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# Physico-chemical Properties Tests of Palm Oil Based Foaming Agent Using Water Solvent Media from Peatland

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**Abstract.** The water supply requirement to extinguish the fire on the occurrence of land fires is enormous. The water used is usually water available in the field, without certain parameter requirements. For frequent peatland fires, the available peat water in the field becomes an option for use in dissolving the tested foaming agent. Indonesia has a peat land area that has a very large water storage capacity of peat soils. Peat water is the surface water of peat soil with characteristic of brownish red color, contains high organic matter, high iron content, acid taste, pH 3-5 and low level of hardness. This study aimed to determine the effect of peat water use as a solvent on the physico-chemical properties of foaming agent concentrate made from palm oil. Tests were performed using two types of foaming agent concentrate products (CFA-1 and CFA-2) with foaming agent concentrates used were 1, 2 and 3%, and well water was used as a comparison (control). The analysis results showed that the use of peat water as a solvent for palm foaming agent concentrate can be done because it still produces high foam stability, high foaming ability, low interfacial tension, and high decrease of contact angle, as well as the use of well water. The analysis results of CFA-1 using peat water were not quite different from those of CFA-2.

**Keywords:** palm foaming agent, foaming agent concentrate, water solvent, peat water.

## 1. Introduction

Forest and land fires in Indonesia occur not only on dry land but also in wetlands such as peatland and forest [1]. Fires in peatlands mainly occur during the dry season, when hotspots are formed. The number of hotspots had the greatest effect on the extension of forest and peat fires [2]. The fire extinguishing processes in forest and land fires generally use water. In objects with wide surfaces such as peat or forest, usually the power to cover, store and seep the water decreases rapidly. Therefore, if the volume of water availability is not as much as the volume of water required for fire suppression, then the fire will be difficult to extinguish.

The water needed to extinguish fires on peat fires is enormous. Total water required for fully suppress peat fires is about 6 l/kg peat [3]. In areas where water sources are limited, efficiency is required in fire suppression by using less water volume. Therefore, it is necessary to add foaming agent (foaming agent) to streamline the need for water outages. In fire extinguishing using foam applications, generally concentrate foaming agent used ranges 1-3% dissolved in water about 97-99%. The water used is usually water available in the field, without requiring certain parameters. For frequent peatland fires, the availability of peat water in the field becomes an option to utilize as solvent of foaming agent.

Indonesia has peat land area about 14.95 million hectares [4]. Peatlands are mostly found in four major islands, Sumatra 35%, Kalimantan 32%, Sulawesi 3% and Papua 30% [5]. The water storage capacity of peat soils is between 289 to 1057%, depending on the level of maturity [6], so that the potential of peat water to be utilized as one of the water resources for fire suppression in Indonesia's peatlands is still abundant.

Peat water is a surface water commonly found in areas of peatlands or lowland, dark brown to blackish (124 - 850 PtCo), has high organic content (138-1560 mg / ln KmnO4), and acidic (pH 3.7 -



5.3), contains high iron metal, and low levels of hardness [5]. The brownish red color of peat water is caused by the high content of dissolved organic matter (humus material), especially in the form of humus acid and its derivatives, derived from the decomposition of organic materials such as leaves, trees, or wood with varying degrees of decomposition [7]. The color intensity of peat water will be higher due to the presence of iron metal that is bound by organic acids dissolved in the water. Therefore, peat water based on water quality standard parameters does not meet the quality requirements of clean water, still require special processing before being used as a source of water for domestic purposes. Therefore, the research aimed to determine the effect of peat water use as a solvent on the physico-chemical properties of palm concentrate foaming agent.

## **2. Methods**

### **2.1. Materials**

The foaming agent concentrate product used is CFA-1 and CFA-2 using combination of three types of foaming agent products: K-palmitic, Na-lauric, and K-methyl ester, with other additional and additive materials consisting of diluent, emulsifier, chelating agent and water [8,9]. For emulsifier in CFA-1 using palm diethanolamide 4%, while CFA-2 used combination alkyl ester sulphate 9% and palm diethanolamide 4%. The mixing process was done at room temperature by using a homogenizer with a stirring speed of 2000 rpm for an hour. Peat water samples were obtained from Desa Kasang Padang, Rokan Hulu District in Riau Province.

