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The Characteristics Study of Palm Oil-in-Water Emulsion by Adding Gelatine as an Emulsifier Agent

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Abstract: Abrasive blasting is a cleaning process for removal old paint coatings, corrosion and residues from metal surfaces. Water is used as a medium in the process of wet abrasive blasting represent new alternative to reduce fine dust released into the environment and potentially produce the formation of corrosion on the metal surface. However, until now there is still no solid evidence to determine that the palm oil-in-water emulsion has been applied into the application of blasting through their characteristic and psychochemical properties. This study analyses the concept of oil-in-water palm emulsion to determine their characteristics and physicochemical properties when adding an emulsifier agent. RBD palm olein was selected and the emulsifying agent was used for the stability of oil-in-water palm emulsion. Emulsifying agents are used to facilitate the process of emulsification reduce the interfacial tension between oil and water due to hydrophilic and hydrophobic properties. The characteristic and physicochemical properties determine in this study are dynamic viscosity, density and creaming stability, microscopy image for visual analysis. The dynamic viscosity increases if the temperature decreases. The density of the emulsion also decreases as the speed of the mixing process of the water and oil increases. In terms of creaming stability, the dynamic viscosity is higher when the use of more gelatine promotes the formation of cream on the surface of the resulting sample after a stirring. The results of the analysis for microscopy images size droplet of water and oil reduced when the speed of the mixing process is increased. In conclusion, the use of gelatine as a natural emulsifier can increase the stability of the oil-in-water palm emulsion. The study recommends to use a relatively high stirring speed between 4000 rpm and above to achieve a viscosity reduction and enhance stability of emulsion.

Keywords: Oil-In-Water Emulsion, Physicochemical, RBD Palm Olein

1. Introduction

Abrasive blasting requires various essential equipment elements for productive cleaning or treating of metal surfaces by projecting abrasive particles using compressed air as the source of power. The

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purpose of abrasive blasting is outside cleaning and treating metal surface process for bridges, ships and other steel substrates in enclosed systems. There are two main type of blasting process which are dry and wet. Both this method indicates to cleaning process that involve propelling small particle at surface at high velocity to removed rust, contaminants and old coating from a substrate. Silica sand commonly used in sand blasting industry because they are cheap and accessible, however the larger amount usage of silica sand may increase side effect of health which can be harmful when inhales. Both two methods have pro and cons in term of costing, efficiency, health hazard and other considerations. Wet abrasive blasting capable produces a corrosion on a cleaned metal surface due to the wetness, yet will reduce dust release.

Palm oil as corrosion inhibitor wet abrasive blasting process commonly contain non-hazardous material. This research study on how to produce the emulsion of palm-oil in water as an alternative liquid in wet abrasive blasting process. According to researcher, corrosion inhibitor will slow the processes of corrosion on metal surface by increasing the anodic or cathodic polarization behaviour. Water and oil have different properties, so they do not interact due to different polarity, yet, emulsify is a substance to force the two immiscible liquids combine on a suspension. Natural emulsion indicated to the natural emulsifier use and the process of emulsification.

2. Materials and Methods

2.1 Materials

Palm oil-in-water emulsion was formulated by undergo some homogenization method by mixed the palm olein, distilled water and emulsifier agent, gelatine using a hot magnetic heating stirrer with heating power 250w to ensure complete dissolution for 15 min at 2400 rpm. Gelatine granule was added as an emulsifier agent purposely to reduce the surface tension at the interface of two immiscible phases which allowing distilled water and palm olein to mix and forms oil-in-water emulsion. Gelatine are natural amphiphilic macromolecules due to their surface-active properties [1] that absorb to the surface of droplets, protective membrane will form in order to prevent droplet aggregation [2]. Table 1 illustrated the list of material used. The composition of the oil-in-water emulsion is shown in Table 2 and Table 3.

