ABSTRACT
In this investigation, the critical micelle concentration of local surfactant was measured with the CMC is 6ml dissolved in 19 ml of water. It has ability to decrease the surface tension from 72 to 29.0 dyne/m. The foam capacity of the local surfactant in solution was investigated. The foam was generated by using a foam generator continuously. The variation of CMC then used to measure the foam capacities dynamically in foam generator. With the concentration 0.5x, 1x, 2x CMC, the surfactant was possible to produce foam capacity (height) 0.9 cm, 2.3 cm and 3.2 cm, respectively. The foam capacity then measures in the presence of the Cd ion, coffee colloidal particle and oil as contaminant with the foam capacity 1.3 cm, 1.9 cm and 2.7 cm for Cd ion; 0.75 cm, 1.8 cm and 2.3 cm for coffee; 1.0 cm, 1.6 cm and 2.2 cm for oil with the same variation concentration. The results show that the decreased foam capacity was more distinct in the presence of coffee colloidal particles and oil than Cd ions contaminant. The colloidal particles of coffee and oil may have stronger interaction with local surfactant and thus reduce the formation of the foam.

Keywords: local surfactant, foam capacity, coffee, oil, Cd$^{2+}$ ions, contaminant.

INTRODUCTION
Surfactants have long chains in which the head has a water-like and the tail has a water-dislike character as heterogeneous molecules. Micelles is the monomer molecule forms an organized group of large numbers of molecules in aqueous phase that occur when the concentration of surfactant over than a certain critical value on liquid surface. This precise concentration is called critical micelle concentration (CMC). Physical properties such as: adsorption, detergency, surface tension and interface tension, have changed to concentrations if molecular structure and intrinsic properties (Razafindralambo, 1998).

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 (Halling, 1981; Razafindralambo, et al., 1998; Durand, 2010; B Haryanto, 2014). 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 (Urum and Pekdemir, 2004).

One of the important interfacial properties possessed by surfactants is foam capacity. The quantity of foam capacity will affect the surfactant's capability to spread and press down to the pores of contaminated material (Mulligan and Gibbs, 2004). Foaming ability can be seen from the increase in volume, once the gas is fed into the solution and foam stability is associated with a decrease in the height of the foam with adding time (Zhang and Miller, 1992). Foam stability is the ability to retain gas for a certain time and foaming ability can be seen from the increase in volume, once the gas is fed into the solution. The efficiency of the surfactant as surface active agent to form and stabilize the foam depends mainly on its molecular structure and intrinsic properties (Razafindralambo, et al., 1998).

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

Application of surfactant was reported by Urum, et al. (2004), with foam applications in recovery of wasted oil to the environment. The application to remediate media contaminated by metal-ions with surfactant foam applications were reported (Mulligan and Gibbs, 2004; B Haryanto, et al., 2014; B Haryanto and CH Chang, 2014; B Haryanto and CH Chang, 2015). In the remediation process for transporting nanoparticle material to porous media (Raymundo, et al., 1998) and Ability of surfactant on interactions with mercury in liquids then can be separated from the fractional fraction (Paria, 2008) have applied. A number of studies in evaluating foam ability and stability (Ross and Miles, 1941) with several methods to measure the nature of this foam capacity (FC), Razafindralambo et al., (1998) measure the foam capacity by the formula:

\[ FC = \frac{\text{The maximum volume of foam (ml)}}{\text{The Incoming gas volume (ml)}} \]  

One of which is the dynamic foam capacity determined by dividing the constant volume of the foam (mL) with the gas flow rate N$_2$ (mL / min) (B Haryanto 2014).
The purpose of this research is to investigate the foam capacity dynamically of the local surfactant base on the CMC variation in the presence a contaminant in the liquid phase. The contaminants are Cd metal ions, coffee powder and oil.

**MATERIAL AND METHOD**

The surfactant was purchased from the Pengabdian Kepada Masyarakat Universitas Sumatera Utara project partner. Cadmium acetate (Cd (CH$_3$COO)$_2$, 2H$_2$O) purchased from Merck KgaA, Darmstadt, Germany and used as a source of cadmium (Cd$^{2+}$) that was used as the model contaminant. The black coffee (Kopi Kapal Api Spesial) purchased from PT Santos Jaya Abadi Indonesia. The cooking oil was purchased from PT Salim Ivolmas Pratama Tbk. The hydrochloric acid (HCl) purchased from Mallinckrodt Baker, Inc, Paris and the sodium hydroxide (NaOH) purchased from Merck KgaA, Darmstadt, Germany. Together chemicals were used to control the pH of the deionized water and used to dissolve surfactant and both contaminants.

The CMC was measured by using the DuNouy ring Tensiometer at Faculty Pharmacy Laboratory Universitas Sumatera Utara. The variation concentration of the surfactant in the water was measured to search until constant surface tension of water as indicator the critical micelle concentration (CMC). The original surfactant already dissolves 5 times.

Foam-generator applied to measure the foam dynamic capacity (FDC) of local surfactant. It was designed and made by laboratory of surfactant and application, Chemical Engineering Department Universitas Sumatera Utara (USU). The size dimension of foam-generator is L= 20 cm and OD=3.5 cm. It equipped with circular porous ceramic, which enabled the foam generation dynamically in the presence of surfactant solution and N$_2$ gas as shown in the Figure-1A. Peristaltic pump was used to delivers the surfactant solution to foam generator (Figure-1B).