### **2.2. The effect of peat water use as solvent of foaming agent concentrate**

The tests were carried out using two types of concentrated foaming agent products (CFA-1 and CFA-2) with concentrates of 1, 2 and 3%. Water used as a solvent is peat water, and as a comparison is also used well water. The test parameters include pH, foam stability, foaming ability, surface tension, interfacial tension, viscosity, density, specificity gravity, and contact angle. Testing is done with two replications. Homogenizer was used to make the formula mixed. pH value was measured by using pH meter. Foaming stability and ability of foam were measured by diluting 1-3% sample in 97-99% water. The dilution was stirred for 15 minutes by using a homogenizer before it was transferred into 100 ml capped graduated cylinders, shaken up 20 times in constant speed. The volume of foam was recorded on day 0, 1, 2, and 3. Surface tension and interfacial tension of foaming agent concentrate solution was measured by using a TX500C spinning drop tensiometer. A Brookfield DV-III Ultra viscometer was used to measure the viscosity of foaming agent concentrate and foaming agent concentrate solution. An Anton Paar DMA 4500M densitometer was used to measure the density and specific gravity of foaming agent concentrate formula. Contact angle of foaming agent concentrate solution was measured by using a Phoenix 300 contact angle analyzer.

## **3. Results and Discussions**

Samples of both peat water and well water had similar salinity value of 0 ppm but different pH values of 4.12 and 7.56, respectively. pH values of foaming agent concentrates made by using peat water was about 8.52 to 9.72, and using well water was about 8.84 to 9.52. pH values of CFA-1 using peat water were not quite different from those of CFA-2. The effects of peat water on pH values of foaming agent concentrate solutions are depicted in a histogram in Figure 1. Results showed that solution pH was relatively lower in foaming agent concentrate diluted in peat water than in well water. Higher concentration of foaming agent concentrate resulted in higher solution pH values.

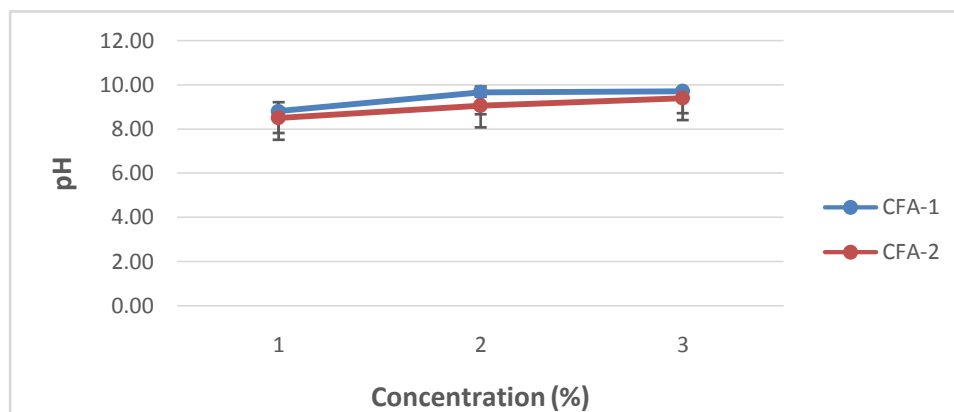


Figure 1. Histogram of effects of peat water on pH values of foaming agent concentrate solutions at different concentrations.

Foam stability of foaming agent concentrates made by using peat water was about 82.07 to 93.49% on day 3, and using well water was about 56.69 to 89.68%. The foam stability of foaming agent concentrates made by using peat water and demineralized water at concentration level of 1% was relatively the same, conducted in previous research (88%) [9]. The effects of peat water on foam stability of foaming agent concentrate solutions are depicted in a histogram in Figure 2. CFA-2 product was found to have higher foam stability than that of CFA-1 product. It was also found that foam stability values were higher in CFA-1 and CFA-2 diluted in peat water than in well water. The use of peat water did not result in low foam stability as foaming agent concentrates diluted in peat water was higher than those diluted in well water. Higher concentration resulted in higher foaming stability.

