Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Der Chemica Sinica, 2011, 2(2): 286-289

ISSN: 0976-8505
CODEN (USA) CSHIA5

Biodiesel production from waste soybean oil

Auwal Aliyu[*], Oseke Godwin and Abdulhamid Hamza

Department of Chemical Engineering, Ahmadu Bello University, Zaria, Nigeria

ABSTRACT

This work focuses on the production of biodiesel from waste soybean oil via NaOH catalyzed transesterification reaction. Many properties of the waste soybean oil and the produced biodiesel have been measured. The density, kinematic viscosity, cloud point and flash point of the waste soybean oil were found to be higher than those of the produced biodiesel. The measured cetane number of the produced biodiesel is greater than that of the waste soybean oil; hence, transesterification process improves the combustibility of the waste soybean oil.

Keywords: Biodiesel, Waste, Oil, Soybean, Transesterification.

INTRODUCTION

Biodiesel is a renewable and biodegradable source of energy derived from various biological sources which can be used in unmodified diesel engines [1-4]. Biodiesel releases less harmful emissions to the environment than petrodiesel. The presence of oxygen in biodiesels leads to their near complete combustion which results in fewer unburned materials than petrodiesel. Vegetable oils consist of triglyceride molecules of three long chain fatty acids that are bonded to a single glycerol molecule. The fatty acids differ by the length of carbon chains, the number, and orientation of double bonds in the chains. In principle, vegetable oils can replace petro-diesel; however, vegetable oils have high viscosities and variable acid composition which create problems in diesel engines.

The problems associated with the direct use of vegetable oils in diesel engines can be solved through various methods such as dilution, catalytic cracking and transesterification. Presently, transesterification is often considered to be the best method for utilizing vegetable oils in diesel engines [4-6]. Biodiesel is generally more expensive to than petrodiesel. However, the cost of biodisel is expected to drop due to technological advancement, economies of scale, rising cost of crude oil, etc. Biodiesel can be used in pure form or blended with petro-diesel in order to enhance the properties of the latter.

Every day, a large amount of waste vegetable oil is produced in food factories and restaurants. Waste vegetable oils are readily available raw materials for the production of biodiesel [8-10]. Production of biodiesel from waste vegetable oils can be used to reduce environmental pollution caused by improper disposal of waste vegetable oils. Present work focuses on the synthesis and characterization of biodiesel from waste soybean oil collected from local restaurants in Zaria town, Kaduna state, Nigeria.

MATERIALS AND METHODS

Waste soybean oil was collected from restaurants in Zaria town, Kaduna state, Nigeria. The oil was first of all sieved in order to remove any sand, fried particles etc. The oil was heated to 40°C in order to reduce its viscosity thereby allowing free flow of the oil through the sieve. The oil was further heated to 120°C in order to minimize the moisture content of the raw oil sample. The free fatty acid content of the oil sample was determined by titration of the oil with sodium hydroxide solution.

For the transesterification reaction, 1.54g of NaOH pellets was dissolved in methanol (20% volume of the oil). The methanol+NaOH (sodium methoxide solution) was then poured into 74ml of heated waste soybean oil and then placed on a hot plate with magnetic stirring. The reaction mixture was stirred for an hour at 60°C. After which, the reaction mixture was poured into a separating funnel for the separation of the biodiesel (top layer) and glycerin (bottom layer). The separated biodiesel phase was then washed with water. After washing, the produced biodiesel was then heated to remove water and methanol. The density of the biodiesel was determined by measuring the mass of a fixed quantity of the biodiesel and the exact volume of the measured mass. The ratio of the measured mass to volume gave the density. To measure the viscosity of the biodiesel, the viscometer spindle was lowered into the beaker containing 250ml of the oil and was allowed to rotate for few minutes. The viscosity was then measured on the viscometer screen at 20^0C. For the cloud Point measurement, 10ml of the biodiesel was put in a test tube and the temperature at which the biodiesel began to solidify when put on an ice bath was recorded. For the flash point determination, 100ml of the oil and fatty acid methyl ester was put in the flash point apparatus pot and then fired from the bottom. A flame source was passed across the heated samples. The temperature at which a flash of light was observed on the heated oil was recorded.

RESULTS AND DISCUSSION

Table 1 summarizes the measured properties of the waste soybean oil and the synthesized biodiesel.

