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A Combined CFD Simulation of Plateau Borders including Films and Transitional Areas of Liquid Foams

Authors : Abdolhamid Anazadehsayed, Jamal Naser

Abstract : An integrated computational fluid dynamics model is developed for a combined simulation of Plateau borders, films, and transitional areas between the film and the Plateau borders to reduce the simplifications and shortcomings of available models for foam drainage in micro-scale. Additionally, the counter-flow related to the Marangoni effect in the transitional area is investigated. The results of this combined model show the contribution of the films, the exterior Plateau borders, and Marangoni flow in the drainage process more accurately since the inter-influence of foam's elements is included in this study. The exterior Plateau borders flow rate can be four times larger than the interior ones. The exterior bubbles can be more prominent in the drainage process in cases where the number of the exterior Plateau borders increases due to the geometry of container. The ratio of the Marangoni counter-flow to the Plateau border flow increases drastically with an increase in the mobility of air-liquid interface. However, the exterior bubbles follow the same trend with much less intensity since typically, the flow is less dependent on the interface of air-liquid in the exterior bubbles. Moreover, the Marangoni counter-flow in a near-wall transition area is less important than an internal one. The influence of air-liquid interface mobility on the average velocity of interior foams is attained with more accuracy with more realistic boundary condition. Then it has been compared with other numerical and analytical results. The contribution of films in the drainage is significant for the mobile foams as the velocity of flow in the film has the same order of magnitude as the velocity in the Plateau border. Nevertheless, for foams with rigid interfaces, film's contribution in foam drainage is insignificant, particularly for the films near the wall of the container.

Keywords : foam, plateau border, film, Marangoni, CFD, bubble
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