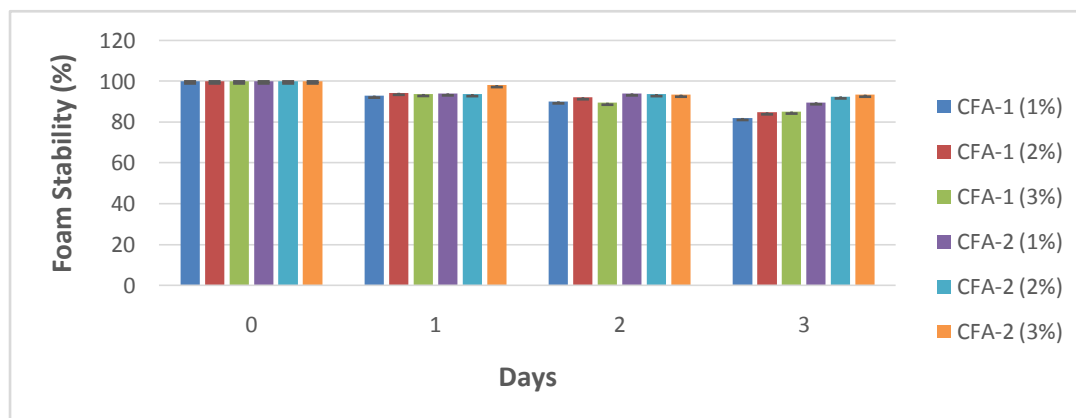


Figure 2. Histogram of effects of peat water on foam stability of foaming agent concentrate solutions at different concentrations

Foaming ability values of foaming agent concentrates made by using peat water was about 283 to 387%, and using well water was about 265 to 352%. The foam ability of foaming agent concentrates made by using peat water was lower than using demineralized water at concentration level of 1%, conducted in previous research (372%) [9]. The effects of peat water on foaming ability of foaming agent concentrate solutions are depicted in a histogram in Figure 3. Foaming ability values of CFA-1 were 302-387% and those of CFA-2 were 283-349%. At concentration levels of 1-3%, CFA-1 product diluted in peat water had higher foaming ability than that diluted in well water. This indicated

that peat water was good to be used as a dilution for foaming agent concentrates as it could maintain high foaming ability and even resulted in foaming agent concentration with higher foaming ability than that diluted in well water. The use of peat water did not lower foaming ability and higher concentration resulted in higher higher foaming stability.

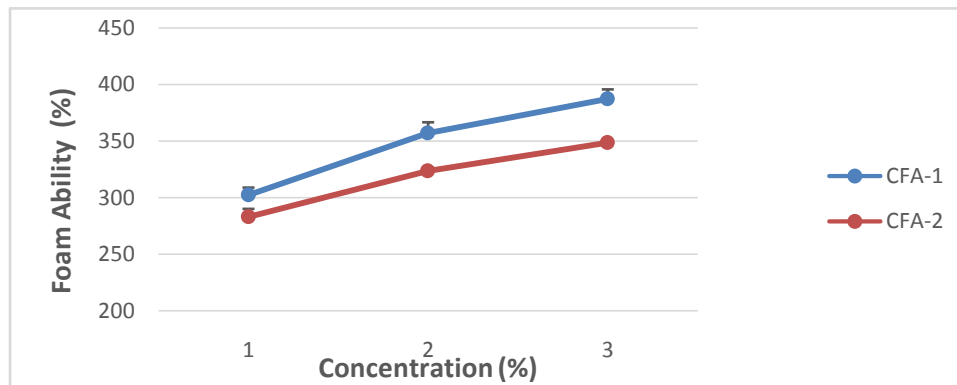


Figure 3. Histogram of effects of peat water on foaming ability of foaming agent concentrate solutions at different concentrations