Table 1: List of material preparation

No	Item	Grade/Specification
1	Palm Oil	RBD Palm Olein, OL 5
2	Gelatine	Gelatine granule
3	Distilled water	-

Table 2: Composition of Oil-in-water emulsion for 2g of emulsifier

Emulsifier (g)	Palm Olein (ml)	Distilled water (ml)
2	20	80
2	30	70
2	40	60

Table 3: Composition of Oil-in-water emulsion for 8g of emulsifier

Emulsifier (g)	Palm Olein (ml)	Distilled water (ml)
2	20	80
2	30	70
2	40	60

The 2g and 8g gelatine granule was added into different volume of distilled water by referring to the ratio of emulsion which are 80ml, 70ml and 60ml. The gelatine granule is left to let it swell in a beaker containing distilled water and dissolved before process of emulsion began. The volume of palm olein was prepared based on the ratio which 20ml, 30ml and 40ml. The palm olein and distilled water that containing emulsifier agent was preheat before mixing process by using hot magnetic stirrer. The emulsification process was conducted by mixing palm olein and distilled water containing emulsifier agent using magnetic heating stirrer for 15 min with 2400 rpm of speed. Each of oil-in-water emulsion was prepared in three different ratio of palm oil and distilled water and two different quantity of emulsifier agent in gram. All the emulsion samples were transferred to 250ml clear glass bottles for further analysis to identify its physicochemical and visual analysis.

2.2 Methods

The palm olein-in-water emulsion were undergone oil analysis to verify the properties of the samples such as dynamic viscosity, density and microscopy image and creaming stability. All the properties measurements of the samples were following the ASTM standard before verified.

2.2.1 Density

In this experiment, the emulsion sample weighted at specific temperature at 20°C in order to determine the buoyancy of the samples. This density test was conducted by using pycnometer which follow the standard method ASTM D4502.

2.2.2 Emulsion creaming

Each of emulsion sample is examine for creaming stability measurement. Immediately after emulsion preparation, the emulsion may be separated into opaque emulsion layer which is shown as a cream layer and transparent layer. The creaming stability of an emulsion was examined at room temperature for 7 days just after creaming phase occurs and estimated by the percentage of the height of cream layer of the sample to the total height of the sample based on the equation [3]:

$$E_c = \frac{h_c}{h_t} x100\% \quad \text{Eq. 1}$$

h_c represent height of cream layer and h_t indicate to the initial height of sample.

2.2.3 Dynamic viscosity

Dynamic viscosity or absolute viscosity is the measurement of the fluid's internal resistance to flow. Through this analysis, it determines the fluidity of palm oil-in-water emulsion when it applied into blast nozzle. The testing was conducted at the temperature range of 40°C until 100°C and 100ml of emulsion sample transferred into 100ml measuring cylinder. This test followed the ASTM D445-94 operating standard to determine the value of dynamic viscosity [4].

2.2.4 Optical Microscopy

To examine the changes in emulsion microstructure, emulsion samples were observed by digital microscope image analyser (Nikon Eclipse LV150Nl, Japan). The microscopic images of the samples were analysed with the public domain software image, iSolution DT-M/DT/DT-L to observed the water and oil droplet after separation phase. The emulsion samples were poured into microscope slides and covered with the glass cover slips usingm100x objectives lenses used to visualized the microstructure of oil-in-water.

3. Results and Discussion

The preparation of oil-in-water emulsion is applied in the blasting process where palm oil is one of the medium capable of reducing corrosion on the surface of the metal material. Therefore, to determine the stability of the emulsion in the blasting process there are several necessary analyses including density, viscosity, microscopy analysis, creaming index. Oil-in-water emulsion evaluated based on its different base ratio and emulsifier performance, gelatine granule act as surface-active ingredient and lower the interfacial tension in any liquid system. The results and discussion section presents data and analysis of the study.

3.1 Results

The result and discussion in this section include the characteristic and physicochemical oil-in-water emulsion based on different ratio and emulsifier performance act to stabilize the emulsion.

