utilizes mahua oil as a raw material for the production of biodiesel. Production, optimization and characterization of mahua oil methyl ester were well established in the study. The experimental techniques and the product evaluation results show that properties of the produced biodiesel are similar to that of conventional diesel.*

Keywords: *Biodiesel; Mahua oil; viscosity; Free Fatty Acid; catalytic activity.*

I. INTRODUCTION

Biofuels have the exciting potential for mitigating the grave threats of global warming, reducing the world's dependence on imported oil from insecure sources and tumbling the sky rocketing costs of fossil fuels. Biodiesel is a renewable, biodegradable, environmentally benign, energy efficient, substitution fuel which can fulfill energy security needs without sacrificing engines operational performance. Thus, it provides a feasible solution to the twin crisis of fossil fuel depletion and environmental degradation [1]. Depending on climate and soil conditions, different nations are looking into different vegetable oils for diesel fuel substitute. The use of edible vegetable oils and animal fats for biodiesel production has recently been of great concern because they compete with food materials – the food versus fuel dispute [2,3,4&5].

Many researchers have reported that the use of pure vegetable oil in unmodified diesel engines may cause various engine related problems such as severe engine deposits, injector coking and piston ring sticking due to their high viscosity and low volatility [6,7,8&9]. The commonly used methods to reduce the viscosity of vegetable oil are blending with conventional diesel, emulsification, pyrolysis and transesterification [6,7]. Among these, transesterification is the most commonly used method for lessening viscosity in vegetable oil [10,11].

Transesterification is the general term used to describe the important class of organic reactions where an ester is transformed into another through interchange of the alkoxy moiety [12]. Biodiesel may be produced by transesterifying triglycerides such as animal fat or vegetable oil with alcohol in presence of an acid or base catalyst [11]. Selection of a particular process depends on the amount of free fatty acid and water content present in the feedstock.

Mahua oil is an underutilized non-edible vegetable oil which is available plenty in India is chosen for the study. The yield of mahua seeds varies (5 – 200 kg/ tree) depending upon the size and age of the tree [12]. It starts giving seeds after 10 years and goes up to 60 years. Kernel contains 20 – 50 % of oil depending on expelled by ghani or expeller.

In the present study, Mahua oil was experimented as an alternative feedstock for the production of a biodiesel. The scope of the study is to produce, optimize and evaluate biodiesel from mahua oil having high FFA with low catalytic activity catalyst (Lithium hydroxide).

II. EXPERIMENTAL METHODS

Physico-chemical characteristics of the mahua oil such as acid value, FFA, viscosity, iodine value, specific gravity, saponification value were analyzed as per ASTM standard methods.

A. Biodiesel (methyl ester) production methodology

Choice of the acid & alkaline catalyst depends on the amount of FFA content present in the raw oil. If the FFA content is beyond 3%, acid esterification followed by alkaline transesterification process is carried out whereas if the FFA is below 3% only alkaline transesterification process is carried out.

B. Acid catalyzed esterification

optimum methanol/oil molar ratio was observed to be at 9:1. Initially, excess addition of methanol increases the solubility of the by-product (glycerol) [19] which may then initiate the reversible reaction and reduce the conversion. Excess methanol can be removed easily by washing with water and its residue may be removed using rotary evaporator.

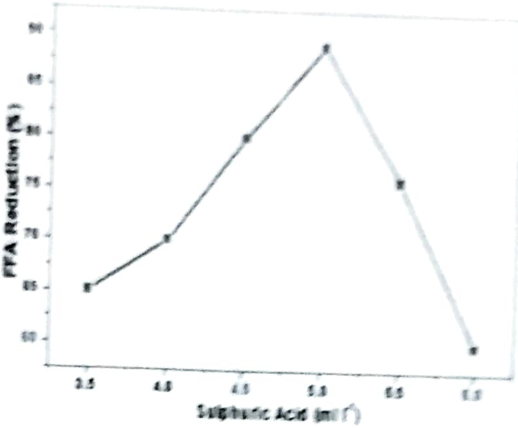


Figure 1. Effect of acid catalyst for the reduction of FFA

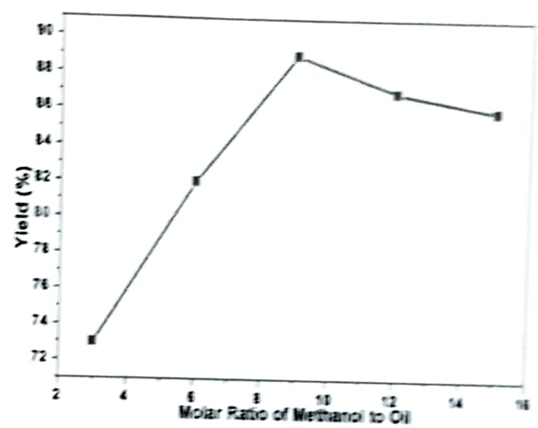
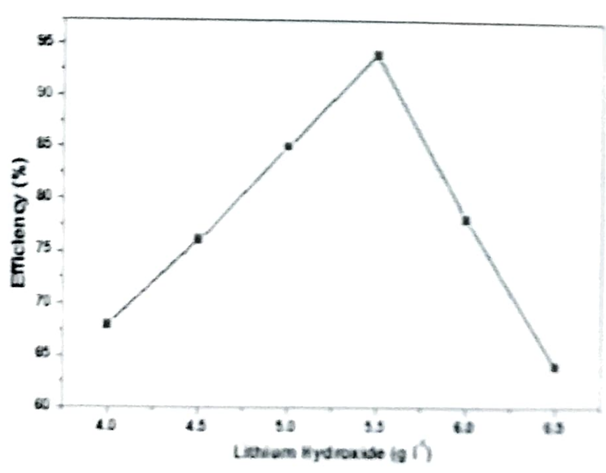


