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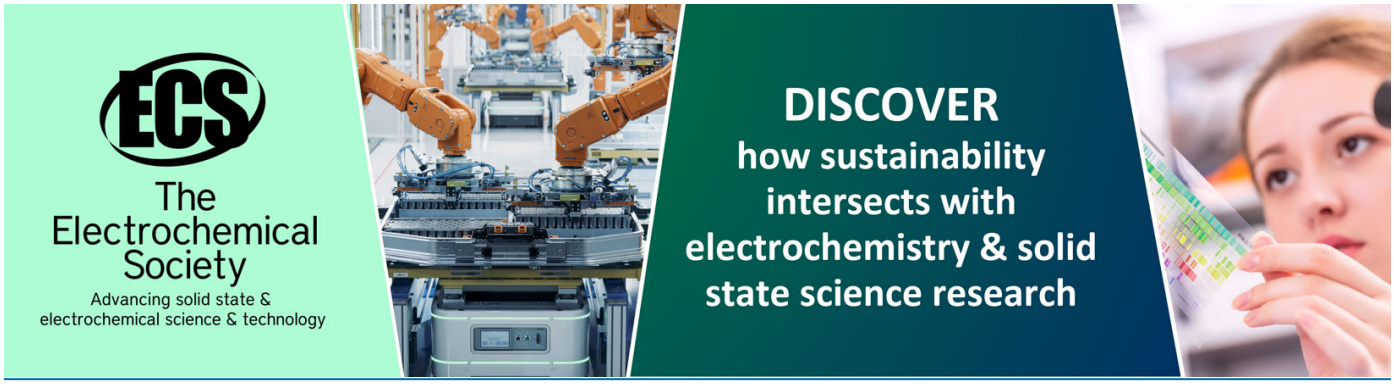

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Foam capacity and stability of Sodium Dodecyl Sulfate (SDS) on the presence of contaminant coffee and Cd ions in solution

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Abstract. In this study, the effect of the coffee colloidal particle and Cd ion contaminant on the foam capacity and stability of sodium dodecyl sulfate (SDS) solution was investigated. The foam was generated by using a foam generator. The foam capacity of SDS was first evaluated at different concentrations. After the foam capacity reaching a constant value, the foam stability was then measured by flowing to a column. The results showed that the presence the coffee colloidal particles or Cd ions in the solution would decrease the foam capacity and stability of SDS. In addition, the decreased foam capacity and stability was more pronounced in the presence of coffee colloidal particles than Cd ions. The colloidal particles may have stronger interaction with SDS and thus reduce the formation of the foam.

1. Introduction

The foam may be described as a dispersed system in which the bubbles of gas are encircled and stabilized by surfactant molecules absorbed in the liquid-air interface in a continuous liquid medium [1,2,3,4]. The foam is a dispersed fluid of a dispersed fluid containing small air bubbles with a large surface area that can be stabilized by surfactant molecules [5].

Surfactants are heterogeneous molecules that have long chains in which the head has a water-like and the tail has a water-dislike character. In aqueous phase, when the concentration of surfactant over than a certain critical value, the monomer molecule forms an organized group of large numbers of molecules called micelles. This particular concentration is called critical micelle concentration (CMC). Physical properties such as: surface tension, interface tension, adsorption, and detergency have changed to concentrations if below CMC, but have no change in these properties if above CMC[6,7]. The surfactant solution exhibits significant changes on others physical properties such as density, equivalent conductivity and organic solubility at below and above the CMC when compared to concentration [2].

Foam capacity is one of the important interfacial properties possessed by surfactants. The amount of foam capacity will affect the surfactant's ability to spread and press down to the pores of contaminated material [8]. Foaming ability can be seen from the increase in volume, once the gas is fed into the solution. Foam stability is associated with a decrease in the height of the foam with time [9].

Foam stability is the ability to retain gas for a certain time. Foaming ability can be seen from the increase in volume, once the gas is fed into the solution. Foam stability is associated with a decrease in

the volume of the foam with time [2]. The efficiency of the surface active agent to form and stabilize the foam depends mainly on the molecular structure and intrinsic properties of the surfactant [2].