3.2.1 The effect of stirring speed, time and weight of emulsifier on density.

Table 4: The density result of oil-in-water emulsion based on 2g and 8g of emulsifier

Emulsifier (g)	Sample ratio	Density, ρ (g/ml)
2	20:80	0.9746
2	30:70	0.9789
2	40:60	0.9616
8	20:80	0.9832
8	30:70	0.9800
8	40:60	0.9736

Based on the recorded result, by considering a limitation of constant mixing speed, 2400 RPM, the density shows a higher value due to the mass of the emulsifying agent (Table 4). It is a known fact that mixing speed and time of mixing process influence the density value of palm oil-in-water emulsion. This is because when the stirring time of emulsion is longer, the density shows a lower value. However, by considering the limitation of setting parameter, the time of stirring to prepare an oil-in-water emulsion is 15 minutes due to the highest setting speed of stirring is only 2400RPM. The separation time of oil-in-water emulsion is lower when the preparation of emulsion is performed by highest speed and longer time of mixing process.

3.2.2 The effect of temperature, mixing speed, time and weight of emulsifier on dynamic viscosity.

Table 5; Dynamic viscosity of oil-in-water emulsion on 2g and 8g emulsifier

Temperature	Dynamic viscosity (Ns/m^2) for 2g of emulsifier			Dynamic viscosity (Ns/m^2) for 8g of emulsifier		
	20:80	30:60	40:60	20:80	30:60	40:60
40	5.6	5.7	6.2	7.7	7.6	8.0
50	5.1	5.4	5.7	5.5	6.2	6.9
65	4.6	5.2	5.9	5.9	6.4	7.2
85	1.8	2.6	3.1	2.1	3.2	3.6
100	1.2	1.3	1.7	1.3	1.7	2.5

The viscosity of emulsion decreases as the temperature is increased which indicated that the fluidity of the emulsion increases if the temperature increases (Table 5). The higher the temperature applied such as in 100 °C, the dynamic viscosity recorded the least number with 1.2 $Ns/m2$ in ratio of 20:80 (oil: water). This means that the viscosity of emulsion decreases as the temperature is increased which indicated that the fluidity of the emulsion increases with respect to temperature.

According to the data analysis, 8g emulsifier recorded high value of dynamic viscosity compared to 2g of emulsifier because the oil-in-water emulsion experience a high content of emulsifier. The high content of emulsifier may contribute to the increasing of viscosity value due to the thickness of emulsifier agent at the emulsion sample interface. The higher the temperature applied such in 100 °C, the viscosity recorded a least number with 1.3 $Ns/m2$ in ratio of 20:80 (oil: water).

3.3.3 The effect degree of gelatinization on emulsion sample.

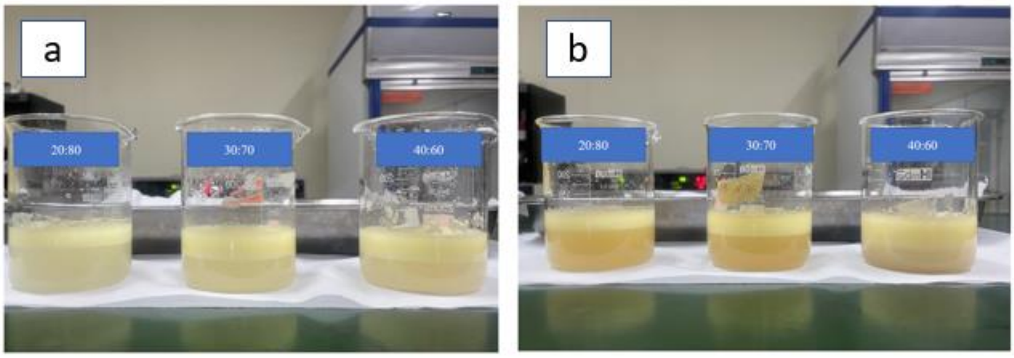

Figure 1: Emulsion samples after mixing process a) 2g of emulsifier for ratio 20:80, 30:70 and 40:60 b) 8g of emulsifier for ratio 20:80, 30:70 and 40:60