Surface tension values of foaming agent concentrates made by using peat water was about 25.59 to 37.00 dyne/cm, and using well water was about 26.26 to 47.04 dyne/cm. The effects of peat water on surface tension of foaming agent concentrate solutions are depicted in a histogram in Figure 4. Surface tension of CFA-1 was 33.95-37.00 dyne/cm and that of CFA-2 was 25.26-33.84 dyne/cm. CFA-1, diluted in peat water had higher surface tension values than CFA-2 did. For CFA-1, there was even a tendency that the use of peat water as a dilution of foaming agent concentrate resulted in lower surface tension. In CFA-2 diluted in peat water, surface tension was found to be slightly higher at the concentration of 3% although the value was still lower than that of CFA-1. An increase in foaming agent concentration resulted in higher surface tension.

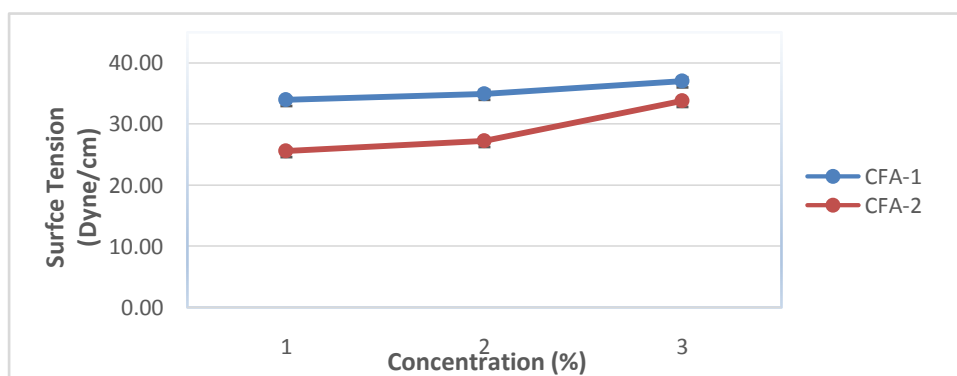


Figure 4. Histogram of effects of peat water on surface tension of foaming agent concentrate solutions at different concentrations

Interfacial tension of foaming agent concentrates diluted in peat water was 1.31 to 3.51 dyne/cm, and in well water was 1.72 to 8.92 dyne/cm. The effects of peat water on interfacial tension of foaming agent concentrate solutions are depicted in a histogram in Figure 5. Interfacial tension of CFA-1 ranged from 1.31 to 2.80 dyne/cm and that of CFA-2 ranged from 1.86 to 3.65 dyne/cm. In both peat water and well water, interfacial tension values of CFA-1 were lower than those of CFA-2. Higher concentration of foaming agent concentrate resulted in lower interfacial tension.

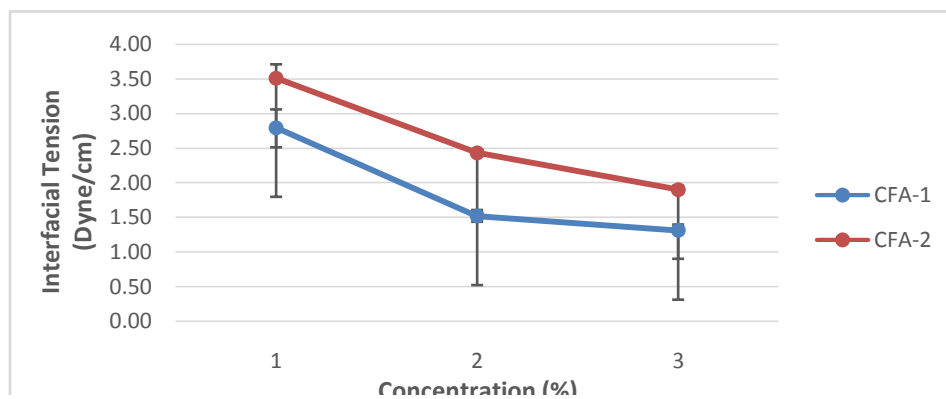


Figure 5. Histogram of effects of peat water on interfacial tension of foaming agent concentrate solutions at different concentrations