The capacity and stability of the surfactant is the most important factor in applying it to the remediation process using foam. The capacity of the foam to be associated with the surfactant's ability to produce foam and foam stability is the ability of the fixed surfactant in the form of foam and its ability not to break.

Surfactant foam applications in recovery of wasted oil to the environment are reported by Urum, et al. 2004 [5]. Surfactants are used to remediate mediacontaminated by metal-ions with surfactant foam applications [8,10,11,12]. Surfactant applications in the remediation process for transporting nanoparticle material to porous media [13]. Ability of surfactant on interactions with mercury in liquids thencan be separated from the fractional fraction [14].

A number of studies and theories in evaluating foam capability and stability [15]. There are several methods to measure the nature of this foam capacity, one of which is the dynamic foam capacity determined by dividing the constant volume of the foam (mL) with the gas flow rate N2 (mL / min)[4]. Razafindralambo et al. [2] measures the foam capacity by the formula:

The purpose of this research is to investigate the foam capacity and stability of SDS as anionic sutfactanton the effect of the presence a contaminants in the liquid phase. The contaminants are Cd metal ions and coffee powder.

2. Material and Method

Sodium dodecyl sulfate (SDS) was purchased from Sigma–Aldrich. Cd (II) was used as the model contaminant. Cadmium acetate (Cd $(CH_3COO)_2$. $2H_2O$) purchased from Merck KgaA, Darmstadt, Germany and used as a source of cadmium (Cd^{2+}). The sodium hydroxide (NaOH) purchased from Merck KgaA, Darmstadt, Germany and the hydrochloric acid (HCl) purchased from Mallinckrodt Baker, Inc, Paris. Both chemicals were used to control the pH variation of the deionized water and used to dissolve SDS and both contaminants. The black coffee (Kopi KapalApiSpesial) purchased from PT Santos Jaya Abadi Indonesia.

Foam-generator applied to measure the foam dynamic capacity (FDC) of SDS. It was designed and made by laboratory of surfactant and application, Chemical Engineering Department University of Sumatera Utara (USU). The size dimension of foam-generator is (L= 20 cm, OD=3.5 cm), equipped with circular porous ceramic, which enabled the foam generation dynamically in the presence of surfactant solution and N_2gas as shown in the Figure 1. Peristaltic pump was used to delivers the surfactant solution to foam generator (Figure 1A). The instrument prepared with progressed cylinder to measure foam stability (Figure 1 B).

In this study, the activity measurements for each run on the variables which have been determined for the dynamics of the formation of foam from the beginning until to achieve constant foam capacity for the time needed (T) as shown in Figure 1A. For the foam stability as shown in Figure 1B, the measurement after the initial foam height 7 cm in cylinder column then was beginning to measure the foam height for the certain time. Measure the height of foam in column generator to get the dynamics foam capacity of surfactant. The foam capacity (FC) is the constant foam volume in the column foam generator. The analysis tools used are scale measuring the height of dynamic foam and Atomic Absorption Spectrometer (AAS) for metal ion concentration. Measuring the time of foam dynamic to reach constant capacity was used timer [16].