The preparation of emulsion involved with mixing process with the highest speed of mixing at 2400RPM. The emulsion mixing process was conducted about 15 minutes with a constant temperature and at a room temperature. The 20 ratios represent volume of oil and 80 represent volume of water, both in ml. Based on observations, it clearly forms two phases liquid layers at the bottom and top of the sample surface when it was left after 15 minutes of mixing process (Figure 1). However, the outcomes of this settling process may not indicate to the break emulsion [6]. It presumed the sample showed an initial separation when a cream layer formed on top surface but not to be an emulsion break and cloudy emulsion layer formed at the bottom of sample. According to the previous study [6], creaming layer exists when oil droplet moves upwards and it generally happen in oil-in-water emulsion. Besides, the highest speed of mixing process at 2400RPM may influence the stability of oil-in-water emulsion. Previous study of [5] reported that the emulsion prepared at 8,000 rpm was stable during storage by applying a high-speed homogenization. The limitation in term of mixing speed may promote a cream layer on the top of sample because the decreasing agitation will reduce emulsion stability [6].

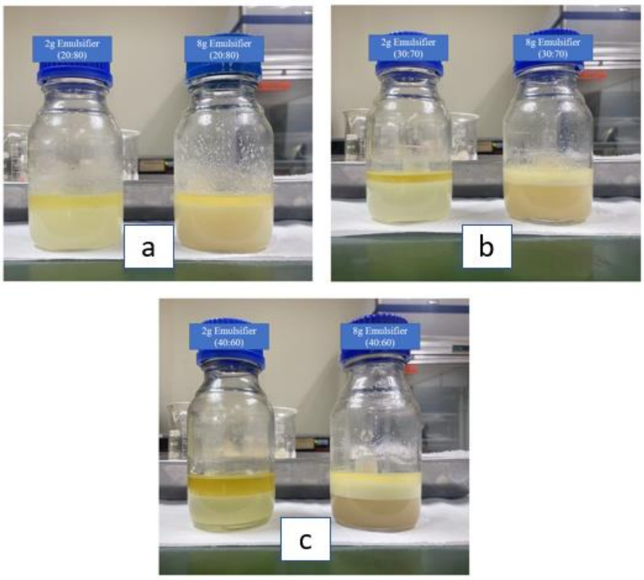

Figure 2: The emulsion samples after storage at room temperature. a) 2g and 8g emulsifier for ratio 20:80. b) 2g and 8g emulsifier for ratio 30:70. c) 2g and 8g emulsifier for ratio 40:60.

Table 6: 8g of emulsifier creaming stability.

Emulsion ratio	Creaming stability, E_c
20:80	0.2571
30:70	0.3429
40:60	0.4571

The emulsion separator occurs at the use of a 2g emulsifier while creaming formation occurs at 8g of emulsifier (Figure 2). This is because, the high ratio of emulsifiers in the stability of the emulsion are able to increase the time separation of emulsion (Table 6). Besides, the limitation of mixing process conducted may increase the creaming formation. According to the previous study [7], performing a higher speed and pressure homogenization during emulsion preparation process may reduce the creaming and enhance the physical stability of emulsion. According to the previous analysis [3] the ability of emulsion to avert the formation of creaming related to the degree of gelatinization and the characteristic of the emulsion

