Biodiesel Production from Tallow

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Introduction

Biodiesel from inedible beef tallow, mostly produced by leather manufacturing can provide an alternative for petroleum diesel. Tallow which is attached to the flesh side of the raw hide is considered as waste in leather manufacturing process. This waste tallow can be used to produce biodiesel. It will reduce the amount of tannery waste materials and also it will reduce the cost of removing tannery wastes. Methyl esters are the product of transesterification of fat and oil with methanol using an alkaline catalyst (KOH). In addition, the process yields glycerol, which has large applications in other industries, such as pharmaceuticals, food and plastic industries. The process of transesterification is affected by various conditions such as mode of reaction condition, alcohol to tallow molar ratio, kind of alcohol, type and amount of catalysts, reaction time, temperature and purity of reactants (Cunha *et al.*, 2009).

Methodology

Fleshing wastes were collected from Ceylon Leather Products PLC. The solution which was containing fleshing wastes was heated to temperature of 70 °C and allowed to settle for few minutes. The top oil layer was separated. Separated oil was heated to the temperature of 110 °C until the oil becomes substantially anhydrous for transesterification. Flat bottom flask was used for this reaction. Tallow was preheated to melt. Melted tallow was filtered using cotton wool in a funnel. Then 100 g of previously melted tallow was added to the flat bottom flask. The flask was placed on a Heating Magnetic Stirrer. Reaction was done under five different temperatures where amount of KOH varied from 0.6 to 1.4% of KOH (wt. /wt.) related to the tallow weight. KOH was dissolved in methanol with a molar ratio of 6:1 (methanol to tallow) in a beaker. Then the mixture was poured in to the flat bottom flask. Reactants were stirred for five different time periods (1 to 5 hours). Then the mixture was transferred to the separation funnel and mixture was left in rest for 240 min to promote the decantation by gravity of glycerol and methyl esters. Biodiesel was separated and it was washed. Initial washing was done by diluted acetic acid and then it was continued by distilled water until the P^H value of lower layer became similar to the P^H of distilled water that was indicated that the bio diesel was free from KOH. Calorific value, flash point, cloud point, viscosity and the specific gravity of the bio diesel were evaluated and they were compared with ASTM D6751 standards and petroleum diesel.

Results and Discussion

The amount of alkali catalyst KOH used has affected the conversion efficiency of the process. The catalyst amount varied in the range of 0.6- 1.4 wt. % for five different values (0.6, 0.8, 1.0, 1.2 and 1.4 wt. % of KOH). It was noted that during the experiments, the addition of excess KOH increased the yield. The optimal product yield (84.6 %) was achieved when the concentration of KOH reached 1.2 wt. %. Addition of excess amount of alkali catalyst reacts with triglycerides to form more soap (Gabelman and Hwang, 1999).

The temperature varied in the range of 45 to 85 °C for five different values (45, 55, 65, 75 and 85 °C). Maximum yield of 87.4 % esters occurred at 65 °C, at 1.2 % wt. of KOH. There was a slight decrease in yield after 65 °C due to enhancement of saponification reaction (Sivakumar *et al.*, 2011).

It has been observed that the ester yield increases with the increase in reaction time. The dependency of reaction time was studied at different time intervals ranging from 1 to 5 hours. The maximum yield of 91.2 % wt. occurred at 4 hours. This reaction occurred at 1.2 % wt. of KOH and 65 °C temperature. Longer reaction time leads to reduction of biodiesel due to the reversible reaction of transesterification resulting in loss of esters as well as soap formation (Mathiyazhagan and Ganapathi, 2011).

Table 2: Comparison of the Properties of Tallow Biodiesel and Petroleum Diesel

Properties	Biodiesel	Petroleum Diesel
Specific Gravity	0.872	0.869
Viscosity	5.35 mm^2s^{-1}	3.97 mm^2s^{-1}
Sulfur	8 ppm	2117 ppm
Cloud Point	16 °C	-23 °C
Calorific Value	37270 $kJkg^{-1}$	44800 $kJkg^{-1}$

Properties of biodiesel were also compared with ASTM D6751 standards.

Table 1: Properties of Tallow Biodiesel

Property	Units	Testing Procedure ASTM	Tallow Biodiesel	Biodiesel Standard ASTM D6751
Specific gravity	-	-	0.872	0.87-0.90
Viscosity	mm^2s^{-1}	D445	5.35	1.9-6.0
Sulfur	ppm	D 7039	8	15
Cloud point	°C	D2500	16	-3 to 12
Calorific value	$kJkg^{-1}$	ASTM D240	37270	-

Conclusion

The transesterification of the beef tallow with methanol produced biodiesel at 65 °C, at

1.2% wt. of KOH and 4 hours of reaction time with highest conversion ratio of 91.2%. Except the cloud point of the produced beef tallow biodiesel, other properties which measured in the analysis met the ASTM D6751 standards. Therefore, it can be concluded that tallow biodiesel can be used as an alternative fuel for petroleum diesel. Sulfur content of tallow biodiesel is considerably lower than that of petroleum diesel. Therefore it can be concluded that the tallow biodiesel is more environmental friendly than the petroleum diesel.

References

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