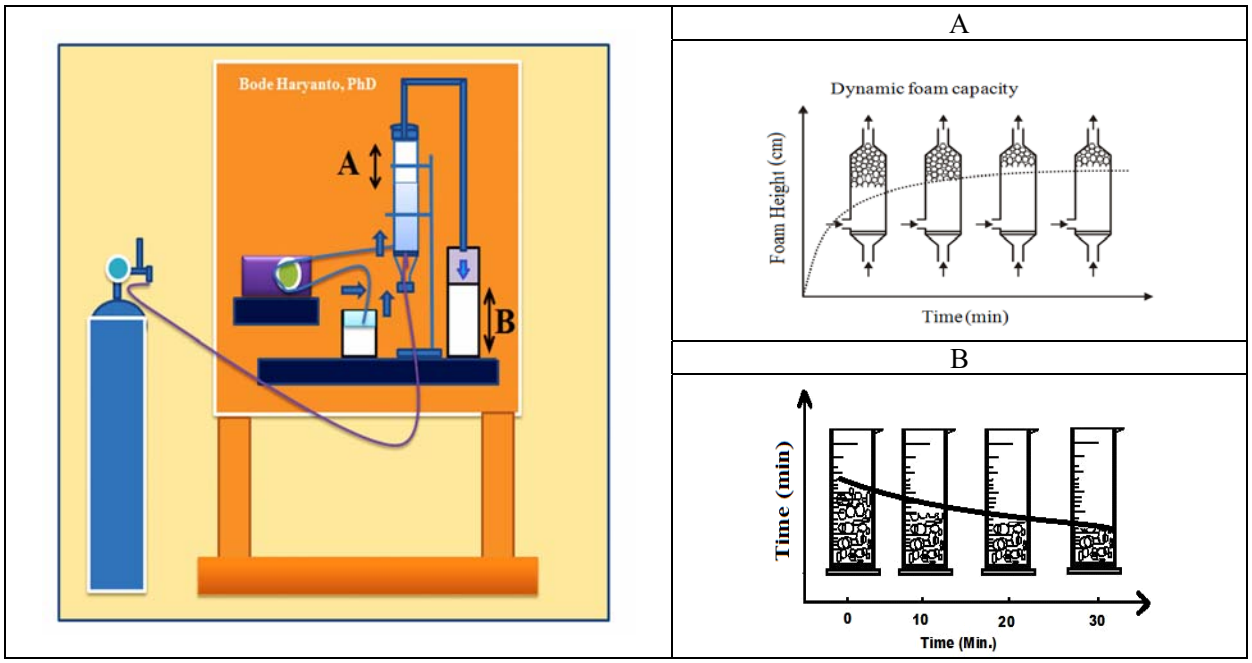

Figure 1. Generator Dynamic Foam Capacity (A) and Column Foam Stability (B) [16].

In this study, the concentration variations used for Cd^{2+} were 10 ppm, 20 ppm, 30 ppm, 40 ppm and 50 ppm. Variations of coffee concentration used were 10 ppm, 20 ppm, 30 ppm, 40 ppm and 50 ppm. SDS concentration variations were 1x cmc, 2x cmc and 3x cmc at pH 7.

3. Result and Discussion

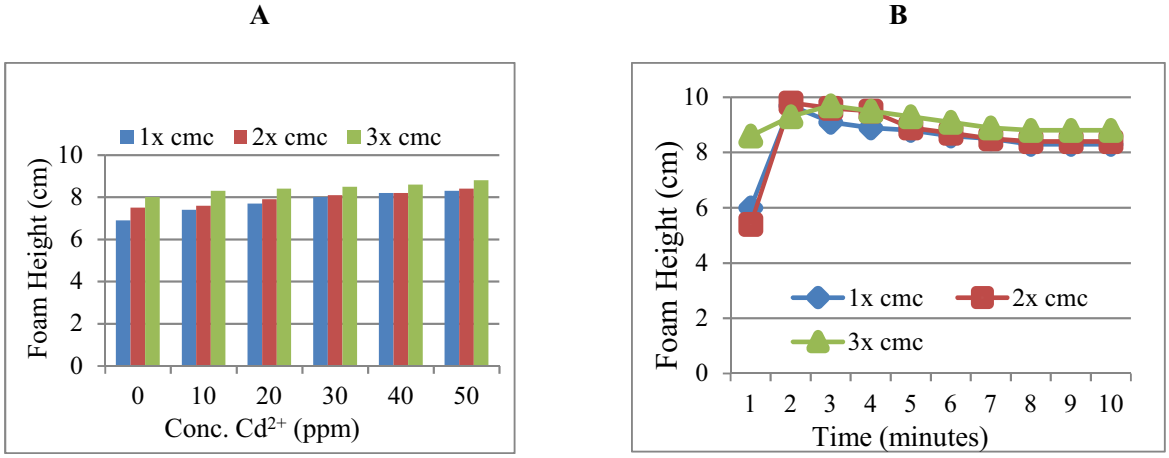

Figure 2. Foam Capacity with Variation Concentration of Cd (A) and Foam Dynamic Capacity with Concentration of Cd ions 50 ppm (B)

