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EVALUATION OF THE STORAGE EFFECT ON THE FUEL PROPERTIES FOR VARIETY BIODIESEL BLENDS

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ABSTRACT

This paper presents the effect of high blending ratio (HBR) biodiesel storage on the acid value and flash point temperature. The samples used, standard diesel (STD), B80, B90 and B100 were stored at temperature24 ˚C for nine weeks in a box. The acid value and flash point temperature were measured according to the American Society for Testing and Materials (ASTM) procedure. The results show that, the acid value and flash point temperature of the samples were increased almost 10% with the rise of 10% biodiesel blending ratio. Under long storage duration, the acid value and flash point temperature for all the samples are nearest to constant. Consequently, there are no significant effect to the acid value and flash point temperature when all the samples were stored in the dark place at room temperature (24˚C) for long period.

Keywords: biodiesel, high blending ratio, acid value, flash point, storage.

INTRODUCTION

Biofuel such as biodiesel and biogas is produce from living organism such as plant oils (palm oil, soybean oil, mustard oil) or animal fats [1-3]. Hence, biofuel is environmental friendly that can reduce the effects of harmful global greenhouse gases [4-6] and as an alternative fuel in diesel engine that can be used with no modification in compression-ignition engine for low blending ratio [7-9]. Moreover, methyl esters of animal and vegetable oils (biodiesel) are used as a fuel for diesel engines due to their cleaner burning tendencies, environmental benefits, and energy security reasons[10].In this research, the most preferable feedstock of biodiesel is palm oil because the availability of production in Malaysia. Through a refinery process called transesterification, the alcohol (ethanol or methanol) was mixed with palm oils with present of catalyst to form fatty acid methyl ester (biodiesel) and glycerin [11-13]. Biodiesel have been used in diesel engine, as consequent, the engine cannot last longer. The mixture of standard fuel and biodiesel for low blending ratio (B5 till B20) shows the diesel engine performs last longer and better than using pure diesel [14]. The blend level is denoted as B, followed by the percentages of pure biodiesel. Although there were many research about biodiesel storage, few of them focused on high blending ratio of biodiesel fuel [15, 16]. So it is necessary to do deep research on biodiesel blend with variety blends because the fuel properties in storage for HBR biodiesel is unrevealed. The properties of biodiesel blend could be change due to temperature and humidity. More recent studies have shown that when the storage time increases, the acid value of the biodiesel samples will be increased [17-19]. Increasing the acid value occurs when hydro peroxide produce from oxidative degradation which undergo hydrolysis reaction of ester further oxidize into acid [20, 21]. The increment of the acid value could damage the engine components such as piston, cylinder wall and shaft due to corrosion and oxidation process [22].

Flash point is important parameter for biodiesel while handling, storage and safety when it used in transportation [23]. The purpose to investigate the flash point is to measure the tendency of fuel sample to form flammable when it mixes with air in controlled laboratory conditions [24, 25].According to Zakaria *et al.* (2014a), a good fuel for diesel engine should have low auto-ignition temperature because the engine using air compression to ignite the fuel in combustion chamber [15]. Study has found that, flash point of fuel under storage with present of antioxidant is higher than fuel without antioxidant [26]. Study by Shahabudin *et al.* [3], found that the flash point temperature reduces when the fuel stored in long duration in storage [16].To demonstrate the potential of this approach, HBR of biodiesel and its effect on acid value and flash point temperature under storage is investigated.

EXPERIMENT PROCEDURES

Biodiesel (B100) was blended with standard fuelto produce B80 (80% of B100) and B90 (90% of B100). The samples were heated at 70 ˚C before blending an hour at 270 rpm [20]. According to biodiesel handling guide, when the biodiesel is blended, the temperature of biodiesel should be above it cloud point to avoid fuel appearing cloudy, showing that the oil is low quality, high viscosity and water content in the fuel[28]. After blending, the sample was stored in a bottle for nine weeks at 24 ˚C. The immediate properties test for all samples have been measured and recorded. At the same time, experiments on the acid value and flash point are conducted as followed test method ASTM D974 and ASTM D93 respectively. ASTM D974 is test method for acid value by color indicator titration. Acid value is an amount (milligram) of potassium hydroxide [4] or sodium hydroxide (NaOH) required titrating one gram of sample until the color appears more than 30 seconds. The titration process in this

experiment was used propan-2-ol as a solvent to mix with biodiesel;0.1 M of NaOH as a base and the color indicator used is polyethylene. Acid value is calculated by using Eq. 1:

$$\text{Acid value (mg KOH/g)} = \frac{56.1 \times 0.1M \times V}{g} \quad (1)$$

Where

56.1 = constant for molecular mass for KOH
0.1 M = concentration of KOH
V = volume of final value – volume of initial value of KOH
g = weight of sample in gram