Foaming agent concentrates made by using peat water had density values of 0.99485 to 0.99628  $\text{g/cm}^3$ , and using well water of 0.99574 to 0.99653  $\text{g/cm}^3$ . The effects of peat water on density values of foaming agent concentrate solutions are depicted in a histogram in Figure 6. Density values of CFA-1 and CFA-2 were found to be 0.99485-0.99584 and 0.99619-0.99628  $\text{g/cm}^3$ , respectively. An increase in the concentration of foaming agent resulted in higher density values.

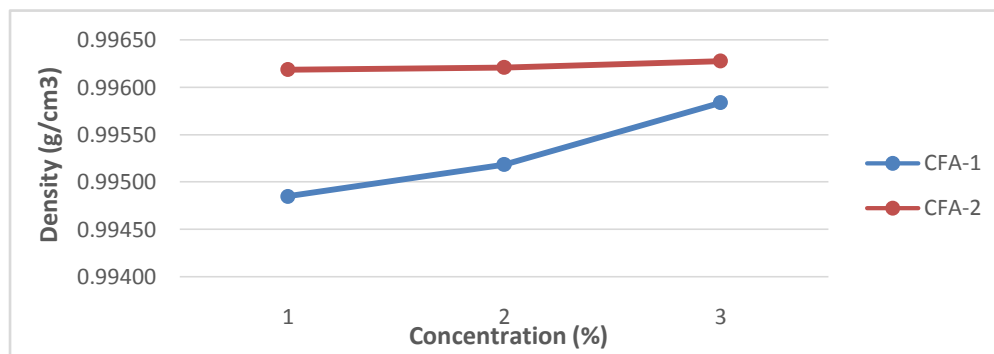


Figure 6. Histogram of effects of peat water on density values of foaming agent concentrate solutions at different concentrations

In peat water, specific gravity of foaming agent concentrates was about 1.00005 to 1.00082, and in well water were about 1.00010 to 1.00085. The effects of peat water on specific gravity of foaming agent concentrate solutions at different concentrations are depicted in a histogram in Figure 7. Specific gravity of CFA-1 ranged from 1.00005 - 1.00082 and that of CFA-2 ranged from 1.00055 - 1.00064. Higher specific gravity values were obtained by using higher concentration of foaming agent.

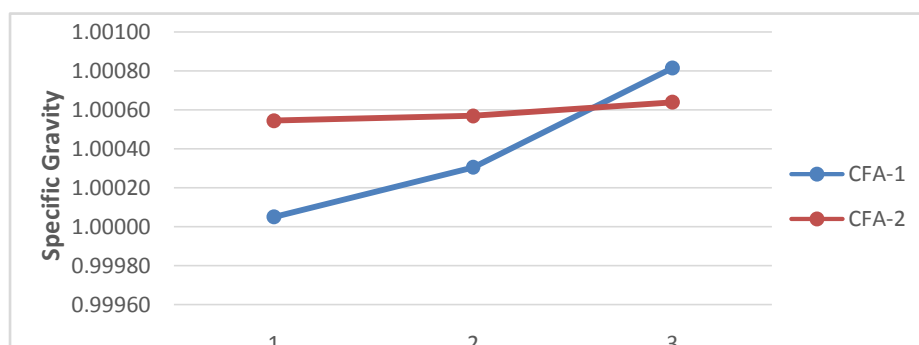


Figure 7. Histogram of effects of peat water on specific gravity of foaming agent concentrate solutions at different concentrations

Viscosity of foaming agent concentrates made by using peat water was about 1.27 to 1.83 cP, and using well water was about 1.14 to 1.24 cP. The effects of peat water on viscosity value of foaming agent concentrate solutions at different concentrations are depicted in a histogram in Figure 8. Viscosity levels of CFA-1 were 1.41-1.83 cP and those of CFA-2 were 1.27-1.30 cP. Viscosity values of CFA-1 were higher than those of CFA-2. Higher concentration levels of foaming agent resulted in higher viscosity levels.

