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Comparative Study of Physical Parameters of Biodiesel from Coconut, Groundnut and Fossil Fuel

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Production of Biodiesel has been reported and used as an alternative source of energy. Biodiesel is a direct fuel substitute derived from vegetable oil or indirectly from industrial or agricultural waste that has several environmental benefits. Bodiesel production is of economic value and environmentally friendly to humans. The aim of the study was to synthesize biodiesel from coconut fruit and groundnut and to assess their physical parameters. The two biodiesels samples were analyzed and their physical parameters (Density, acidity/basicity, P^H, Calorific value, flash point, cloud point, pour point, viscosity, cetane number and iodine number) determined. Physical data for biodiesel from groundnut and coconut fruit biodiesel indicated some significant consistency compared to those of fossil fuel. The flash point of coconut biodiesel was lower than that of fossil fuel, depicting that the product is more combustible than fossil diesel. However, its viscosity was slightly higher than of the latter, indicating a high resistance of the fuel to flow into the engine. The cloud and pour points of the biodiesel were higher than those of commercial diesels indicating that the performance of biodiesel in cold condition would normally be worse than those of fossil fuel.

Key words: Vegetable oil, Biodiesel, Density, acidity/basicity, P^H, Calorific value, flash point, cloud point, pour point, viscosity, cetane number and iodine number.

Introduction

The oil crisis of the 1970’s and the political instability, coupled with the depletion of fossil fuels in the world, led to an innovative thinking for an alternative source of energy; hence the introduction of biodiesel. Biodiesel is produced either directly from plants or indirectly from industrial, commercial, domestic or agricultural waste.

Some countries have developed a national policy to foster the rate of domestically produced renewable resources as a source for motor vehicle fuels. In the U.S.A for example, the energy Tax Act was articulated. This is a provision which reduce the highway tax on motor fuels containing alcohol derived from biomass. In addition congress put in place additional laws which include provisions designed at least -in-part to further reduce the dependence on gasoline and diesel fuel for transportation fuels. The added statues are the Alternative Motor Fuels Acts (AMFA P.L) and the national energy policy Act of 1992 (EPACT.P.L.)

Biodiesel is simple to use, biodegradable, none toxic and essentially free of sulphur, aromatics and nitrogen compouds and hence do not contribute to acid rain or smog. It is environmentally friendly because it's made from renewable resources and has lower particulate emissions compared to petroleum diesel. Biodiesel can be produced from a variety of feed stocks such as sorghum, coconut, barley, potatoes, sunflower etc as well as many types of cellulose wastes. Its use decreases the dependence on foreign oil and contributes to the economy.

Biodiesel from renewable resources may differ slightly in terms of energy constants, cetane number and other physical properties. It can be used in a variety of engines and generators, provided that they are modified to utilize such fuel. Biodiesel is available mostly in Brazil, Colombia, U.S.A, and China (Kononova M.M. 1961)

Since the main source of biodiesel is from vegetable oils, farmers benefit a lot from planting crops used for the production of the vegetable oil. The use of biodiesel in the country minimizes importation cost of fossil fuels; hence money can be used for other aspects e.g. for promoting economic growth and increasing employment opportunities. It is therefore of great importance for scientists and economists to have reliable data on the physical parameters of different biodiesels and their economic values for viable production.

Materials and Methods

Four coconut kernels from Eldoret market were carefully ground into fine powder. The kernel particles (chips) were then dried in an oven overnight to remove moisture and the product weighed. The fine powder was put in 2.5 litre glass bottle. 2.0 litres of solvent toluene added, corked and kept for three days. After three days, the mixture was filtered, and the filtrate was concentrated in a rotavapor. The extract was heated at 60^{o}C for 15 minutes and allowed to settle for 24 hours. After the duration, the oil was heated at 35^{0}C for 30 minutes to make sure that the solid part was in liquid form. A quantity of methanol (8% by volume) was added to the heated oil. The mixture was then stirred for 5 minutes and a drop of concentrated H_2SO_4 was added to catalyze the reaction in a round bottomed flask. The mixture in the round bottom flask was connected to rotavapor for refluxing for 2 hrs and the temperature was maintained at 35^{o}C and allowed to settle overnight. A quantity of 8.22 g of NaOH was dissolved in 28 ml CH_3OH, stirred for complete reaction and to settle for 4 hours. After settling for 4 hours, half of the methoxide was poured into the unheated mixture (oil and methanol) and stirred for 5 minutes and then heated at 55^{o}C. The remaining half of the methoxide was then added to the heated mixture and refluxed in a rotavapor for one hour and allowed to settle. Washing was done by preparing 10% Phosphoric acid in a 220 ml volumetric flask. One third of prepared phosphoric acid was added to the mixture and stirred for 5 minutes then put into a tap funnel and allowed to settle for 25 minutes. The lower layer of glycerin, water and other impurities was drained slowly. The procedure was repeated using the remaining phosphoric acid until pure biodiesel was obtained. Various physical parameters of the product were then analyzed.

Results and Discussion

The percentage yields were too low probably indicating that coconut (53.9%) and groundnut (60.83%) had a lot of residual glycerin or the recovery process was not efficient. The density of biodiesel from groundnut (0.88 g/ml) compared well with that of fossil diesel (0.8 to 0.86g/ml); indicating that the biodiesel could act as an alternative fuel. The P^H values for coconut and groundnut biodiesel oils were 8.5 and 6.2 respectively with former being slightly alkaline in nature. The P^H of the fossil diesel was neutral. The calorific values for coconut and groundnut biodiesel oils were 12.14 Kcal/g and 11.02 Kcal/g respectively. These were lower than that of fossil fuel (38.3 Kcal/g). The flash point of the coconut biodiesel was 39^{o}C compared to flash point of 82^{o}C for fossil fuel and 182^{0}C for groundnut biodiesel. The former biodiesel was significantly more combustible than fossil diesel. The standard viscosity for fossil fuel is between 1.9 to 4.0 while biodiesel from coconut and groundnut had viscosities of 6.96 and 4.37 respectively.

Biodiesel from groundnut and coconut had a higher cetane number than fossil fuel. This leads to improved combustion quality during compression. The higher the cetane number, the more efficient the fuel and hence the engine starts more easily, runs better and burns more cleanly. The cloud and pour point for biodiesel were higher than those of diesel, with the performance of biodiesel in cold conditions being markedly worse than for petroleum diesel. The results of the analyses are presented in Table 1.

Table 1: Physcial parameters of biodiesels

Parameters	**Coconut**	**Groundnut**	**Fossil fuel**
Percentage yield	53.9%	60.83	-
Density	0.88 g/ml	0.825g/cm^3	0.835g/ml
Acidity/Basicity	Basic	-	-
PH	8.48	6.2	-
Calorific value	12.14 Kcal/g	11.02 Kcal/g	38.3 Kcal/g
Flash point (^{o}C)	39	182	82
Cloud point (^{o}C)	-	3	-14
Pour point (^{o}C)	-	6	- 21
Viscosity (cs)	6.96	4.37	2.98
Cetane number	59.2	50.55	49.2
Iodine number	-	-	88

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