ASTM D93 is test method for flash point using close vessel and the ignited fuel temperature was recorded as a flash point. The flash point machine, Set a flash Series 3 Closed Cup Flash Point was used to measure the flash point for every sample. Ignition mechanism was applied where; at the maximum temperature the sample will 'pop' and the flash temperature are automatically recorded.

RESULTS AND DISCUSSIONS

Table-1 shows the initial biodiesel properties that were recorded after the fuels have been blended. These data were used as reference to all the samples before further study is done. The methyl esters contain in biodiesel for all samples, B80, B90 and B100 were constantly increased with the rise of biodiesel blending ratio. Figure-1 shows the FTIR graph, the spectral region from 1680-1800cm-1, carbonyl compound (C=O bond) have very distinctive and strong absorbance [29]. The range interprets the ester contain in biodiesel. The graph shows the percent of absorbance increase when the value of biodiesel blending is increase, B80 increase by 56.47%, B90 increase 67.06% and the increment of B100 is 82.35%. As the increment of biodiesel blending ratio, the amount of fatty acid methyl ester (FAME) contain in biodiesel was increased too and it will affecting biodiesel properties including acid value.

Table-1. Properties of biodiesel for all samples at 24˚C.

Fuel type	Properties			
	Density [g/cm³]	Kinematic viscocity[mm²/s]	Flash point [˚C]	Acid value [mgKOH/g]
STD	0.8337	3.0	77.0	0.1400
B80	0.8654	4.4	113.0	1.9600
B90	0.8684	4.1	123.0	4.3400
B100	0.8729	3.9	124.0	5.1800

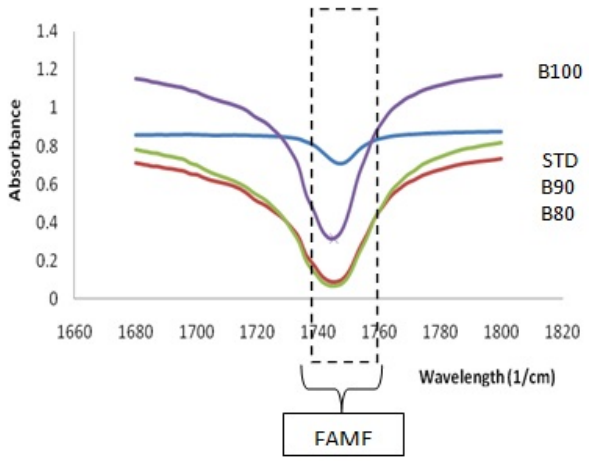

Figure-1. FTIR graph for four samples of biodiesel.

As shown in Figure-2, the acid value of the samples is increased almost 10% with the rise of 10% biodiesel blending ratio due to the increment of free fatty acid in biodiesel. It can be seen through FTIR graph in Figure-1. In Figure-2, there is no significant effect to the acid value of all samples when storage duration increases. This result is disagreement with Zakaria *et al.* [21], where the acid value is increased with storage duration. It proved that the biodiesel fuel more stable and maintain their chemical bond from oxidation process that effecting to high acid value of biodiesel when the biodiesel is stored at 24 ˚C and not expose to lighting and sunlight. Zakaria *et al.* [21] declared that, the number of flash point will decrease as the storage time is increased. However, result in Figure- 3 shows that all the samples near to constant throughout the storage time. The result shows that the samples which were stored at 24 ˚C in the dark place prevent biodiesel from degradation and give stability to flash point value. The result also describes the increase of biodiesel blend effects on the increment of the sample flash point. The increasing of flash point shows that the fuel has low auto-ignition; diesel fuel ignite spontaneously without an external source of ignition, the high flash point shows the fuel is low auto-ignition, not flammable, less hazardous and safe to be stored. Except for B100, the fuel shows the flash point temperature raise as the duration time increase.

