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# The Effect of HLB Surfactant Value on The Characteristics of Emulsion Biodiesel Palm Oil Using Homogenizer

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**Abstract** - *The process of making water emulsion in palm oil biodiesel is assisted by using two types of surfactants with different HLB values, namely Tween 80 and Span 80. This study aims to determine the characteristics of palm oil biodiesel emulsion made using a homogenizer with different HLB values, surfactant composition and water content in each sample. Density, viscosity, stability and microscopy tests were carried out to determine the characteristics of palm oil biodiesel emulsion. The results were obtained in the form of the highest density and viscosity values found in samples with high HLB values, surfactant composition and water content, while for stability test results were found in samples with low HLB values, surfactant composition and low water content. This shows that the difference in the value of HLB used will affect the amount of surfactant composition and moisture content in the sample composition and will affect the density, viscosity and stability of the palm oil biodiesel emulsion formed.*

***Keywords*** *–HLB, emulsion, biodiesel, tween 80, span 80*

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## 1. Introduction

Homogenization is a process of uniform particle size with the aim of maintaining the stability of a mixture formed from two incompatible phases or commonly called an emulsion where the uniformity process is carried out by reducing the particle size in the dispersed process because of the force that occurs due to the mechanical treatment given that causing the breakdown of the dispersed particles [1]. Emulsion is a type of colloid that contains two or more substances which cannot be mixed and stabilized with a suitable emulsifier or surfactant so that the resulting emulsion is stable [2]. Emulsions can be used as products in various industries such as cosmetics, agriculture, pharmaceuticals and food.

Palm oil is a triglyceride or a compound with fatty acids which according to its fatty acid chain structure, palm oil belongs to the oleic-linoleic oil group. Palm oil has a red-orange color that caused by the presence of semi-solid concentrations of carotenoids (especially β-carotene) at room temperature [3]. The low cholesterol content in palm oil makes it possible to convert it into consumable ingredients such as cooking oil, margarine and fat. In addition, palm oil can also be processed into non-food needs such as glycerin, soap, detergent and fuel.

The manufacture of biodiesel using palm oil as raw material is based on an emulsion system. Because palm oil is a type of vegetable oil, the processing process still experiences several problems, including the high water content contained in palm oil.

This study aims to determine the characteristics of water emulsion in palm oil biodiesel by calculating the HLB value of the two types of surfactants. The research process on the characteristics of water emulsion in palm oil was carried out by using the homogenization method. The homogenization method was carried out using a homogenizer with a speed of 18,000 rpm and using two types of surfactants, namely Span 80 and Tween 80. Span 80 (Polysorbate 80) functions as a lipfilic nonionic surfactant. Meanwhile, Tween 80 functions to make the oil-in-water emulsion system more stable and has a hydrophilic and lipophilic group balance value of 8-16 [4].

## 2. Methodology

### 2.1 Materials

The Process of making palm oil biodiesel emulsion in this study using a homogenizer (DLAB D-500), ostwald viscometer, pycnometer, measuring cup, beaker, stopwatch, analytical balance, dropper pipette, thermometer, microscope and hot plate magnetic stirrer.

The materials used in this research are palm oil, KOH, methanol, aquades and two types of surfactants, namely span 80 and tween 80.

### 2.2Procedure

#### 2.2.1 Process of Making Biodiesel Sampling

The process of making palm oil biodiesel emulsion begins with making biodiesel through a transesterification process between palm oil and KOH as a catalyst using a hot plate magnetic stirrer for 1 hour with an operating temperature of 60 ℃ and a speed of 300-600 rpm.

**Biodiesel Emulsification Process**

The process of making water emulsion in palm oil biodiesel is carried out by mixing biodiesel with water, span 80 and tween 80 into a beaker with a different composition for each sample. The homogenization process was carried out at a speed of 18,000 rpm for 5 minutes. The composition of each sample is shown in Table 1.

Table 1. Composition of Each Palm Oil Biodiesel Emulsion Sample

| Sample | Density (gr/mL) | Viscosity (Cp) | Stability (%) |
|---|---|---|---|
| 1 | 0,752 | 1,752 | 33,33 |
| 2 | 0,832 | 2,771 | 30 |
| 3 | 0,772 | 4,756 | 26,67 |
| 4 | 0,852 | 8,699 | 23,33 |
| 5 | 0,872 | 11,728 | 31,67 |
| 6 | 0,912 | 14,483 | 28,33 |
| 7 | 0,886 | 16,710 | 25 |
| 8 | 0,932 | 19,453 | 21,67 |

## 3. Analysis

### 3.1 Stability Analysis

Emulsion stability is very important to ensure the compatibility of palm oil to be used as a fuel. Emulsion stability is determined by the phase separation period which can be seen in the formation of sedimentation or sediment below. Where the sample without sedimentation separation is considered as a stable emulsion [5].

