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PRODUCTION AND ANALYSIS OF BIODIESEL FROM PURE AND RECYCLED PALM OIL

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ABSTRACT:

Biodiesel from palm oil based appears to be a practicable long-term solution. Although the fuel may offer many advantages as direct fossil diesel fuel substitute. Conversion of low cost feedstock such as used frying oils is complicated if the oils contain large amounts of free fatty acids that will form soaps with alkaline catalysts. The soaps can prevent separation of the biodiesel from the glycerin fraction. The objective of this study was to investigate the effect of process variables on acid-catalyzed transesterification. The molar ratio of alcohol, reaction temperature, catalyst amount, reaction time, water content, and free fatty acids were investigated to determine the best strategy for producing biodiesel. Food grade palm oil was used to prepare esters using excess methanol and potassium hydroxide as a catalyst. To check the highest production yield of the biodiesel, different types of oil: methanol ratios were compared with each other. ASTM standards i.e. American Society for Testing and Materials (ASTM) were used to for the quality check and the analysis of it using various parameters like flash point, sulpher content, acid number etc. It was found that the ratio 1:3 of oil: methanol gives the highest production yield of the biodiesel and it was also observed that the biodiesel from the pure vegetable oil has good quality than the biodiesel produced from the recycled vegetable oil. Using some additional techniques it can be possible to make or to increase the quality product of biodiesel from the recycled vegetable oil, but that may increase the cost of the biodiesel simultaneously.

KEYWORDS:

Biodiesel, Fuel, recycled oil and Vegetable oil.

INTRODUCTION

Biodiesel has become more fascinating because of its environmental benefits and the fact that it is made from renewable resources. The prefix bio refers to renewable and biological nature, in contrast to the traditional diesel made from petroleum. The cost of biodiesel, however, is the main hurdle to commercialization of the product. Biodiesel has the same properties of diesel used as fuel for cars, trucks, etc. This may be mixed in any proportion with the diesel from the oil refined. It is not required to make any modifications to the engines in order to use this fuel [1]. Natural vegetable oils and animal fats are extracted or pressed to obtain crude oil or fat. These usually contain free fatty acids, phospholipids, sterols, water and other impurities. 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. [2]

In accordance with the US Standard Specification for Biodiesel (ASTM 6751), biodiesel is defined as a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats [3]. It has similar physico-chemical properties of conventional fossil fuel and can consequently, entirely or partially substitute fossil diesel fuel in compression ignition engines [4]. The high viscosity and poor

volatility are the major limitations of vegetable oils for their utilization s fuel in diesel engines. Because high viscous vegetable oils deteriorate the atomization, evaporation and air-fuel mixture formation leading to improper combustion and higher smoke emission. Converting vegetable oil to biodiesel is one of the options to reduce the viscosity. [5,6]The most studied process to obtain biodiesel from feed stocks is transesterification of triglycerides with low molecular weight alcohols catalyzed by homogenous catalysts [7] Apply of base catalysts may cause problems due to the side saponification reaction. Which occur because of higher content of fatty acids and water in used cooking oil [8].In spite of these drawbacks, transesterification process using base catalyst has some benefits like low production cost, faster reaction speed and mild reaction conditions [7]

This study aims to produce biodiesel from pure and waste palm oil through transesterification process using alkaline catalyst. In this work, the quality of biodiesel from both pure and used edible palm oil has been analyzed and compared.

MATERIAL AND METHOD

Materials

Pure Palm cooking oil was purchased from local grocery shop. The used cooking palm oil was obtained from canteen of our university. To remove impurities the used palm oil was filtered. Potassium hydroxide, magnesium sulfate anhydrous, methanol, was purchased from chemical shop.

Transesterification reaction

The transesterification reaction performed at different volumetric ratio of oil to methanol, varying from 3:1, 1:3, 4:1, 1:4, and 1:6. at 40ºC and 350 rpm. The reaction time was kept constant at 3 hours for all experiments. Potassium hydroxide is used as catalysts at 2.0% wt. of oil . After transesterification reaction the biodiesel was separated from glycerol using separating funnel and finally washed with 5% water followed by magnesium sulfate anhydrous to remove the water. Basic variables like methanol to oil ratio of transesterification were investigated as this play a significant difference in biodiesel produced [9].

Biodiesel analysis

Several parameters have been analyzed by specific ASTM method to verify whether the products fulfill the specification of standard methods [10]. These includes ASTM D93- Flash point, closed cup (Requirement: 130 ºC min), ASTM D 445 – Kinematic viscosity, 40 º C (Requirement: 1.9 – 6.0 mm2/s), ASTM D 5453 – Total sulfur (Requirement: 0.05 wt. %, max), ASTM D 664 – Acid number (Requirement: 0.80 mg KOH/g, max), ASTM D 86 – Atmospheric distillation end point (Requirement: 327 ^{0}C-360 ^{0}C, at 90 % liquid distilled).

RESULT AND DISCUSSION

Biodiesel, derived from vegetable oil or animal fats, is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is a renewable, domestic resource with an environmentally friendly emission profile and is readily biodegradable.

