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Utilization of Used Vegetable Oil as a Biodiesel Fuel

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ABSTRACT

In this study the reusing of vegetable oil as an alternative substitute for biodiesel was investigated. The used vegetable oil (UVO) was obtained from Baraka Factory – Potato chips line, Wad Madani, Sudan. The biodiesel is produced from used vegetable oil by alkali transesterification. The kinematic viscosity of biodiesel (at 40ºC), flash point, density (at 15ºC), and calorific value were 5.35cSt, 119ºC, 0.881gm/ml, and 41.9MJ/kg respectively. The results showed that the used vegetable oil is suitable for biodiesel production.

Keyword: Vegetable Oil, Biodiesel Fuel

INTRODUCTION

The major part of all energy consumed world wide comes from fossil sources (petroleum, coal, and natural gas). However, these sources are limited and will be exhausted in the future (Macleana and Laveb, 2003). The energy consumption and demand are increasing every year due to the continuous increase in population. Increasing use of petroleum fuels will intensify local air pollution, which is one of the most serious environmental problems all over the world, that accelerate the global warming problems caused by CO_2. Economically and environmentally sound alternatives to petroleum fuels deserve the attention of both developed and developing countries. Thus, looking for alternative sources of new and renewable energies (biomass, wind, solar, hydrogen, nuclear) will have the potential to solve many of the environmental problems.

Recently, because of the rise of crude oil prices, limited resources of fossil fuels and environmental concerns, there has been renewed focus on vegetables oil to make biodiesel fuels. Biodiesel is non- toxic, biodegradable and renewable fuel which can be produced from great varieties of feed stocks, including most vegetable oils (edible or non-edible) and animals fat (Gerhard *et al.,* 2005). Vegetable oils have high viscosity; the most common method used to reduce the

viscosity is transesterification, which is a chemical conversion of the vegetable oil to its corresponding fatty ester (Bala, 2005). Biodiesel can be used in any diesel engine without any modification; this demonstrates that there must by some similarity to petrodiesel fuel properties, but biodiesel have many advantages when compared with fossil fuels. It is biodegradable, has a high flash point and it is derived from a renewable domestic resources (Gerhard *et al.,* 2005).

The food consumption around the world produces large amount of used vegetable oils and animal fats which are disposed off in harmful ways in many world regions (Tashtoush *et al.,* 2003). Using used vegetable oils in biodiesel production not only solve the disposal problems, but one of their major intensive uses is their lower prices, since the commercial use of biodiesel is strongly dependent on the price of feed stocks, so that lower cost feed stocks are needed. This work aims to use the used vegetable oils as alternative source for biodiesel production.

MATERIALS AND METHODS

The used vegetable oil (UVO) is the main substrate in this study which was obtained from Baraka Factory, Wad Madani, Sudan. The used vegetable oil sample (Palm Olien) was filtered to remove suspended solids, and dried by heating at 110^{o}C. Acid Value (AV) was determined according to AOCS

official method 3d.63, (2003). Iodine Value (IV) was measured by Wijs method according to AOCS official method cd1-25 (2003). Peroxide Value (PV) was determined according to AOCS CD 8-53 (2003). Transesterification ratio of used vegetable oil was carried out according to that reported by Freedman *et al.* (1984). 1.8g potassium hydroxide dissolved in 33.5ml methanol was added to 120g of waste vegetable oil at 35-45ºC, vigorously stirred with a magnetic stirrer in a hot plate in 250 ml conical flask. Stirring was continued for 1h, then the mixture was transferred to a separating funnel and allowed to separate for 3h. After the removal of glycerol layer, the methyl ester was washed gently with one volume of water and allowed to separate for 1h. Residual water and methanol were removed by heating at 110-120ºC. The kinematic viscosity was determined according to American standard Testing Method (ASTM) D445 (2004), using Calibrated viscometer (Model TV 4000 France). The flash point was determined according to ASTM D93 (2002a) using semi automatic Pensky-Martens closed-cup apparatus (model NPM-440 France). The density was determined according to ASTM D4052-96 by using a digital density meter (Model DMA 4500 Germany). The higher heating value (HHV) was determined according to Demirbas, (2008).

RESULTS AND DISCUSION

Results in Table (1) present some properties of UVO sample. The AV of UVO sample is found similar to the results reported by Bouaid *et al.* (2007). However, the PV, IV and kinematics' viscosity of UVO sample are lower than that reported by Bouaid *et al.* (2007).

Table (1): Properties of used vegetable oil

Properties	Used vegetable oil	
	This study	Bouaid *et al.* (2007)
Acid value(mg KOH/kg)	2.44	2.74
Peroxide value (meq per/kg)	25.26	37.7
Iodine value	67.95	119
Kinematic Viscosity cSt at 40ºC	54.18	80.81

At 40ºC the kinematic viscosity is found 5.35cSt (Table (2)) which is higher than that reported by Serdari *et al*. (2000), which was 4.5cSt. The result is approximately similar to that reported by Dorado *et al*. (2003) which was 5.29cSt. Moreover, the kinematics' viscosity of UVO biodiesel shows good result when compared to ASTM

biodiesel standards. Furthermore, the kinematic viscosity of used vegetable oil biodiesel is suitable when compared to others vegetable oil biodiesel like cottonseed (6.8) (Geyer, 1984), palm oil (5.7) and sunflower (4.6) (Pischinger, 1982). The flash point of biodiesel was found 119 ºC seems to be in a good agreement with that reported by Serdari *et al*. (2000), Compared to others vegetable oil biodiesel like cottonseed (110) (Geyer, 1984), palm oil (164) and sunflower (183) (Pischinger, 1982).The flash point of produced biodiesel, however, seems to be acceptable. On the other hand, the density of biodiesel is 0.881gm/ml which is lower than that reported by Mittelbach *et al*. (1988). The HHV of biodiesel is 41.9MJ/kg, which is higher than that reported by Demirbas (2008) for cottonseed is (41.18); palm oil is (41.24) and sunflower (41.33).

Table (2):Properties of biodiesel from used vegetable oil.

Properties	**Biodiesel**				
	This Study	Serdari *et al*, 2000	Mittlbach *et al*, 1988	Dorado *et al.*, 2003	Biodiesel standards
Kinematic viscosity (cSt)	5.35	4.5	-	5.29	(1.9-6)[a]
Flash point(°c)	119	>110	-	-	>130 [a]
Density Kg/L	0.881	-	0.888	-	(0.860-0.900)[b]
Heating value (MJ/Kg)	41.9	-	-	-	>35 [b]

[a] source: Biodiesel Standard ASTM D6751 (United States); [b] source: European Standard EN 14213 for Biodiesel as Heating Oil.

CONCLUSION

The findings of this study are highly reliable and showed that the used vegetable oil has potential for biodiesel production. The kinematic viscosity is equivalent to ASTM biodiesel standards. The flash point results showed that the biodiesel produced is safe for handling, with a good result of heating value.

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