Table 1: Properties of the waste soybean oil and the produced biodiesel

Property	Waste soybean oil	Biodiesel
Free fatty acid, %	0.3	
Density at 20^0C, g/cm^3	0.893	0.860
Kinematic viscosity at 20^0C, mm^2/s	32.6	4.1
Cloud point, ^{0}C	8	2
Flash point, ^{0}c	286	178
Cetane number	38.0	46.0
Color	Dark brown	Golden yellow

The waste soybean oil was characterized in order to determine its suitability for biodiesel production. The free fatty acid content of the waste soybean oil is 0.3%. Hence, base-catalyzed transesterification would be suitable for the biodiesel production because free fatty acid content of the waste oil is less than 1% [2,3,5]. As reported in Table 1, the density of the biodiesel is lower than that of the waste soybean oil. This is in agreement with the data reviewed by Karmakar et al. [11] which shows that the density of biodiesels is lower than that of the raw oil feeds. Viscosity of fuels influences injector lubrication and fuel atomization [3,4]. Fuels with low viscosity may not provide sufficient lubrication, a condition that leads to leakage or increased wear. Fuels with high viscosity tend to form larger droplets on injection which may cause exhaust smoke and emissions due to poor combustion. The kinematic viscosity of the biodiesel is eight times lower than that of the waste soybean oil. Indeed, one of the major purposes of transesterification process is to substantially reduce the viscosity of oil feeds in order to achieve proper atomization and good combustion of the fuel [1,5].

Cetane Number determines the combustion quality of diesels during compression ignition [11]. The measured cetane number of the produced biodiesel is greater than that of the waste soybean oil by 8 units. Hence, transesterification process improves the combustibility of the waste soybean oil. Flash point is the minimum temperature at which a given fuel will ignite on application of an ignition source. The flash point of the produced biodiesel is also in the range of the flash points of most biodiesels. Majority of biodiesels have very high flash points of about 150 °C and above [11]. Biodiesels are classified as non-flammable liquids because of their higher flash points when compared with petro-diesels. Cloud Point is the temperature at which oil begins to solidify. Operation of an engine at temperatures lower than oil’s cloud point requires heating in order to avoid waxing of the fuel. The cloud point of the produced biodiesel indicates the utility of the biodiesel in the tropics where the temperature hardly goes below 10 °C. The colour of the used soybean oil changes from dark brown to golden yellow after transesterification.

CONCLUSION

Biodiesel has been produced from waste soybean oil via NaOH catalyzed transesterification reaction. Several properties of the waste soybean oil and the produced biodiesel have been measured. The density, kinematic viscosity, cloud point and flash point of the waste soybean oil were found to be higher than that of the produced biodiesel. The measured cetane number of the produced biodiesel is greater than that of the waste soybean oil.

.

REFERENCES

[1]. Jain, S., Sharma, M.P., *Renewable and Sustainable Energy Reviews*, **2010**, 14, 667.
[2]. Winayanuwattikun, P., Kaewpiboon, C, Piriyakananon, K., Tantong, S., Thakernkarnkit, W., Chulalaksananukul, W., *Biomass Bioenergy*, **2008**, 32, 1279.
[3]. Singh, S.P., Singh, D., *Renewable and Sustainable Energy Reviews*, **2009**, 14, 200.
[4]. Leung, D. Y.C., Wu, X., Leung, M.K.H., *Applied Energy*, **2010,** 87, 1083.
[5]. Ma, H., Hanna, M.A., *Bioresource Technology*, **1999,** 70, 1.
[6]. Knothe, G., Sharp, C.A., Ryan, T.W., *Energy & Fuels*, **2006,** 20, 403.
[7]. Tang, H.Y., Abunasser, N., Wang, A., Clark, B.R., Wadumesthrige, K., Zeng, S.D., *Fuel*, **2008**, 87, 2951.
[8]. Gui, M.M., Lee, K.T., Bhatia, S., *Energy*, **2008**,33,1646.
[9]. Zhang, Y., Dube, M.A., McLean, D.D., Kates, M., *Bioresource Technology*, **2003**, 90,229.
[10]. Predojevic, Z.J., *Fuel*, **2008**, 87,3522.
[11]. Karmakar, A., Karmakar, B., Mukherjee, S., *Bioresource Technology*, **2010**, 101, 7201.