Surfactants at the Design Limit

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Generally speaking, molecules can be broken down into being either polar or non-polar (examples being water and oil respectively). These two classifications of molecules display individual, and often opposite chemical properties and hence for example, do not mix well. Surfactants help overcome these limitations of immiscibility because they are amphiphilic (dual-natured) molecules, possessing both hydrophilic and hydrophobic groups. Due to the dual nature, they are associated with many useful interfacial phenomena, and as such are key components for diverse industrial processes including – detergents, cosmetics, paints, herbicides, medicine and oil recovery. The most heavily investigated interfacial phenomena of surfactants is their ability to significantly alter surface tension (γ). Fluorocarbon surfactants display the most effective reduction of surface tension. Unfortunately, this has important environmental consequences because of the persistence, bioaccumulation and toxicity of fluorocarbons [1,2]. One alternative is to use hydrocarbon surfactants. However, typically, these are unable to reduce the surface tension to significantly low values compared to fluorocarbon analogues.

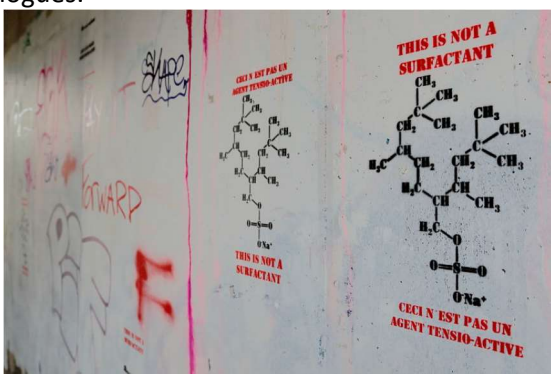

Figure 1. A “hedgehog“ surfactant Na+-iC18S (FO-180)

Recently a series of novel low-surface energy hydrocarbon surfactants has been introduced, with highly branched chains [3]. These so called “hedgehog“ surfactants have achieved low surface tensions which match those of fluorocarbon analogues. A recent review proposed that the limiting surface tension at the CMC (γcmc) is dependent on efficient surface packing at the air-water interface, hence excluding air/vacuum from the film [4]. These highly branched chain “hedgehog“ surfactants give rise to efficient packing and space filling in surface monolayers, yielding very low values for hydrocarbon surfactants (the lowest published value being γcmc =23.8mNm-1) [5]. By mixing “hedgehog“ surfactants and manipulating the architectural structure of the tail or headgroup, even lower aqueous surface tensions have been achieved. The research presented here describes some of the novel ways hydrocarbon surfactants have been developed, and their special properties.

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