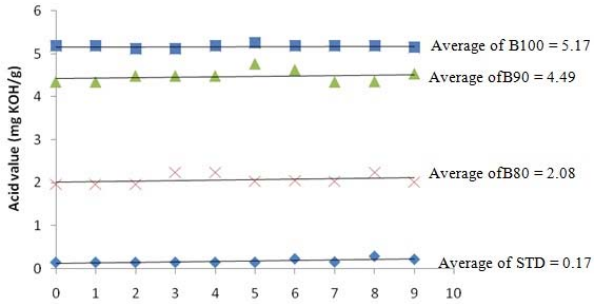

Figure-2. Acid value [mg KOH/g] against storage duration [week].

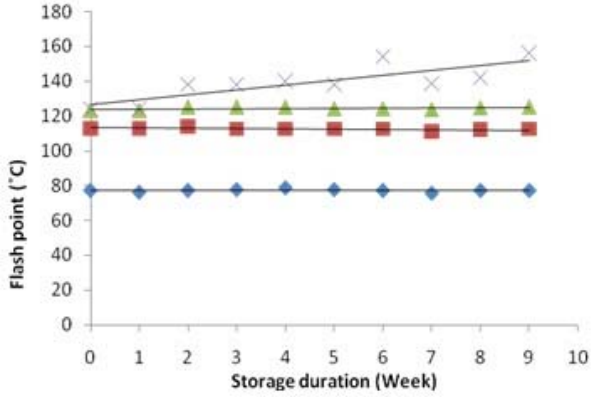

Figure-3. Flash point [˚C] against Storage duration [week].

Figure-4 and Figure-5, FTIR graph show the comparison of spectral region from 2500-3500cm-1, O-H stretch for standard fuel (STD) and B100 in storage for four week [29]. It shows the O-H stretch near to constant for four week. Besides, B100 fuel, O-H stretch is increase as storage time increase. The increasing of the flash point for B100 explains that the biodiesel is low quality and oxidation happen during storage time that makes the fuel degradation and unstable (change as the time increase).

CONCLUSIONS

This paper presents the effect of storage time to the acid value and flash point. Important conclusions drawn from this work include, there are no significant effect to the acid value and flash point in long storage time. It shows that the samples are stable when it stored in the dark place and without present of light. Further, it helps the biodiesel from degradation. Secondly, the increasing of biodiesel blending ratio is corresponding to increase of acid value. This acid value increment is due to higher composition of methyl ester in biodiesel fuel. The increment of acid value could damage the engine components because of corrosion and oxidation process. Lastly, flash point increase with the increase of biodiesel blend. The increasing of flash point makes the fuels less hazardous, good for storage, handling and transportation. In summary, this study has contributed to our knowledge about long storage duration and the effect to the biodiesel properties. In particular, further research should be conducted to study the effect of engine performance and emission when biodiesel high blending ratio is use in diesel engine.

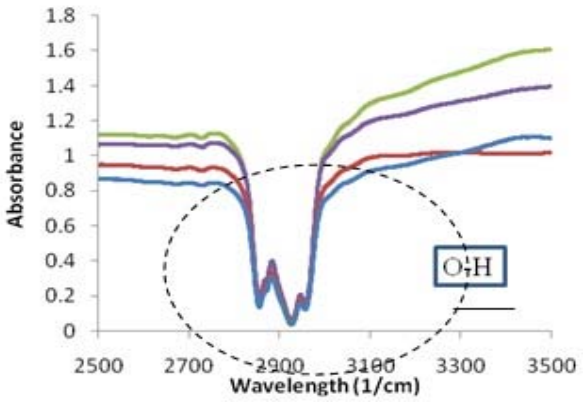

Figure-4. FTIR graph for standarf fuel.

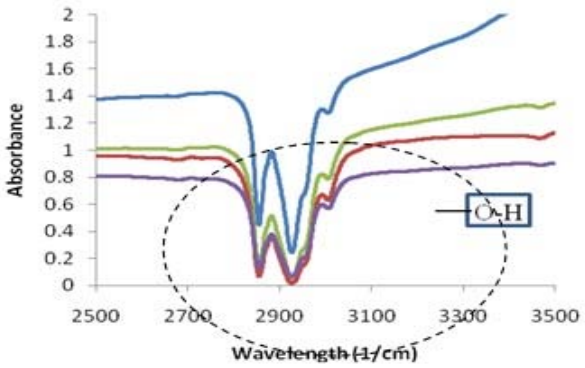

Figure-5. FTIR graph for B100.

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