Thermodynamic analysis of the interaction between trivalent metal ions and sodium dodecyl sulfate

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The effect of unsymmetrical 3:1 electrolytes on ionic surfactants has been studied because of its importance for fundamental and practical applications in areas such as, detergency, catalysis, wastewater treatment, analytical chemistry and materials. Such applications are strictly related with the effect that trivalent ions can induce on surfactant in either micellar or monomer forms [1].

In this work, we report the effect of the trivalent cations of lanthanum, gadolinium, aluminum and chromium on the formation of aggregates with sodium dodecyl sulfate (SDS), at surfactant pre-micellar concentrations, and how the micellization properties of the surfactant are affected by the presence of these trivalent cations. A relationship between hydrated radius of metallic ions and the decreased capacity of ions to induce aggregation was found, where an increase of the effective charge density leads to a decrease in the critical aggregation concentration. However, the formation of SDS/Cr(III) aggregates is not only driven by a charge density criterion due to the very important role of water molecules of the hydration shell on the interaction between these metal ions and SDS.

The presence of metallic ions affects directly the SDS micellization process [2]. An analysis on the entropy and enthalpy sheds light on the balance of forces involved in micelle formation. The SDS micellization is entropically-driven in the presence of the lowest metal ion concentration. However, upon increasing the ionic strength, the enthalpic factor becomes more significant and, in the case of solutions with 1.0 mM Cr(III) or Al(III), the micellization is enthalpy driven. In the case of Gd(III), the increase of its concentration leads to a micellization process which is more exothermic but in which both enthalpic and entropic factors balanced in terms of absolute value. The exception occurs with La(III) where, in the concentration range considered, the micellization process is always clearly entropy-driven, since only a slight decrease of enthalpy is observed upon increase of La(III) concentration.

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