



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : Shailesh Ravi Varade

Roll Number : 146107014

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Thesis Title: Foaming Behavior of Aqueous Solutions of a Zwitterionic Surfactant in the Presence of Salts: Analysis of Specific Ion Effect and Synergism

Name of Thesis Supervisor(s) : Prof. Pallab Ghosh

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SHORT ABSTRACT

Zwitterionic surfactants have the unique property of bearing hydrophilic head-groups having both positive and negative charges. Aqueous foams are the dispersion of gas bubbles in water containing stabilizing surface-active species, such as surfactants and particles. Surfactants constitute the primary materials required in almost all the foaming processes. The presence of salts in the surfactant solution influence the foam stability in various ways. Salts in the surfactant solution can compress the electrical double layer associated with the adsorbed surfactant molecules on the two opposite sides of a foam lamella and can alter the foam stabilities. The magnitude of these changes depends on the nature and concentration of the added salts and can help to tune the foaming properties. Thus, a study on the effect of NaCl, CaCl₂ and AlCl₃ on the stability of foams generated from the aqueous solutions of the zwitterionic surfactant, N-Dodecyl-N,N-dimethyl-3-ammonio-1-propanesulfonate (DDAPS) using the blender test was performed. To develop insight into the mechanisms of the adsorption of zwitterionic surfactants in absence and presence of salts, surface and interfacial tensions were measured. The quantity of salt required for reducing the surface tension and CMC was in the sequence: NaCl > CaCl₂ > AlCl₃. The effectiveness of salts in reducing the foam stability followed the sequence: AlCl₃ > CaCl₂ > NaCl. The effect of oil (i.e. *n*-hexane) on foam stability was also investigated in the presence of these salts. The presence of oil decreased the foam volume and reduced its stability. The stability of foams in the presence of oil was explained by calculating the entering, bridging, and spreading coefficients.

The specific nature of electrolytes makes them most suitable to control ionic strength of the solution. The specific interaction between electrolytes and surfactant are of significant importance with respect to foam film properties. The stability of foam is linked to the adsorption of ions at the air–water interface and the specific ion effect between the head-groups and ions. Therefore, the specific interactions between the salts (i.e., NaCl, LiCl, and CsCl) and surfactant and its effect on the foamability and foam stability were thus regarded within this thesis. The efficiency of these salts in decreasing the surface and interfacial tension followed the order: CsCl > NaCl > LiCl. Similarly, the efficiency of these salts in decreasing the foam stability followed the above-mentioned order. The hydrated radii of the ions played a significant role in the foaming properties of the surfactant solutions. Furthermore, the zeta potential was also measured and the efficiency of the salts in making the zeta potential more negative followed the same order.

The surface tension, foamability and stability of foam for the mixture of zwitterionic (i.e., DDAPS) and cationic [i.e., cetyltrimethylammonium bromide (CTAB)] surfactants at different concentration ratios and in the presence of salt (i.e., NaCl) were investigated. The interaction occurring between the surfactant molecules adsorbed at the air–water interface influenced the monolayer properties. The interaction among the surfactant molecules at the air/water interface and the same in the mixed micelles was quantified by the respective interaction parameters. The foamability studies showed synergistic behavior inasmuch as higher foam volumes were generated in the mixed surfactant systems as compared to the single surfactant systems. The addition of salt had a remarkable effect on the foaming properties of the mixed surfactant systems. It increased the stability of foams significantly. Furthermore, the synergism between the surfactant molecules had a notable influence on the zeta potential at the air–water interface.