Applied Mechanics and Materials Vols. 465-466 (2014) pp 260-264
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doi:10.4028/www.scientific.net/AMM.465-466.260

Overview Effect Of Biodiesel Storage On Properties And Characteristics

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Keywords: Biodiesel, storage, properties

Abstract. Biofuels based on vegetable oils offer the advantage being a sustainable and environmentally attractive alternative to conventional petroleum based fuel. The key issue in using vegetable oil-based fuels is oxidation stability, stoichiometric point, bio-fuel composition, antioxidants on the degradation and much oxygen with comparing to diesel gas oil. This provides a critical review of current understanding of main factor in storage method which affecting the biodiesel properties and characteristics. In the quest for fulfill the industry specifications standard; the fuel should be stored in a clean, dry and dark environment. Water and sediment contamination are basically housekeeping issues for biodiesel. Degradation by oxidation yields products that may compromise fuel properties, impair fuel quality and engine performance. The effect of storage method on the fuel properties and burning process in biodiesel fuel combustion will strongly affects the exhaust emissions.

Introduction

Burning fossil fuels such as coal, diesel and gas produces greenhouse gases give impacts on the environment. A range of greenhouse gases were produced when fossil fuels are burned, these gases include carbon dioxide, water vapour, methane and nitrous oxides. These gases trap the sun's heat in the atmosphere, it concentrate and increase the heat of the sun where it works quite similar to the lens in a magnifying glass. This is called the greenhouse effect.

Studies have found that first-generation biofuels produced from current feedstock's using the most efficient systems and carbon releases results in emission reductions in the range of 20-60 per cent relative to fossil fuels. Generally, biofuels offer many priorities, including sustainability, reduction of greenhouse gas emissions, regional development, social structure and agriculture and security of supply [1].

On the other hand, biomass sources will be more attractivesince the scarcity of conventional fossil fuels, growing emissions of combustion generated pollutants and their increasing costs [2]. Many people already have an interest in biomass use, in which it has the properties of being a biomass source and a carbon neutral source [3].

Biodiesel Overview

Biodieselhas almost very close property to that of diesel fuel and is also renewable, biodegradable, non-toxic [4][5]. It can be producedfrom vegetable oil and animal fats. Oils or fats are basically triglycerides which are composed of three long-chain fatty acids [6][7]. These oils or triglycerides cannot be used as fuel because of high viscosity. In order to be used as fuel, viscosity has to be reduced, triglycerides are converted into esters by transesterification reaction [8]. Thus, three smaller molecules of ester and one molecule of glycerine are obtained from one molecule of fat or oil. Glycerine is then removed as by product and esters are known as biodiesel.Biodiesel is produced by chemically reacting a vegetable oil or animal fat with an alcohol, an alternative fuel for diesel engines. Alcohols are the most frequently used acyl acceptors, in particular, the methanol and, to a lesser extent, ethanol [9]. Biodiesel, also known as fatty acid methyl ester (FAME), with the addition of methanol is produced from transesterification of vegetable oils or animal fats [10]. The outcome is quite similar to petroleum-derived diesel in its main characteristics such as cetane number, energy content, viscosity, and phase changes [11]. Biodiesel is compatible with conventional diesel although it contains no petroleum products and can create a stable biodiesel blend when blended in any proportion with fossil-based diesel [12].

Advantages and Disadvantages of Biodiesel

The advantages and disadvantages of biodiesel weredeeply discussed in many researches [13–18]. Biodiesel is a biodegradable, non-toxic, environmentally friendly, ultra-low sulfur diesel fuel and renewable resource. It can reduce the amount of greenhouse gas emissions and it emits less CO_2, SO_2, CO, HC, and PM in comparison to conventional diesel. Production of biodiesel is easier than production of diesel fuel and it creates a brand new job infrastructure and will help local economies. In some researches biodiesel decreases the vibrations, smoke, and noise produced. It also can make the energy security of the country will be increased and there can be a reduction in fossil fuel use. In other hands, biodiesel is more cost efficient because it is produced locally. Biodiesel has a high flash point, which makes it a safer fuel. The main advantage of biodiesel does not need engine modification up to B20.

But biodiesel also has it disadvantages. Many researchers have found it emits higher NOx emissions in comparison with conventional diesel. Higher pour and cloud points create problems in cold weather. Biodiesel has a corrosive nature against copper and brass. It has a higher viscosity in comparison with diesel fuel but has low volatility.

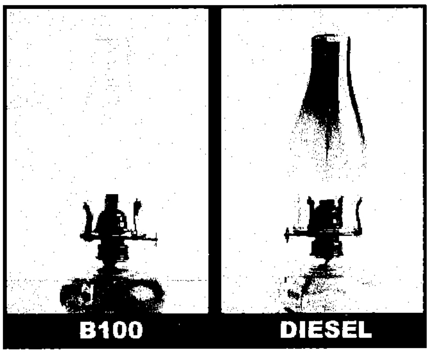

Figure 1: Comparison between burning biodiesel (B100 and diesel)

Research Methodology

Cherng Yuan et al [13] had stored their sample in 20°C and 60°C with and without antioxidant (butylatedhydroxytolune, BHT). Duration for their storage is about 3000 hours using B100 palm biodiesel.

DYC Leung et al [19] stored B100 rapeseed biodiesel for 52 weeks without using any antioxidant. Biodiesel were stored with different temperature (4°C, 20°C and 40°C). Some of the storage bottle used sealed with glass stopper and some of the storage bottle is exposed to ambient air. They also were using 5% of water in some of storage. The entire storage bottle covered with aluminium foil.