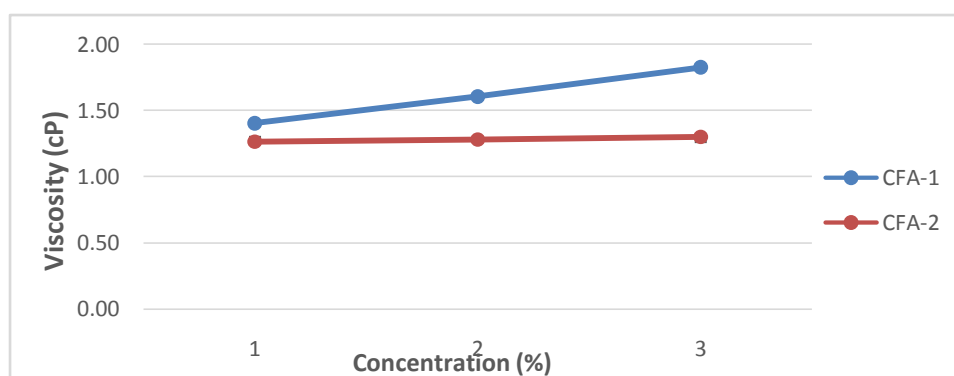


Figure 8. Histogram of effects of peat water on viscosity value of foaming agent concentrate solutions at different concentrations

Contact angles of foaming agent concentrates made by using peat water in minute-0 were found to be 40.36-54.41° and in minute 10 were 10.23-14.32°. These meant that there was a reduction of contact angles by about 62.30-74.65% by using peat water, and 62.30 – 79.45% by using well water. The effects of peat water on decrease of contact angles of foaming agent concentrate solutions at different concentrations are depicted in a histogram in Figure 9. The reduction of contact angles in CFA-1 and CFA-2 were 62.30-73.45% and 71.78-74.65%, respectively. An increase in foaming agent concentration resulted in higher reduction in contact angles.

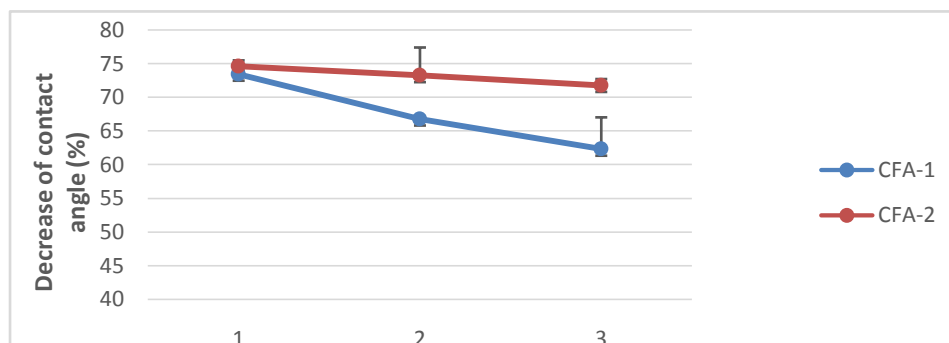


Figure 9. Histogram of effects of peat water on decrease of contact angles of foaming agent concentrate solutions at different concentrations

#### 4. Conclusions

The use of peat water as a solvent for palm foaming agent concentrate can be done because it still produces high foam stability, high foaming ability, low interfacial tension, and high decrease of contact angle, as well as the use of well water. The analysis results of CFA-1 using peat water were not quite different from those of CFA-2. Higher concentration resulted in higher foaming stability, higher foaming ability, higher surface tension, lower interfacial tension, higher density, higher specific gravity, higher viscosity, and higher reduction in contact angles.

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