The HBR Palm Oil Based Biodiesel Properties on Long Duration Storage Parameters

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Abstract: - Biodiesel is one of the most important alternative source for fossil fuel that has several distinctive advantageous. However, biodiesel has high level of acidity and water content that the practical application of biodiesel needed to be blended with fossil fuel. This paper investigated on the effect of the high blended ratio (HBR) biodiesel over the long storage time that was analyzed at three different temperature setting. The HBR biodiesel has high level of acidic content that high level of acidic was found on the high ratio of HBR biodiesel. The storage time further increase the acidic content of biodiesel especially at high temperature storage. The water content in HBR biodiesel was also found increases with increases of storage time and rate of water content was more aggressive at high temperature storage time.

Key-Words: - High Blend Biodiesel, Biodiesel storage, Acid Value, Water Content

1 Introduction

The potential impact of fossil fuel shortage and green environmental campaign leads to the exploration of alternative fuels, source for energy efficiency, design for energy conservation and management. [1] Biodiesel is one of highly potential alternative fuels due to its clean production fuel and reduce the dependencies on foreign oil. [2] The major chemically bound oxygen component in the biodiesel fuel has responded to reduce the pollutant concentration in exhaust gases because fuel was better burning in the engine [3].

Biodiesel's characteristics strongly depended on various plant feed stock, growing climate conditions, soil type, plant health and plant maturity upon harvest. These parameters affect the physical and chemical properties, which also have direct relationship with performance and emission of the engine [4]. Biodiesel is typically manufactured through a process called "trans-esterification" [5]. This process uses an industrial alcohol (typically methanol, sometimes ethanol) and a catalyst (sodium methylate or sodium hydroxide) to convert the base plant oil or animal fat into a fatty-acid mono-alkyl ester fuel (biodiesel), with glycerin as a byproduct. [6]. Wu et. al. (2011) has studied the effect of degradation and oxidation on biodiesel fuel. He studied one commercial biodiesel and three laboratory-produce biodiesels to verify the effect of storage temperature, type of storage container, storage time as well as the moisture content on the properties of the biodiesel. The properties of biodiesel were shown changed due to temperature high and humidity [7].

Few studies were done on properties for low blending biodiesel into fossil fuel. H. Zakaria et. al. (2014) investigated on low blend biodiesel B5 (5% biodiesel) up to high blend biodiesel B45 (45% biodiesel). The sample were kept in long storage duration to investigate the oxidation stability, fuel degradation and microbial growth on biodiesel fuel [8]. The biodiesel with low blending ratio has proved little change in fuel performance [2]. While high blending ratio (HBR) biodiesel cannot be used directly on the diesel engine for long usage due to fuel acidity and higher moisture content on the fuel [9]. In order, to overcome the problem regarding HBR of biodiesel, some research on HBR of biodiesel and its effect on acid value and flash point temperature under storage were investigated and the result shown as the blending ratio increase, the properties for acid value and flash point were also increased. Recent studies have shown that when the storage time increases, the acid value of the biodiesel samples will be increased [10-12]. Increasing the acid value occurs when hydro peroxide produce from oxidative degradation which undergo hydrolysis reaction of ester further oxidize into acid [13, 14]. The increase of acid value could damage the engine components such as piston,

cylinder wall and shaft due to corrosion and oxidation process [15]. High water content can lead to problem for engine such as fuel filter plugging, corrosion at engine compartment and fuel degradation

This paper focus on the effect of long term storage of HBR biodiesel at ambient as well as high temperature storage on the acidity performance and water content.

2 Methodology

In this study, the three different samples for HBR of biodiesel that are B70 (70% of B100), B80 (80% of B100) and B90 (90% of B100). The samples were blended for an hour and heated around 70 ˚C [11]. The heating procedure as per biodiesel handling guidelines that biodiesel temperature should be above it cloud point to maintain the quality and to avoid fuel appearing cloudy. The cloudiness of the fuel indicates that the fuels is in low quality and contain high viscosity and water content [12]. The fuel properties (acid value, flash point, density and water content) for all samples were analysed in accordance to ASTM D6751. All samples were stored for seven weeks at three different temperatures, cold (9-12˚C), ambient (24-26 ˚C) and hot (39-41 ˚C).

