Comparative Analysis of Electrical Conductivity and Tensiometry Methods for Measuring Critical Micelle Concentration (CMC) of Surfactants CAHS and SDS: Impact of Water Type on CMC Measurements

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Résumé

Surfactant foams play a crucial role in different operations in porous media, like enhanced oil recovery and soil remediation. Foam, is characterized as a scattering of gas in liquid films called lamella, which constitute of surfactants and water. Surfactants, also known as surface-active agents, can reduce the surface tension between two immiscible phases, such as oil and water, and therefore in some cases act as major foaming agents (Mulligan et al. 2001). Depending on the type of surfactant and foam generated, foam in porous media can play different roles when used in soil remediation techniques: blocking agent, vectorizing agent, and mobilizing agent (e.g. Davarzani et al. 2021, Wu et al. 2021). This work is part of the ANR project BBFOAM, aiming to utilize electrical geophysical methods, in a broadband frequency range, to characterize the foam flow in a porous medium, in the presence of hydrocarbon pollutants. For surfactant analysis, determining the critical micelle concentration (CMC) is of paramount importance. The CMC is the concentration at which surfactant molecules begin to self-assemble and form micelles, which significantly affect their surface tension and electrical properties. Because we are interested in building foam with two different waters, we wanted to estimate the CMC of surfactants in two types of water: Tap and deionized, the former used in the field, and the latter used in the laboratory work. In this study, we assess two commonly used methods for measuring the CMC of surfactants: conductimetry (electrical conductivity measurement), and tensiometry (surface tension measurements), and the impact of using water of different ionic charges on each method. Two types of ionic surfactants were used: Sodium Dodecyl Sulfate (SDS), an anionic surfactant, and Cocamidopropyl hydroxysultaine (CAHS), an amphoteric surfactant. The results of the study underline the influence of the water type on choosing the CMC measurement method, with a recommendation to use both methods when working with deionized water, and the unfeasibility of the conductimetry when using tap water. The results also showed that the tensiometry method expresses higher sensitivity to micelle formation

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than conductimetry. The conductimetry method shows more distinguishable results with the ionic surfactant than with the amphoteric surfactant. Determining the CMC point while using tap water was prone to interference coming from ions that exist in tap water, thus, a further chemical analysis is needed to better understand the effect of the different ions that exist in water on the CMC point.