The properties of aqueous solutions of ternary surfactant mixtures at water-air interface

Katarzyna Szymczyk

Faculty of Chemistry, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Sq. 3, 20-031 Lublin, Poland

E-mail: katarzyna.szymczyk@poczta.umcs.lublin.pl

Surfactants are usually prepared commercially as mixtures rather than pure forms due to the fact that it is simply much more efficient and more economically viable to synthesise mixtures. Mixed systems are often more efficient in the environment, which is called as synergism. This synergism can be attributed to nonideal mixing effects in aggregates, and it results in critical micelle concentration (CMC) and interfacial tension that are substantially lower than expected on the basis of the properties of the unmixed surfactants alone. The synergism fundamentals in binary systems have been well understood on the basis of nonideal theories, for example, the regular solution approximation, especially by means of β parameters [1]. However, while most experimental and theoretical works on mixtures of surfactants have been focused on binary mixtures, in practice, ternary and other multicomponent surfactant mixtures are also encountered. Liquid detergents, for example, commonly include synthetic anionic surfactants, nonionic surfactants, and natural soaps [2]. To our knowledge rare studies on mixed adsorption and surface tension reduction of ternary surfactant mixtures, taking the properties of a binary mixtures into consideration, can be found in the literature. Thus, the purpose of the presented studies was to determine the influence of the concentration of aqueous solution of a third surfactant on the values of the surface tension of different binary mixtures of aqueous solutions composed of two nonionic surfactants, p-(1,1,3,3-tetramethylbutyl) phenoxy poly(ethyleneglycols), Triton X-100 (TX100) and Triton X-165 (TX165) and cationic surfactant, cetyltrimethylammonium bromide (CTAB) in which synergism was confirmed on the basis of the values of β parameters. Ternary mixtures were prepared by adding the third surfactant to the binary mixture of TX100+TX165 (αTX100=0.2), CTAB+TX100 (αCTAB=0.2) and CTAB+TX165 (αCTAB=0.2). The interactions between surfactants in the surface layers were also investigated.

From measurements of the surface tension of aqueous solutions of singular surfactants and their binary and ternary mixtures and from the literature data of their analysis it results that there is no linear dependence between the surface tension and the monomer mole fraction of surfactant in the studied binary mixtures. The addition of a third surfactant to these binary mixtures deepens the negative deviation between the values of γ_{LV} and α. It means that synergism in the reduction of surface tension of water by ternary surfactant mixtures is expected. These synergetic effect was confirmed for all studied ternary mixtures of surfactants by the values of molecular interaction parameters calculated from Rosen’s equation on the assumption that the binary system can be treated as one surface active agent.

Acknowledgment: This study was supported by grant N N204 130635.