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Dynamics of a surfactant-laden falling film

George Karapetsas and Vasilis Bontozoglou

Department of Mechanical Engineering, University of Thessaly,
GR-38334 Volos, Greece

Abstract

We investigate the dynamics of a thin film flowing down an inclined solid surface in the presence of soluble surfactants. Lubrication theory for the fluid motion, and advection-diffusion equations as well as chemical kinetic fluxes for the surfactant transport, lead to coupled evolution equations for the film thickness, interfacial concentrations of surfactant monomers and bulk concentrations of monomers. We solve numerically the evolution equations using the finite element method and we perform a full parametric study. The results of our simulations show that surfactants have a strong stabilizing effect on the flow due to the presence of Marangoni stresses. The wave patterns that arise differ significantly from the case of clean fluids. It will be shown that the dominant structures, even at high Re numbers, are sinusoidal traveling waves in direct agreement with experimental observations.



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