The result of the measurement of the height of the SDS foam capacity on the effect of variation concentration of Cd^{2+} ions in the presence on the solvent is shown in Figure 4.A. The greater of SDS concentration that will cause increasing the foam height obtained. The greater metal concentration Cd^{2+}

was tending to produce higher foam capacity. The presence of Cd^{2+} ions in a liquid phase with its positive charge and the SDS surfactant having a negative charge will increase the interaction on the formation of micelles. So when the gas bubbles flow into the column, the micelle's ability to absorb the N_2 gas in producing the foam is tends to more stable and quicker to reach a constant foam capacity as shown in Figure 2.B. [16,17,18]. Figure 2.B shows graphic kinetics of foam capacity by adding the time against variation of concentration SDS in the presence of contaminant Cd^{2+} 50 ppm. The higher concentration has higher foam capacity produced [19].

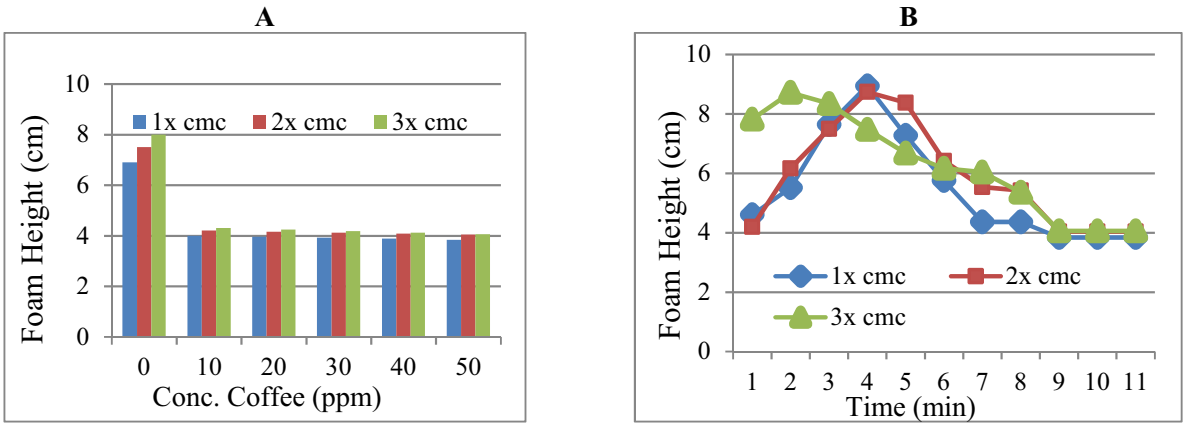

Figure 3. Foam Capacity with Variation Concentration of Cd (A) and Concentration of Coffee 50 ppm (B)

Figure 3A shows the result of variation concentration of coffee on the effect of the foam capacity of SDS. The result obtained that coffee colloidalparticle has ability to decrease foam ability of SDS. The presence of the contaminant was decreased the foam capacity of SDS significantly. The foam capacity of SDS was decreased by increasing the concentration of coffee.

Black coffee as reported has pH 4.5 to 5 [19,20] with negative charge on its surface particle [21]. Thekinetics of dynamic foam capacity of the SDS in the presence the coffee particle50 ppm shows in Figure 3B.Initially, when the N_2gas starts to flow into the foam generator to produce bubbles, the foam capacity was tend to normal ability. The condition was possible to produce higher foam capacity becausethe interaction of the contaminant black coffee with the micelles is not significant in impacting the foam dynamic capacity [16]. After a few minutes, the presence of coffee colloidalparticle in the solution may create complexity on the SDS micelles in the solution. The coffee particles with negative charge interact with micelles, the foam capacity start to reduce then after 9 minutestend to reach constant height.Theoretically, the bubble N_2 gas flowing in promising for wet foam lamellae from the micelle where the both layers as fairly thick water slab become more complex by presence of coffee colloidalparticle. Then it impacted the dynamic foam capacity of variation SDS concentration even though with the higher SDS concentration has higher foam capacity [19]. One can see the results of this study that the coffee contaminant has ability to decrease the foam capacity in comparing with Cd^{2+} ions.