The measurements for each run on the certain 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 1B. Measurement was the height of foam in column generator to get the dynamics foam capacity of surfactant. The foam capacity (FC) is the constant of volume foam in the column foam generator. The analysis tools used are scale measuring the height of dynamic foam. Atomic Absorption Spectrometer (AAS) for metal ion concentration. Measuring the time of foam dynamic to reach constant capacity was used timer (B Haryanto et al., 2017).

In this study, the contaminant concentration variation used for Cd$^{2+}$ and coffee was 50 ppm. An oil concentration used was 50 mg/liter. Surfactant concentration variations were 0.5x cmc, 1x cmc and 2x cmc at pH 7. The runs were controlled with flow rate of N$_2$ gas 70 ml/min and the local surfactant 3 ml/min.

**RESULT AND DISCUSSIONS**

**Interfacial properties of surfactant**

![Figure-2. The surface tension local surfactant.](image-url)
Surfactant has the ability to lower surface tension of water (B Haryanto and Chang, 2014). The surface tension lowering ability of local surfactant is demonstrated in Figure-2. From the surface tension vs. concentration curve, the critical micelle concentration (cmc) of surfactant was estimated to be 6 to 7 ml of surfactant in 19 to 18 ml of water. When the surfactant concentration was increased from zero to the 1x cmc of 5 to 6 ml, the surface tension of water was decreased from 72 to 29.6 mN/m. With a further increase in the surfactant concentration to 2x cmc, the surface tension was reduced to 28.3 mN/m. The CMC for this original local surfactant product before diluted 5 times was 50 ml per litter of water.

**Foam capacity of surfactant with concentration variation**

![Figure-3A](image1.png)

![Figure-3B](image2.png)

**Figure-3.** Foam capacity with variation concentration (0.5x; 1x; 2x cmc).

Foam capacity with concentration variation is shown in Figure-3A after generated in foam generator. By increasing the surfactant concentration 0.5, 1 and 2x cmc was increase the foam capacity 0.9 cm, 2.2 cm and 2.7 cm respectively. The foam dynamic capacity is shown in Figure-3B. The local surfactant with concentration variation 0.5, 1 and 2x cmc have reached stability after 2 to 4 minutes. The 0.5x cmc has lower foam capacity compare to 1 and 2 x cmc as shows in Figure-3B. Increasing the surfactant concentration will increase the quantity of micelle, and then increase the interaction of bubble with the micelle to produce higher foam capacity (R Petkova, et al., 2013). In this study, with the same flow rate of bubble gas was found that the dynamic capacity by increasing the concentration, tend to similar.

**Foam capacity of surfactant with the presence of Cd^{2+}**

![Figure-4A](image3.png)

![Figure-4B](image4.png)

**Figure-4.** Foam capacity of variation Local surfactant concentration in the presence of 50 ppm Cd (II) is demonstrated in Figure-4A. The results show that the presence of 50 ppm Cd^{2+} ion influence the foam capacity of local surfactant in comparing without contaminant. Cd ion in liquid phase with the positive charge is that may interact with the micelle then impact to ability in generating foam. When the bubble flowing in to the column, the ability of micelles to adsorb the gas in producing foam was tend to decrease to reach constant foam capacity as shown in Figure-4B.

As shows, the foam capacity has faster time to reach the constant height by increasing the local surfactant concentration. In the presence of Cd^{2+} with higher surfactant concentration, it may make the micelles has costume properties of the adsorption layer and the foam (Liguang Wang and Roe-Hoan Yoon 2004; Pandey, S., R. P. Bagwe and D. O. Shah. 2003).
The concentration of the black coffee used in this study is 50 ppm with a concentration cmc local surfactant was 0.5, 1 and 2 x cmc. It was reported that Black coffee has pH about 5 (Daniel and John 2016) with negative charge on its surface (Julia Hinde, 2000). The existence particle of coffee in the solution may produce complexity on the local surfactant micelles. Figure 5A show the foam capacity of the local surfactant in the presence the coffee particle. The presence of coffee particle was possible decreasing the capacity of foam quite significant in comparing with free solution (Figure-3). It was the same trend for foam dynamic capacity as shown in Figure-5B.
As known that Oil is an antifoaming agent (Sarah J Routledge, et al., 2011). The result of the foam capacity local surfactant with different concentration was impacted by the presence of oil as contaminant shows in Figure 6A. In the presence of oil, foam becomes less stable because the oil can break down more quickly. Oil has negatively effect on foam Capacity and stability. In presence of oil starts as small and rapid decay dominated by gravity drainage, followed by a stabilized foam volume (M. Simjoo, et al., 2013). As in this study, Oil is significantly decreasing the foam capacity as shown in this result (Figure-6B).

In comparing impact of the presence Cd, coffee and oil to foam dynamic capacity shows in Figure-7. The coffee and oil were ability to decrease the foam capacity in compare to Cd ion in solution. The particle coffee and oil were possible to influence the lamella to produce foam in compare to Cd ions. The physical properties of contaminant may influence the micelle to produce the foam specifically as shown in these results.

CONCLUSIONS
Local surfactant in generate foam was measured by the effect of the presence metal ion, oil and coffee. Increasing the local surfactant concentration increased the number of monomers then increases the micelles in liquid phase to generate foam. In measuring the foam capacity and dynamic capacity; the foam generator was treated with variation concentration local surfactant. The presence of contaminant was possible to decrease the Local Surfactant by disturbing the generating of foam. Coffee and oil were important factors that affect the capacity of the foam and have ability to decrease the foam capacity in comparing of Cd ions presence. Cd ion with positive charge may have ability to increase the micelles stability and foam constancy.

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REFERENCES