The acid values expose the low amount of free fatty acids (FFA) in both types of oils. In contrast, RVO has significantly high viscosity than PVO. Both oils can be utilized as fuel in diesel engines, but the main barrier to employ the oil as fuel is its high viscosity which creates troubles in

Effect of different volumetric ratios of oil: methanol on biodiesel yield.

Methanol, ethanol, propanol, butanol and amyl alcohol can be used in the transesterification reaction, amongst these alcohols methanol and ethanol are applied more frequently as its cost is low and it is physically and chemically advantageous (polar and shortest chain alcohol) over the other alcohols [11,12,6].

The effect of volumetric ratio of oil/ methanol was studied. Results exhibit that highest biodiesel yield at 1:3 oil/methanol was 88.7% (Figures 1) and the yield

from the 1:6 were lowest i.e. 24.47 %. Hence 1:3 ratio of oil/ methanol was selected due to its better yield and used further. (Table 1) results provide evidence that increase of alcohol ratio improve the yield of biodiesel.

But decreased yield in 1:4 and 1:6 most probably as a result of emulsification during separating and washing process.

Fig.1: Effect of volumetric ratio of palm oil to methanol on biodiesel yield (Reaction conditions: temperature = 40°C, catalyst KOH = 2 wt. % of oil, Reaction time = 24 hours)

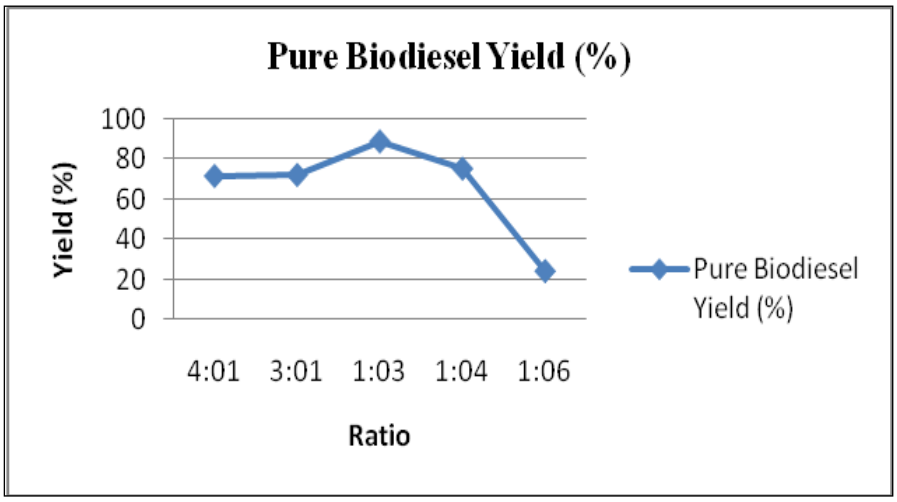

Table 1: Characteristics of biodiesels produced from PVO and RVO in contrast with standard value

Property	Standard method	Unit	Standard Value	RVO value	PVO value
Acid number	ASTM-D 664	Mg KOH/g of oil	0.80	0.80	0.70
Kinematic viscosity	ASTM-D 445	mm^2/s at 40ºC	1.9-6.0	6.0	5.6
Atmospheric distillation (90%liquid distilled)	ASTM-D 86	ºC	327- 360	350	328
Flashpoint, closed cup	ASTM D93	ºC	>130	225	213
Total sulfur	ASTM D5453	wt %	< 0.05	0.04	0.02

Analyzing biodiesel produced under optimum condition

Biodiesel produced from pure and recycled palm oil under optimum conditions were analyzed according to standard methods (ASTM methods).Results exhibit that biodiesel produced from

RVO has higher acid number and viscosity. Viscosity is the most important property of diesel fuel because it influences the wear rate of engine components [13].

Pure and Waste vegetable oils can be used as fuel purpose but because of high viscosity it create problems in atomization of the fuel spray and operation of the fuel injectors in diesel engines. Biodiesel obtained from both oil through transesterification process have lower viscosity. (Table 2).The distillation (volatility) characteristics give information on the composition, the properties, and the behavior of the fuel during storage and use. Atmospheric distillation value of the RVO is higher than pure one, which further will affects the degree of formation of solid combustion deposits in diesel engines. ASTM- D5453 method covers the determination of total sulfur in liquid hydrocarbons, which is an indicator of contamination of protein material and/or carryover catalyst material or neutralization material from the production process.PVO and RVO meet this specifications. Flash points classify material as inflammable/flammable, as

all methanol may not be removed during production and purification of biodiesel. PVO better meet this specification than RVO. Excess methanol in the fuel may also affect engine seals and elastomers and corrode metal components.

CONCLUSION

The proposed materials and methods in the project are believe to fulfill the objective for using pure vegetable oil and recycled vegetable oil as a raw material to produce biodiesel. Because, the produced biodiesel is of good quality within the array of standard method specifications and the production yield is 89% up to approximately under optimum conditions.

Advance research is needed to reduce the production cost by developing a method to decrease the emulsification during base catalytic transesterification and aqueous-washing of the product. Biodiesel from used cooking palm oil could be used as a diesel fuel which considered as renewable energy and environmental recycling process from waste oil after frying.

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