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# Storage Stability and Corrosive Character of Palm Biodiesel

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**Abstract** – *Biodiesel is gaining global attraction as an alternative fuel because of its biodegradability and environmental-friendliness. It can be mixed with diesel fuels and used in diesel engines with no or slight modification. In Malaysia, palm oil is used as a feedstock for the production of biodiesel due to its abundant availability. This study was conducted to investigate the stability of pure palm oil biodiesel over a storage time of 2, 4 and 6 months. The static immersion test was carried out at room temperature to evaluate corrosion characteristics of biodiesel towards copper, mild steel and aluminium. The kinematic viscosity increased slightly with storage time. The results showed that copper was more prone to corrosion than aluminium and mild steel. The corrosion rate for copper is 0.5794 mpy, 0.2087 mpy for aluminium and 0.1682 mpy for mild steel for 2,016 h of immersion test.* 

**Keywords:** Biodiesel, Stability, Transesterification, Corrosion, Fuel Properties

## 1.0 INTRODUCTION

The diminishing supply of fossil fuels has raised concerns for the need of renewable energy sources as substitutes for fossil fuels. One of the alternatives to renewable energy that has been getting a lot of attention lately is biodiesel. Biodiesel is an alternative biofuel consisting of alkyl monoesters of fatty acids prepared from vegetable oils [1-3]. Malaysia has a huge potential to produce biodiesel from palm oil as it is the largest palm oil exporter in the world. The use of B5 (a blend of 5% palm oil biodiesel and 95% petroleum diesel) has been fully implemented nationwide in July 2014. The Malaysian government is also considering the introduction of a higher biodiesel blend B7 in the near term and studying the prospects of the B10 and B20 biodiesel programmes.

The properties of biodiesel depend on the fatty composition of parent oil, especially the level of saturated and unsaturated fatty acid esters [4-8]. Palm oil contains highly saturated components compared to other vegetable oils. Unsaturated components in biodiesel are more chemically reactive and less stable. Biodiesel can be mixed with petroleum diesel and used as transportation fuel without engine modification. Biodiesel is more prone to oxidation compared to petrol diesel, especially when exposed to air in a storage tank. Upon oxidation, biodiesel may change its properties and thus affect the quality and performance of biodiesel. Oxidation of biodiesel produces acidic species that attack metal through corrosion and degradation reactions. Metals in engine parts and storage tanks are exposed to biodiesel and therefore, corrosive characteristics of biodiesel are important information. Kaul et al. [9] used the static

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immersion test for 300 days at room temperature to assess the corrosion of metallic pistons immersed in different biodiesels produced from jatropha oil, karanja oil, mahua oil and salvadora oil. They reported that the corrosion rate depends on the type of oil used as the feedstock in biodiesel production. The corrosion rate is higher if biodiesel contains more 18:2 fatty acids [9].

However, there is still a lack of adequate literature on palm oil biodiesel fuel properties. This study was conducted to investigate the properties of biodiesel stability and corrosion characteristics.

## 2.0 METHODOLOGY

### 2.1 Biodiesel preparation

Biodiesel samples were prepared by transesterification of palm oil with methanol at 700°C in the presence of NaOH as the catalyst. After glycerol had been separated, biodiesel was washed with water. The biodiesel was then heated to 100ºC for 1 h to remove methanol and the remaining impurities.

### 2.2 Biodiesel (B100) stability

Biodiesel samples (100 mL each) were stored for 2 months, 4 months and 6 months at room temperature. The samples were stored in sample bottles that were not exposed to the air. After storage, biodiesel samples were taken out and biodiesel properties were monitored. The parameters namely kinematic viscosity and density were measured according to ASTM standards.

### 2.3 Corrosion rate determination

For immersion test, copper, aluminium, and mild steel parts were polished with silicon carbide abrasive papers, preweighed and immersed in in a closed 200 mL beaker containing biodiesel at room temperature for 2,016 h. Then, the specimens were removed and polished with silicon carbide abrasive papers, cleaned, and reweighed. The weight loss of each test metal was recorded. The corrosion rate was calculated through weight loss according to Eq. 1 as given below [9].

$$\text{Corrosion rate (mpy)} = \frac{W \times 534}{D \times T \times A} \tag{1}$$

Where the unit of corrosion rate, mpy stands for mils per year, W is the weight loss in mg, D is the metal density in g/cm$^3$, A is the exposed surface area (square inch) and T is the exposure time (h)

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## 3.0 RESULTS AND DISCUSSION

The stability of biodiesel in storage is important since it can affect the quality of biodiesel, as well as its performance in diesel type engine [10]. Among the most important fuel properties are kinematic viscosity and density. Viscosity is defined as the resistance to flow of a fluid and it affects the operation of fuel injection system. The acceptable range of density and kinematic viscosity for biodiesel according to ASTM D6751 standard are in the ranges of 0.86–0.9 g/cm$^3$ and 3.5–6.0 mm/s$^2$ respectively. High viscosity leads to poorer atomization of fuel spray and less accurate operation of fuel injectors. Figure 1 shows the viscosity and density of biodiesel after it has been stored for 2, 4, and 6 months at room temperature. The viscosity increased with storage time. However, the change in biodiesel properties is not significant and is still in the acceptable range for short storage duration. The oxidation of biodiesel leads to the formation of high molecular weight polymer compounds that increase the viscosity of biodiesel, and consequently leading to the formation of gums and sediments that clog filters [10-12].