To determine the amount of acid value in the samples, a colour indicator titration method was used. One gram of each sample was used and titrated with sodium hydroxide (NaOH) solution individually. The titration will cause the sample to change in violet colour. The process continued until the sample maintained the violet colour for more than 30 seconds.

Water content testing was measured using oil analyser (Spectro 5200 Trivector Oil Analyzer). The blended biodiesel diluted with solvent in 1:1 ratio. The diluted oil sample is about 20ml. The dilution process was to reduce the viscosity and allows the particle to settle during experimentation. The sample was shake vigorously to mix the sample well right after dilute the sample using appropriate solvent. Then, the sample was poured into the chamber until sensor detects the right amount of fluid before it start calculating the water content.

3 Results and Discussions

Fig. 1 is the FTIR spectrum of HBR biodiesel at different ratio plotted in a region of 1680-1800cm-1, carbonyl compound (C=O bond), that was representing ester content in biodiesel which have very distinctive and strong absorbance [29]. In general, the result shows that the absorbance increase with the increasing of biodiesel blending ratio. The standard diesel, B70, B80 and B90 was absorbance increased by 11.12% 29.40%, 31.31% and 33.47% respectively. This result indicates that methyl esters contain in biodiesel for all samples, B70, B80 and B90 were increased with the increased of biodiesel blending ratio. Table 1 is the initial data of HBR biodiesel properties that were measured immediately after the fuels have been blended. As the blending ratio of HBR biodiesel increases, the amount of fatty acid methyl ester (FAME) contain in biodiesel was also found increases.

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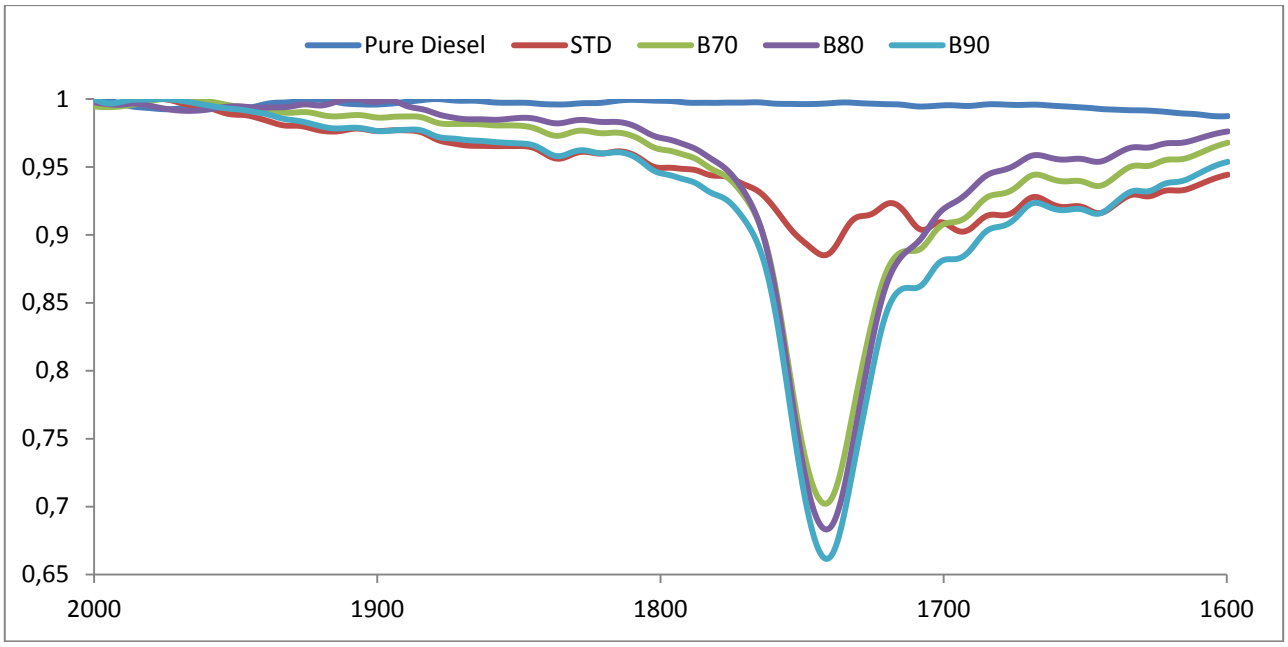