Palm oil biodiesel emulsion stability test was carried out by leaving it for 1 week then observing it, then calculating it with the formula:

$$\text{ES\%} = \frac{High\ sedimentation}{Total\ heigh\ emulsion}\ x\ 100\%$$

### 3.2 Density Analysis

Density analysis on the formed emulsion aims to measure the density of the emulsion formed. The density test is carried out using a pycnometer and then the calculation is carried out using the formula:

$$\rho = \frac{mass\ pycnometer\ content - empty\ pycnometer}{pycnometer\ volume}$$

### 3.3 Viscosity Analysis

Viscosity analysis was carried out using Ostwald Viscometer then the sample viscosity was calculated using the formula:

$$\eta = \eta_o \frac{t.\rho}{t_o.\rho_o}$$

### 3.4 Microscopis Analysis

Microscopic analysis were performed to observe the size of the water particles and the distribution of water in the sample using a 10 times magnification microscope. Through testing using this microscope, it can be seen the level of stability of the emulsion produced. Where the emulsion is considered stable if the water particles and the distribution of water in the sample are uniform [6].

## 4. Result and Discussion

The preparation of water emulsion on palm oil biodiesel was carried out according to the sample composition in Table 1. After the emulsion is formed, the density and viscosity analysis is carried out and the sample will be observed for 7 days for stability and microscopic analysis.

Table 2. Density, Viscosity and Stability Analysis Results

| Samp le | HLB Value (-) | Surfactant Composition (%) | Water Content (%) |
|---|---|---|---|
| 1 | 6 | 5 | 9 |
| 2 | 9 | 5 | 9 |
| 3 | 6 | 7 | 9 |
| 4 | 9 | 7 | 9 |
| 5 | 6 | 5 | 15 |
| 6 | 9 | 5 | 15 |
| 7 | 6 | 7 | 15 |
| 8 | 9 | 7 | 15 |

From Figure 1, it can be seen that the results of the density analysis show that the density value increases with the increase in the HLB value, the surfactant composition and the water content. From these data it can be concluded that there is an increase in the density value along with the addition of the HLB value, surfactant composition and water content in the sample [7]. In the sample, the increase in density is in accordance with the

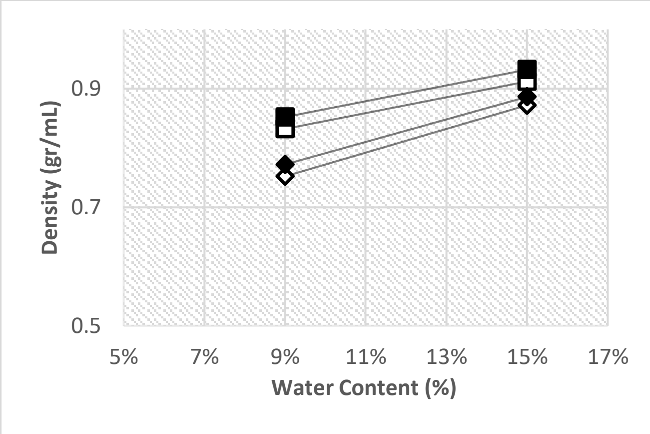



Figure 1. The Effect of HLB Value, Surfactant Compositions and water content (◇ 6 (5%); □ 9 (5%); ◆ 6 (7%); ■ 9 (7%) Againts Density

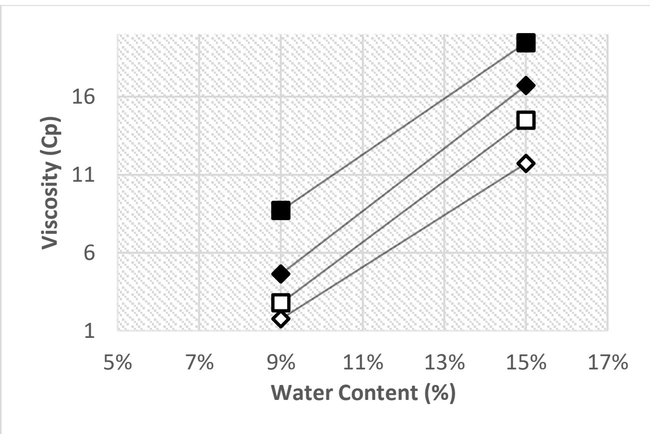



Figure 2. The Effect of HLB Value, Surfactant Compositions and Water Content (◇ 6 (5%); □ 9 (5%t); ◆ 6 (7%); ■ 9 (7%) Againts Viscosity

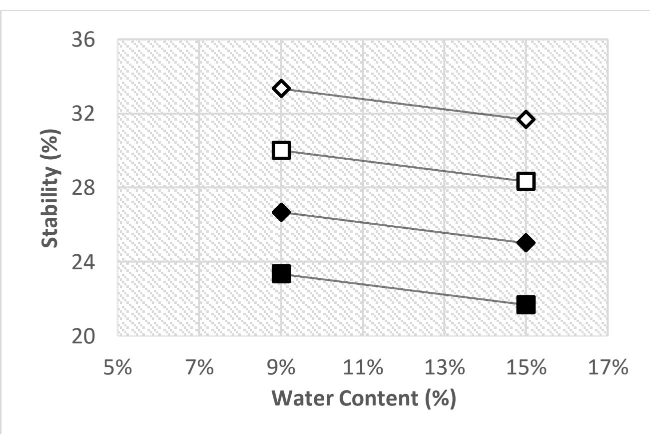



Figure 3. The Effect of HLB Value, Surfactant Compositions and Water Content (◇ 6 (5%); □ 9 (5%t); ◆ 6 (7%); ■ 9 (7%) Againts Stability.

theory regarding the relationship between density and water content. Where the greater the water content added to the sample, the greater the density value. This is because the value of higher density or water density is added to biodiesel which has a lower density value so that the density of the emulsion formed is greater [8].