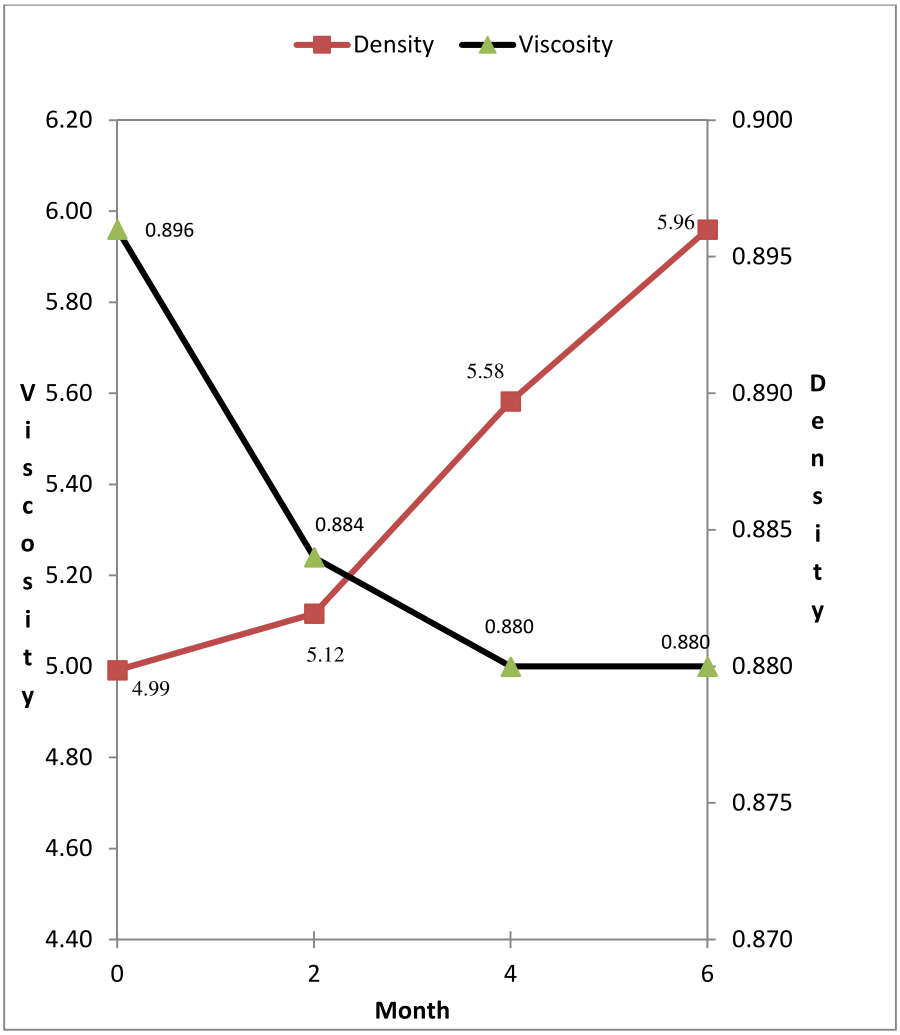


**Figure 1:** Kinematic viscosity (mm/s$^2$) and density (g/cm$^3$) of pure biodiesel after storage for 2, 4, and 6 months at room temperature.

Lin and Chiu [12] investigated the change in kinematic viscosity of biodiesel samples with and without antioxidant during a storage period of 3,000 h. They reported that the antioxidant helps

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to stabilize kinematic viscosity. They also observed that higher storage temperature results in an increase of kinematic viscosity

Biodiesel is more prone to absorb water compared to petrodiesel. The corrosion behavior of biodiesel can be caused by free water and free fatty acids present in biodiesel. Table 1 shows the corrosion rate of metals at room temperature. It was observed that the corrosion rate of metals in biodiesel increased with immersion time. Copper had the highest corrosion rate, followed by aluminium and mild steel. It implies that mild steel is compatible with biodiesel. Similar findings have been reported by Fazal et al. [13] in their study. They reported that copper has 0.586 mpy and mild steel has 0.202 mpy corrosion rate at 1,200-hour study period at 80°C.

**Table 1:** The corrosion rate of metals at different time.

| Metal | Corrosion rate (mpy) | |
|---|---|---|
| | Immersion Time (1,344 h) | Immersion Time (2,016 h) |
| Copper | 0.2905 | 0.5794 |
| Aluminium | 0.1730 | 0.2087 |
| Mild steel | 0.0879 | 0.1682 |

## 4.0 CONCLUSION

From this study, kinematic viscosity slightly increased with storage time, but it is still within the acceptable range when the storage duration is short. The results show that copper is more prone towards corrosion than aluminium and mild steel. The corrosion rate for copper is 0.5794 mpy, 0.2087 mpy for aluminium and 0.1682 mpy for mild steel in 2,016-hour immersion test.

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