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Foam drainage: experimental study and numerical simulations

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Foams are widely used in food, cosmetics, pharmacy etc [1, 2]. stabilised by surfactants, but during the last decade polymers (polyelectrolytes) become a frequently used additives to foaming solutions [3]. Polymers often increase considerably the viscosity of foaming liquids and in this way affect the foam drainage kinetics.

We present the results of experimental study on drainage of foams produced from solutions of commercially available polymers Aculyn^{TM} 22 and Aculyn^{TM} 33 broadly used in cosmetic industry. In particular the influence of bulk and the surface rheology of foaming solutions on the drainage kinetics is addressed.

For many applications, particularly in pharmacy and cosmetics, the interaction of foam with substrate is of considerable importance. This interaction can affect, for example, the kinetics of the release of acting substances from foam and therefore have to be taken into consideration for finding optimal formulations.

Often the surfaces where foam is applied are porous (skin, hair). To identify the methods to control the kinetics of liquid release in this case we performed direct numerical simulations of foam drainage on the porous substrate. The mathematical model developed combines the foam drainage equation with the equation describing the penetration of liquid in the model porous substrate of prescribed structure coupled with appropriate boundary conditions at foam/substrate interface.

The performed numerical simulations have shown that depending on the liquid viscosity, bubble size, foam height, substrate porosity and wetting conditions two different scenarios are possible with and without the formation of continuous liquid layer between the foam and porous substrate. Kinetics of foam drainage and penetration of liquid into porous substrate is considered in details for both scenarios depending on the properties of foaming liquid and substrate.

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