Figure 1: FTIR graph

Table 1: Initial properties for all samples

Sample	Acid value (mgKOH/g)	Flash point (˚C)	Density (g/cm³)	Water content (ppm x10³)
STD	0.1412	90	850	0.00
B70	4.4470	120	870	0.75
B80	5.3877	128	870	1.00
B90	5.7297	138	875	1.65

Result on the level of acidity for various HBR biodiesel over long term cold storage temperature was presented in Fig. 2. As expected, the standard diesel shows no change in the level of acidity for over 7 weeks of cold storage duration. For the HBR biodiesel, regardless of the blended ratio, all samples show an increasing trend of the acidity level

The B70 was found increased up to 16.6% from initial value of 6.014 to 7.013 after 7 weeks' storage. Same trend goes to B80 and B90 that have an increasing trend of the acidity up to 15.55% and 18.61% respectively.

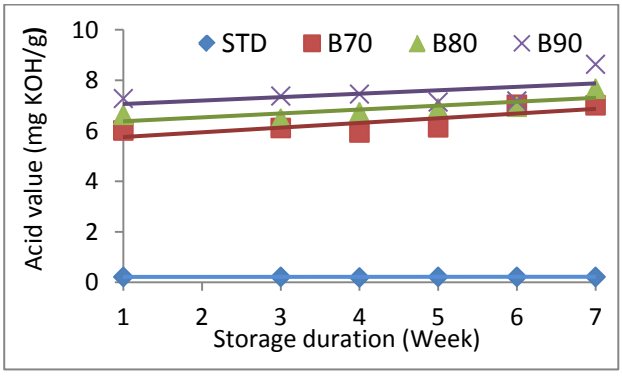

Figure 2: Cold Temperature Storage

Fig. 3 is the result for HBR biodiesel at different blended ratio over the ambient environment long term storage. Standard diesel has no significant effect on acidity level in seven weeks' storage. For the HBR biodiesel, regardless of the blended ratio, all samples show an increasing trend of the acidity level. The B70 shows 12.49% increases that the acidity value increased from 5.709 to 6.422. The B80 increase 8.54% when the value of acid value was rise from 7.350 to 7.977. The B90 increases to 14.41% from 7.355 to 8.415 after 7th week.

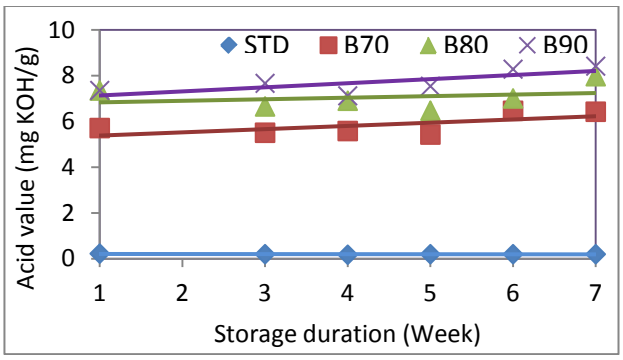

Figure 3: Ambient Temperature Storage

Acidity value on HBR biodiesel B70, B80 and B90 for hot temperature storage was shown in Fig.

4. The standard diesel has no impact to the fuel when duration time increases for hot storage. Other samples with same condition of storage B70 and B90 also show the increasing trend. B70 shows the ascending trend when the acid value increased from 5.370 to 5.888 with 9.65% increment. Meanwhile, B80 decreased 4.85% when the value of acid value was drop from 7.074 to 6.731. For B90, the value for early storage is 7.548 and the value for the end of experiment in week 7 is 9.497. It is shows the increment by 26.38% of high blending biodiesel for B90.

