Interplay between the rate of surfactant adsorption and hydrodynamic conditions during foaming

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ABSTRACT

In our previous studies we clarified how the surfactant type and concentration affect the foamability of surfactant solutions at given hydrodynamic conditions [1] and how the hydrodynamic conditions affect the solution foamability at high surfactant concentrations when the bubble coalescence is suppressed [2]. The current, complementary study presents results from dedicated experiments, aiming to clarify how the hydrodynamic conditions affect the ability of surfactants to stabilize the bubbles against coalescence during foaming. The obtained results show that the nonionic surfactants, which adsorb slowly on the bubble surfaces, are unable to stabilize the bubbles against coalescence in the fast foaming methods, such as the Bartsch test. However, the same surfactants are very efficient for foam stabilization when milder hydrodynamic conditions are applied, e.g. in Kenwood mixer. On the other hand, the anionic surfactants are very suitable for foam stabilization in the fast foaming methods, while they are less efficient under milder conditions. Results from surface tension measurements are used to clarify how the main dynamic surface properties (surfactant adsorption, surface coverage and surface elasticity), as a function of the bubble surface age, affect the outcome of the various foaming methods. We interpret the results from the foaming tests by considering the properties of the dynamic adsorption layers on the surface of the bubbles, formed during foaming. The previously revealed large qualitative difference between the nonionic and ionic surfactants with respect to their foaming properties [1] was confirmed to be important for all foaming methods studied. Additional experiments with surfactant mixtures showed that these mixtures can be much more efficient for bubble stabilization during foaming, as compared to the respective individual surfactants.

[1] B. Petkova, S. Tcholakova, M. Chenkova, K. Golemanov, N. Denkov, D. Thorley, S. Stoyanov. Foamability of Aqueous Solutions: Role of Surfactant Type and Concentration. Adv. Colloid Interface Sci. 276 (2020) 102084.

[2] N. Politova, S. Tcholakova, Zh. Valkova, K. Golemanov, N. D. Denkov. Self-regulation of Foam Volume and Bubble Size during Foaming via Shear Mixinge. Colloids Surf. A, 539 (2018) 18–28.