M. Berios et al [20] were use two different storage material (glass and stainless steel) and stored in two different temperature; 15°C and 45°C. The entire samples are not exposed to light. Three different of biodiesel from use cooking oil biodiesel (which is from sunflower) blending ratio were use (B5, B20 and B100). They stored their biodiesel about 6 months.

C. Pattamaproma et al [21] also stored their biodiesel for 6 months. They used two type of biodiesel; B100 palm stearin biodiesel and B100 palm olein biodiesel. The biodiesel had store in dark closed container in ambient temperature.

Asir Obadiah et al [22] used five types of antioxidant in B100 karanja oil which is butylatedhydroxyanisole (BHA), butylatedhydrotoluene (BHT), tert-butylhydroxyquinone (TBHQ), gallic acid (GA) and pyrogallol (PY). They stored their biodiesel for 50 weeks in two type of temperature (30°C and 42°C) in open glass bottle.

Abderrahim et al [23] stored five types of biodiesel, high oleic sunflower oil, high erucic brassica oil, low erucic brassica oil and used frying oil for 30 months. They stored their biodiesel in closed glass bottle, in room temperature and with or without exposed to sunlight.

M. Shahabuddin et al [24] stored with the shortest duration compared to others with 2160 hours. But using five different types of biodiesel, B100 and B20 palm methyl ester, B100 and B20 jatropha methyl ester and B100 coconut oil methyl ester comparing with petroleum diesel. They stored their products in glass bottles in room temperature with relative humidity was about 65%. The entire storage was stored in dark cabinet.

Impact of Storage on Biodiesel Properties

Acid Value

The acid value is a measure of the amount of acidic substances in fuel. During storage, the hydro-peroxide produced from the oxidative degradation can undergo the complex secondary reactions including a split into more reactive aldehydes, which further oxidize into acids, leading to an increase in acid value.Almost all the study, found acid value will increase after storage. The rate of increasing acid value is higher depending of storage duration [23 –25][28]. Acid value increase differently depending of storage temperature. Higher temperature of storage will give the higher result of acid value [21]. They also found that acid value increase higher in high temperature of storage compared low temperatue. Although non-metal storage also can effect the increasing of acid value value compared metal material of storage [20]. Storage expose to sunlight will give the higher rate of increasing acid value to biodiesel storage [25]. Diesel gives the lowest number of acid value. However all the samples show an increasing of acid value with increasing the duration time of storage [24].

Density

The densities of biodiesels also increased with storage time by the same pattern as the peroxide values. Therefore, this increase was potentially due to the increase in molecular interaction of degraded biodiesels as peroxides were formed [21]. Density cannot show the significantly increasing in value compared to others [21][24]. Density of biodiesel were increase about $5g/m^3$ in 6 months for low temperature storage [21].

Kinematic Viscosity

All study had found that the kinematic viscosity will increase after storage duration. Sample which has blend with diesel did not show significant variation for kinematic viscosity. Higher viscosity increasing can see in low temperature storage compared to high temperature of storage. Metal also can increase the rate of increasing in kinematic viscosity [20]. Some of the research did not see any changes in kinematic viscosity for all the sample [21]. It's because the storage condition for all sample were locate in dark area in ambient temperature. The researchers found the increasing of kinematic viscosity of all the sample except for sample show the increasing of water content [23]. Biodiesel without antioxidant give the kinematic viscosity increasing very high. The result is over the limit for EN 14214. However, the sample with antioxidant still maintain under control for kinematic viscosity. Antioxidant gives more stability to biodiesel to maintain its properties [22].

Water Content

Biodiesel is generally considered to be insoluble in water, it actually takes up considerably more water than diesel fuel [26]. In EN 14214 water contamination limit is 500ppm.Water content will only increase if the sample store in air exposure condition in high temperature storage. In this condition, water content has increase about 30% within week 10 to week 50 of storage. In low temperature storage the results show that the water contents almost no change in acid value although in air exposure condition. For the storage with sealed storage bottle, also show that there is no increasing in water content [19]. Some of the research found the increasing of insoluble impurities in all sample. However effect of light cannot show very difference result to the impurities of biodiesel [23].

Flash Point

The flash point temperature is an important property for a fuel, especially in terms of handling, storage and forming of a combustible mixture. The flash point indicates the difference between a highly flammable, volatile and a relatively non-flammable non-volatile material [27]. It is expected that a good fuel should have a low auto-ignition temperature, especiallyin a diesel engine, since it has no extra mechanism to ignite the fuel in the combustion chamber. The auto-ignition temperature of a fuel is the lowest temperature at which the fuel could spontaneously ignite without an external source of ignition [24]. Fuels with a flash point above 66 °C can be considered to be safer fuels; therefore, biodiesel is a safer fuel for handling and storage [24]. Flashpoint of storage biodiesel is will be higher for biodiesel storage which has antioxidant [13]. The biodiesel from storage give the result 187.1°C for flash point. This is higher than EN14214 standard which is 101°C. Biolipids that contain more free fatty acids or higher water content [28] have lower flash points. However all the storage conditions sample had shown number of flash point were reduce depending of storage time.But in some research they have shown that the flash point of each sample was reducing depending of storage duration [24].

Conclusion

In conclusion, biodiesel can affect by various conditions such as material of storage tank, temperature, light exposure and others. The storage conditions must be seriously considered to make sure quality of biodiesel can maintain in good condition. Antioxidant is one of the additive can help to prevent degradation of biodiesel storage.

Acknowledgement

The authors would like to thank the Universiti Tun Hussein Onn Malaysia for supporting this research under short term grant (STG) vot 1000.

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