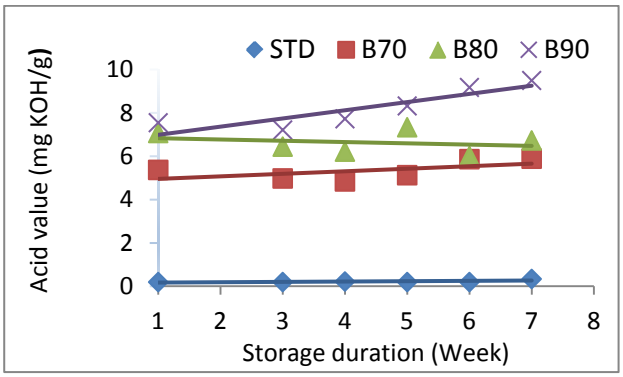

Figure 4: Hot Temperature Storage

The same experiment procedure was applied for all samples to get the results of acid value. Fig. 5 shows the result is aligned with the theoretical understanding that at cold temperature the acid value of biodiesel is the lowest gradient, with coefficient of determination, R^2 = 0.2731 and the highest gradient, has coefficient of determination is R^2 = 0.7817. As stated by Zakaria et. al. (2014) as the temperature of the storage increase, the acid value also increases because the increment of free fatty acid in biodiesel, while lower storage temperature will give the stability to the sample [8]. As the temperature increases, the molecule in biodiesel react more actively to the environment because the presence of C=0 bonding which escalate the degradation process. This will result to high acid content in the fuel and consequently acid value increases as the storage time increase. The hydro-peroxide produced from oxidation process is the reason the increment of acid value in a fuel.

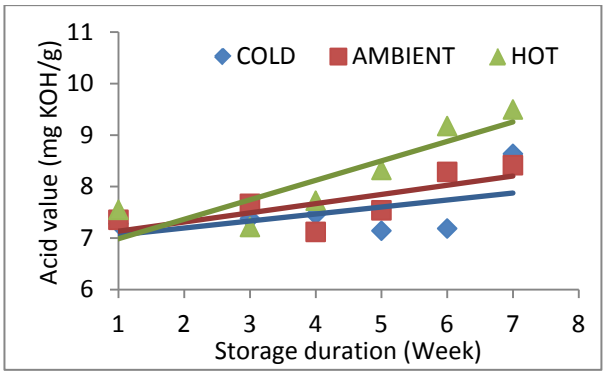

Figure 5: B90 for all temperatures storage

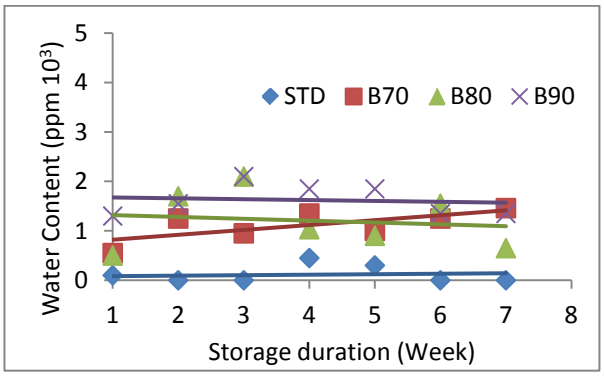

Figure 6: Cold Storage

Fig. 6 shows the result of standard diesel, B70, B80 and B90 on water content for cold storage. Generally, the graph shows the stable trend for standard diesel, B80 and B90, while B70 shows the ascending trend that water content increases in the fuel as the storage time increase. Water content reading for standard diesel in week 1 is 0.1 and the average value is 0.12. For B80, the initial reading is 0.5 and the average is 1.2. The initial reading for B90 is 1.3 and the average is 1.62. For B70, the initial reading was 0.55, while the final was 1.46 where the percent increase for the blending is 62.33%.