Measurement the stability of the foam is carried out by flowing the foam generated from the foam generator at a constant foam height to the foam stability measurement column. Measurement of foam stability on the measuring cup column began to be done to the height of the foam at 7 cm. Figure 4 A and B show the foam stability measurement. It has done to find the time that the foam needed to return to the liquid phase. In surfactants, the bubble interface stabilization mechanism is concerned with the ability of micelles to withstand surface tension gradient.Resistance to changes in surface area or surface concentrations are described by interface resistance [22].From the results of foam stability show that coffee contaminant has similarstability in comparing with Cd^{2+}ions.On the other hand still more stable

than SDS without contaminants.The presence of coffeecolloidalparticles with negatively charged and has a low pH that may cause lower stability as slightly lower at low SDS concentration (Figure 4B).

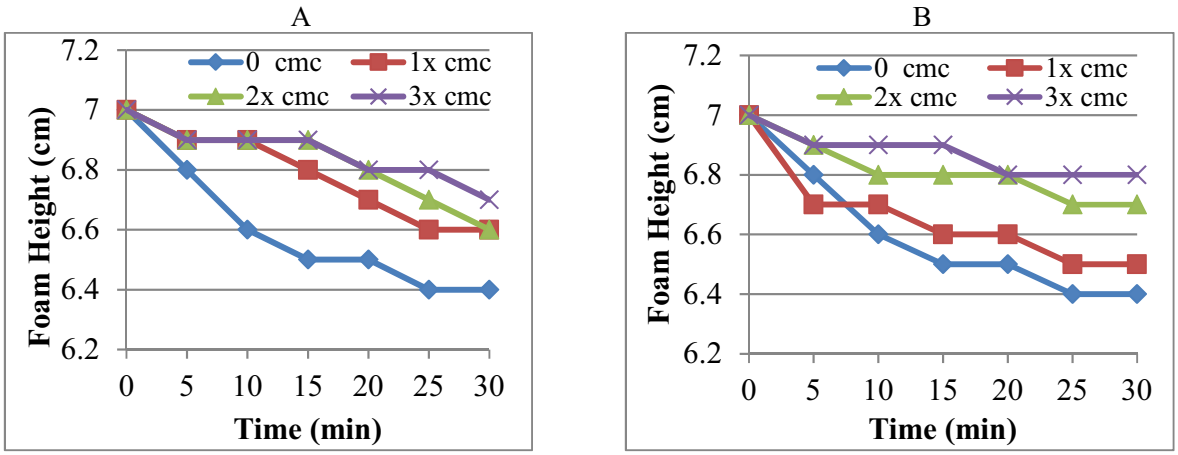

Figure 4. Foam Stability with Concentration of Cd ion 50 ppm Figure 7. Foam Stability with Concentration of Coffee 50 ppm

4. Conclusion

The contaminants Cd^{2+} and coffee is an important element that affects the capacity of the foam. The foam capacity of SDS at 3x cmc with presence of concentration Cd^{2+} 50 ppm was obtained the highest foam height 8.8 cm. Coffee has ability to decrease the foam capacity with the high of foam about 4 cm to all variation concentration of coffee contaminant and SDS. The foam dynamics capacity of SDS in the presence of Cd^{2+} reaches a constant height is about 8 minutes. The height of foam dynamic capacity with Cd^{2+} is more stable and quicker to reach a constant foam capacity. The fluctuation of the foam height of SDS was occurred at the beginning of measurements the kinetics of foam dynamic before reach the constant height in the presence of coffee. Presence of coffee particle in the solution may create complexity on the SDS micelles in the solution. The foam stability shows that coffee and Cd^{2+} ions have similar stability.The presence of coffee colloidalparticles may cause lower stability at lower SDS concentration.

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