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Nonlinear Dynamics and Plug Formation in a Long-wave Model of Film Flows Inside a Tube in the Presence of Surfactant HAROLD OGROSKY, Virginia Commonwealth Univ — A long-wave model based on lubrication theory is developed for the flow of a viscous liquid film lining the interior of a vertical tube in the presence of an insoluble surfactant on the interface; no thin-film assumption is made. Linear stability analysis identifies two modes; in the absence of base flow, the 'interface' mode is the only unstable mode. The growth rates of this mode serve as an accurate predictor of how surfactant concentration increases plug formation time, and the effects of film thickness on this increase are quantified. For a falling film, both the interface mode and 'surfactant' mode may be unstable, resulting in a richer variety of free-surface dynamics. Previous work has shown that turning points in families of traveling wave solutions for gravity-driven film flow with a clean interface can be a good indicator of h_c, the critical thickness past which plugs may form. In the presence of surfactant, it is found that turning points in branches of traveling waves that arise from an unstable surfactant mode give an estimate of h_c, provided the interface mode is linearly stable. When both modes are unstable, interpretation of these turning points as they relate to plug formation is more complicated.

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