3.3.4 The micrographs of emulsion sample based on digital microscope image analyser observation.

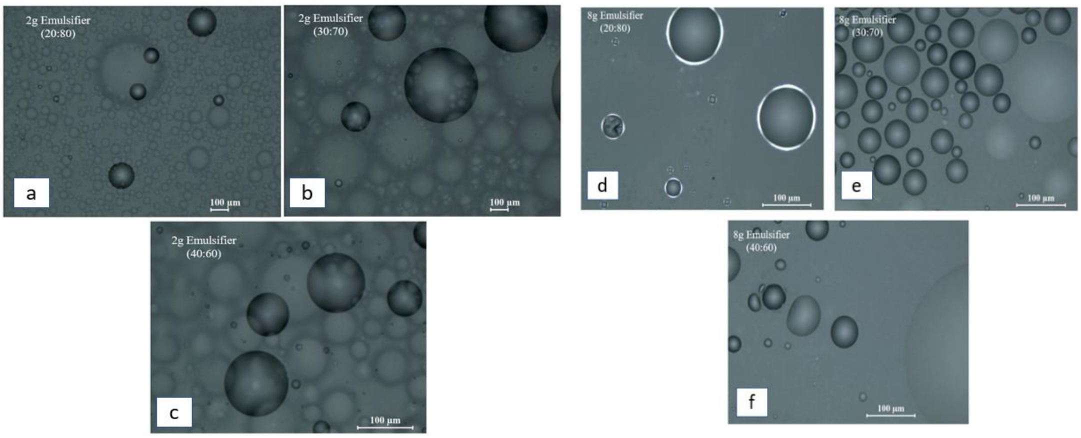

Figure 3 Micrographs image of oil-in-water emulsion for 2g and 8g of emulsifier a) 2g emulsifier for 20:80 ratio b) 2g emulsifier for 30:70 ratio c) 2g emulsifier for 40:60 ratio d) 8g emulsifier for 20:80 ratio e) 8g emulsifier for 30:70 ratio e) 8g emulsifier for 40:60 ratios.

The microstructure emulsion image was captured by using a digital microscope image analyser (Nikon Eclipse LV150NL) and iSolution DT-M/DT/DT-L software was used for image measurement. The observation method using digital microscope image analysis was conducted to identify the oil and water droplet after mixing process. A small drop of sample placed on top glass cover slips. Image of oil-in-water emulsion microstructure was captured using a digital microscope image analyser under a light microscope view at a magnification of 100x.

An emulsion with tiny droplet size generally more stable compared to larger droplet size [8]. It was observed that the sample with high oil content create a larger oil droplet suspended in water even with the same weight of emulsifier agent (Figure 3). The stability of emulsion increased with the decrease of emulsion droplet size [9]. During mixing process, gelatine mainly produce relatively larger droplet sizes as the result shown in 8g of emulsifier image analysis. Besides, the speed of mixing or homogenizer can have a significant influence on the emulsification process. When the emulsion is subjected to a high speed and pressure of mechanical forces, the large emulsion droplet changes into small droplet [5].

4. Conclusion

Based on the limitation parameter in terms of speed of mixing at 2400rpm, mixing time about 15 minutes, temperature setting in between 50-60°C, weight of emulsifier at 2g and 8g and three different ratios, 20:80, 30:70 and 40:60, the emulsification process of palm oil-in-water is successfully carried out. The physicochemical analysis was conducted in terms of density, creaming stability and dynamic viscosity to measure the emulsion fluidity which is applied in blasting machine. The visual analysis is performed by observing the oil and water droplet under a digital microscope. Based on the image analysis, the oil droplets suspended in water for both the 2g and 8g of emulsifier. However, after seven days of storage at room temperature, the breaking formation present for 2g of emulsifier and a stable creaming occur for 8g of emulsifier. In order to examine the percentage of oil and water content, the Karl Fisher water content should be carried out. However, due to the limitation of laboratory equipment, the water content analysis was unable to be performed due to malfunction of equipment. Therefore, a visual analysis was used to measure the sample emulsion to determine the formation of oil-in-water emulsion. It was observed that the larger oil droplet occured for a 2g of emulsifier. Based on the previous study, a high speed of homogenization process fabricated a small droplet and emulsion was stable after storage [10]. The settling process resulted to the formation of two different liquid layer after 1 to 2 minutes of mixing process. The outcomes of this formation may not be the emulsion break. In fact, in order to break the emulsion, the demulsification is achieved by introducing a chemical and electrical method [6]. Generally, through this initial approach, the preparation of oil-in-water emulsion can be applied to the blasting process. The wet abrasive blasting process known as an alternative cleaning work to reduce the fine dust particles from abrasive blasting spread into the surrounding which may affect human health for long term exposure [11].

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