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Theoretical Study of Effects of Inertia, Gravity & Interfacial Activities on Steady Plug Propagation in a 2D Channel YING ZHENG, HIDEKI FUJIOKA, JAMES GROTBERG, University of Michigan — In many clinical treatments, liquid plugs may form and propagate throughout the pulmonary airways due to the air pressure drop from inspiration and gravity. These will influence the final distribution of liquid in the lung or the success of liquid removal. In this work, we develop a model of propagation of a plug laden with soluble surfactant in a two-dimensional liquid-lined channel oriented at an angle α with respect to the direction of gravity. The equations of motion and surfactant transport are solved numerically using a finite volume method. We study the effect of varying plug propagation speed, U; plug length, Lp; α and surfactant concentration in both Stokes flow limit and finite Reynolds number (Re) regime. The volume ratio, V_R, of the liquid above and below the center line of the channel, excluding the liquid volume in film region, is calculated to quantify the asymmetric liquid distribution. We find that V_R increases with U and Lp for a fixed α. V_R decreases (increases) with α for $\alpha \leq (\geq) \quad \pi/2$. For finite Re, V_R increases with Re for a given value of Lp and α. We discuss the effects of U, Lp and α on the wall shear stress and wall pressure. This work is supported by NIH grant HL-41126, HL64373, NSF grant BES-9820967, NASA grant NAG3-2196 and NAG3-2740.

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