In the results of the viscosity analysis, it was found that the viscosity value of palm oil biodiesel emulsion increased along with the increase in HLB value, surfactant composition and water content [Figure 2.]. From the results of these calculations it can be concluded that there is an increase in the viscosity value of each sample. In addition, it can also be seen that the viscosity value obtained is greater as the water content is added to the sample. This is in line with the results of research by Melo-Espinosa, Bellettre, and D. Tarlet in 2018 which stated that as the percentage of water content added to the sample increases, the viscosity of the emulsion will also increase. This is because when the percentage of water content increases, a more complex micellar structure will form and will cause viscosity to increase [9]. In addition, the increasing percentage of water content is also due to the hydrodynamic interaction between emulsion particles which causes high internal friction and results in high viscosity values [10].

The low viscosity value of biodiesel will result in better combustion performance of biodiesel so that it can reduce the amount of fuel used and the resulting low pollution emission value so it will safe for the environment [11].

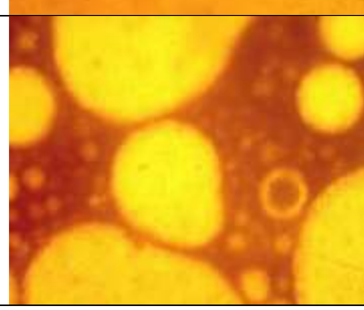
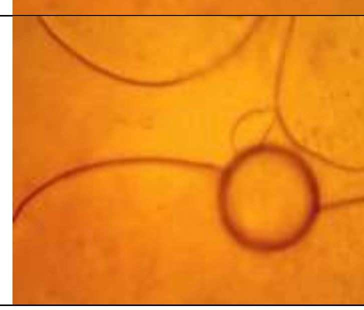
For stability analysis, different results obtained from density and viscosity analysis. As can be seen in Figure 3. the results obtained in the stability analysis are inversely proportional to the results of other analyzes. Where the greater the HLB value, the surfactant composition and the water content used in the sample, the smaller the percentage of stability is. The results obtained are in accordance with the existing theory where for the stability value of an emulsion the most influential is the HLB value and the surfactant composition. The use of a surfactant composition that is too high can reduce the level of emulsion stability because the incorporation process in making the emulsion is faster. In addition, the HLB value also affects the level of stability of an emulsion because to obtain a stable emulsion it is necessary to calculate the HLB value which will determine the type of surfactant used so that the emulsion is more stable.

The emulsion stability analysing process is carried out by immersing it in room temperature for seven days to see if there is separation and phase change. The test at room temperature is carried out to avoid the stability influence factor in the form of temperature differences.

Emulsion is said to be stable if after seven days and observations are made less sedimentation results are found. According to research conducted by Awang and May in 2008, palm oil biodiesel emulsion with a surfactant composition of 0.1-5% was considered the most stable and good [8].

In addition to analysis of density, viscosity and stability, microscopic analysis was carried out using a microscope with a magnification of 10 times. From microscopic analysis, the results are shown in table 3.

Table 3. Microscopic Analysis Test Results Using a Microscope With 10 Times Magnifications

| | HLB Value 6 | HLB Value 9 |
|---|---|---|
| | Water Content 9% | |
| Surfactant Composition 5% |  |  |
| Surfactant Composition 7% |  |  |
| | Water Content 15% | |
| Surfactant Composition 5% |  |  |
| Surfactant Composition 7% |  |  |

In sample 1 with an HLB value of 6, the surfactant composition of 5% and water content of 9% has the best level of stability among the eight samples observed because the water particle size looks the same and the water distribution looks equally. Whereas for sample 8 with an HLB value of 9, a surfactant composition of 7% and a moisture content of 15% can be said to be a less stable sample where it can be seen that the water particle size is not uniform and the water distribution is not look equally.

The results obtained are in accordance with the theory where as the HLB value increases, the surfactant composition and water content used in the sample, the emulsion stability will decrease [7].

## 5. Conclusions

The HLB value, surfactant composition and water content had a significant effect on the emulsion characteristics of palm oil biodiesel.

The value of density and viscosity is directly proportional to the value of HLB, surfactant composition and water content. Where the greatest density and viscosity values were found in sample 8, namely 0.932 gr / mL and 19.453 Cp with HLB 9 values, 7% surfactant composition and 15% moisture content. While the good viscosity value for biodiesel used as fuel is in sample 1, namely 1.752 Cp because it has the lowest viscosity value.

For the resulting stability value gets smaller as the HLB value increases, the surfactant composition and water content so that it can be said to be inversely related. The best stability of the biodiesel emulsion that will be used as fuel is in sample 8 with a value of 21.67% or the most unstable.

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