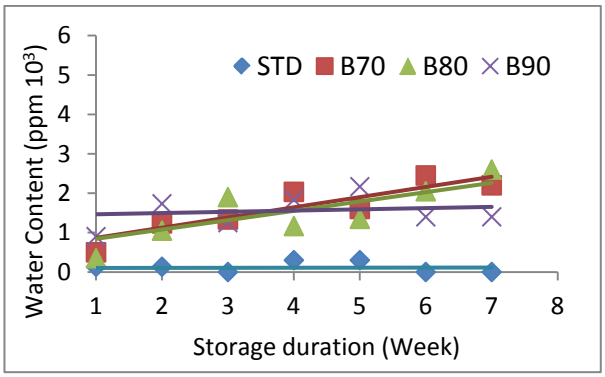

Figure 7: Ambient Storage

The results of water content in ambient storage were shown in Fig. 7. The samples in this graph

were standard diesel, B70, B80 and B90. In general, standard diesel and B90 has no increment for water content in fuel while B70 and B80 give the ascending trend that increasing of moisture in the fuel. The initial value for standard diesel is 0.133 and the average 0.12. While, B90, the earlier reading is 0.9 and the average reading is 1.525. The B70 shows the rise trend when the water content increased from 0.5 to 2.2 with 340% increment. B80 increased by 64.2% when the value of acid value was drop up from 0.35 to 2.6.

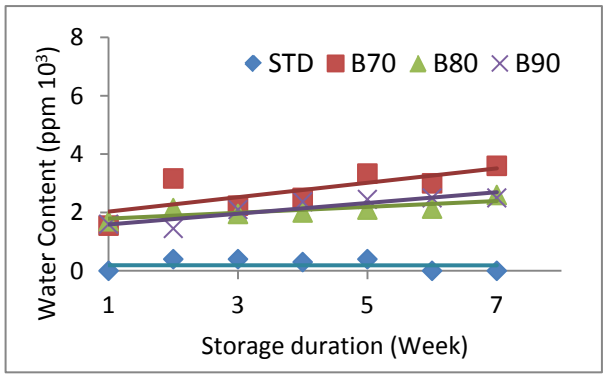

Figure 8: Hot Storage

Fig. 8 shows the result of water content for hot temperature. The samples in this graph were on standard diesel, B70, B80 and B90. The graph was shown the standard diesel results give no significant effect to the fuel as storage time increase in hot storage. And initial reading is 0 with average reading 0.2. Besides, other samples with same condition of storage B70, B80 and B90 show the increasing trend. For B70, the value for early storage is 1.55 and the value for the final reading in week 7 is 3.6. It is shows the increment of high blending biodiesel by 132.26%. B80 shows the rise trend when the water content increased from 1.7 to 2.6 with 56.94% increment. B90 increased by 56.25% when the value of acid value was rise from 1.6 to 2.5.

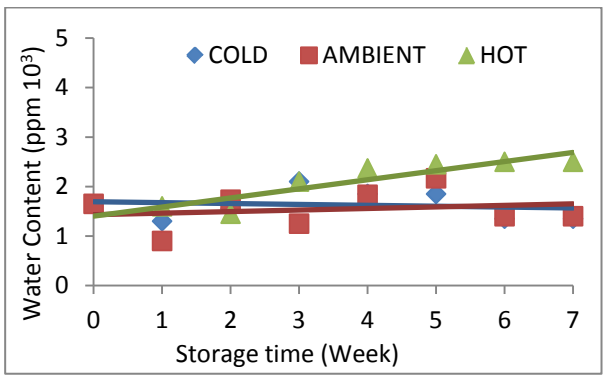

Figure 9: B90 for all temperatures storage

Water content will only increase if the sample store in air exposure condition in high temperature storage [16]. In this condition, water content has the highest value of water as shown in Fig. 9 with R^2 = 0.8055. In low temperature storage the results show that the water contents almost no change in acid value where R^2 = 0.0152. Biodiesel fuel is more hygroscopic compared to diesel fuel. It has a natural tendency to absorb moisture and water which tends to condense on the metal surface, favoring the corrosion [17] Water accelerates oxidation, dramatically increases the corrosives and promotes microbial growth.

4 Conclusion

The HBR biodiesel has high level of acidic content that high level of acidic was found on the high ratio of HBR biodiesel. The storage time further increase the acidic content of biodiesel especially at high temperature storage. The water content in HBR biodiesel was also found increases with increases of storage time and rate of water content was more aggressive at high temperature storage time.

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