Figure 2. Effect of methanol to oil molar ratio on esterification with respect to their yield

B. Base catalyzed transesterification

B.1 Effect of alkaline catalyst

Biodiesel with the best properties are obtained by using KOH or NaOH as a catalyst in many studies [8,13]. The present study investigates the performance of LiOH as an alkaline catalyst which has low catalytic activity when compared with NaOH & KOH.



Temperature positively influences the biodiesel yield. The reaction was carried out at 45, 50, 55, 60 and 65°C to experiment the influence of reaction temperature towards ester. Generally, as the reaction temperature increases, the rate of reaction also increases; Fig. 5 shows the conversion increases from 60 to 94 % when the temperature increased from 45°C to 60°C. Higher temperature of 45 – 60°C progress the efficiency of transesterification, which in turn enhances the ester yield.

B.4 Influence of reaction time

The effect of reaction time on fatty acid methyl ester content and it was observed that the conversion rate was dawdling till 45 min and finally reached steady state at 60 min. The conversion rate deprived after 60 min because excess residence time can negatively influence the biodiesel production by favouring the backward reaction (hydrolysis of ester) which results in a reduction of product yield.

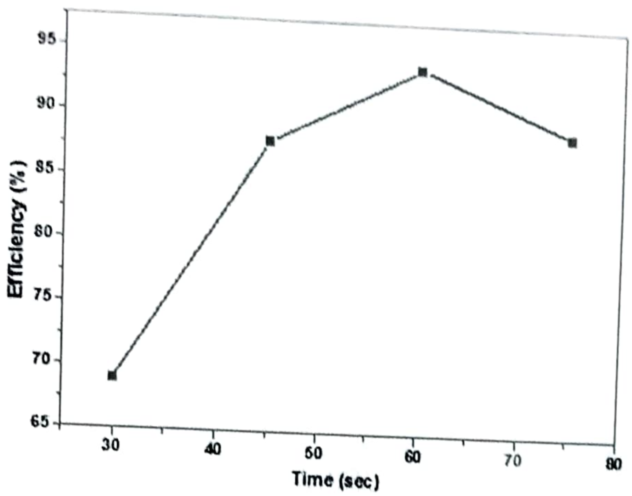


Figure 6. Influence of reaction time with respect to their methyl ester yield

IV. Quality assessment of produced biodiesel

The quality of biodiesel is most important for engine part of view and therefore, the fuel characteristics of the alkyl esters synthesized were studied according to ASTM standard methods.

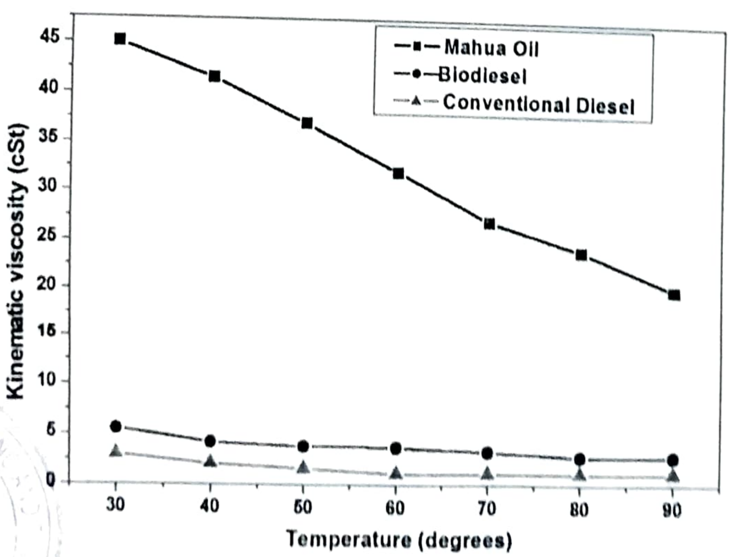


Figure 7. Comparison of kinematic viscosties of mahua oil, biodiesel and diesel in relationship with temperature

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standard. Functional group vibration of the prepared biodiesel from mahua oil was examined by FT-IR. The overall study suggests that LiOH (whose catalytic activity is low) can also be used as a potential catalyst for the production of biodiesel.

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