

Activators and overcharging: What causes the adsorption of negatively charged surfactants on negatively charged surfaces?

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In the flotation of ores, one often uses collectors in order to effectively hydrophobize the valuable minerals. Many of these collectors show such a high affinity to surfaces that a sufficient selectivity cannot be achieved unless the valuable mineral has a distinctly different surface chemistry as compared the remaining minerals. Taking for instance systems that are majorly composed of oxides and silicates, finding a sufficiently selective collector will be a non-trivial task. One may try to use ionic surfactants, which, at least in part, adsorb electrostatically. This means that the adsorption of a cationic (anionic) surfactant requires a negatively (positively) charged surface. As the majority of silicates and oxides are negatively charged in usual pH ranges, such an electrostatic route cannot represent a universal option. An appealing alternative to the adsorption mechanisms just described is the use of certain inorganic electrolytes to promote the adsorption of ionic surfactants. Within the flotation literature these inorganic electrolytes are known as activators (Schubert, 1996; Fuerstenau and Pradip, 2005). Common to all activators is the fact that they show a more or less pronounced, pH-dependent speciation in aqueous solution. By speciation, it is understood that hydrolyzed metal cations exist in certain pH ranges and these are precisely the pH ranges where best flotation results are obtained (Fuerstenau et al., 1965).

The precise mechanisms of this sort of adsorption are not entirely resolved. In this study we have focused on the adsorption of sodiumdodecylsulfate (SDS) on negatively charged, amorphous SiO_2 in the presence of AlCl_3 and ZnCl_2 . Electrophoretic and phase transfer experiments indicate the particles need to be overcharged for the adsorption of DS-. Overcharging is a phenomenon by which more charge is accumulated in the Stern layer than needed to compensate the surface charge of the particle. As a result of this superequivalent adsorption, the diffuse layer charge density has to change sign, which is experimentally observed as a sign-change of the zeta potential.

Based on these experiments and a number of studies conducted on the overcharging phenomenon (Lyklema 2013, 2006 and references therein), we will discuss the role of overcharging and double layer structure in relation to the adsorption of surfactants.

References:

Schubert, H. (1996) *Aufbereitung fester Stoffe Band II: Sortierprozesse*. Deutscher Verlag für Grundstoffindustrie Stuttgart

Fuerstenau, D. W. and Pradip (2005) Zeta potentials in the flotation of oxide and silicate minerals. *Advances in Colloid and Interface Science*, 9-26, 114–115.

Fuerstenau, M. C., Somasundaran, P. and Fuerstenau, D. W. (1965) Metal ion hydrolysis and surface charge in beryl flotation. *Transactions of the American Institute of Mining and Metallurgical Engineers*, 74, 381–391.

Lyklema, J. (2006) Overcharging, charge reversal: Chemistry or Physics. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 291, 3–12.

Lyklema, J. (2013) Coagulation by multivalent counterions and the Schulze-Hardy rule. *Journal of Colloid and Interface Science*, 392, 102–104.