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The Influence of Non-Newtonian Properties on Steady Plug Propagation in a 2D Channel YING ZHENG, HIDEKI FUJIOKA, JAMES B. GROTBERG, University of Michigan — In obstructive pulmonary diseases, the lung's small airways can be closed by the formation of liquid plugs, which obstruct the airflow and propagate throughout the pulmonary airways due to the air pressure drop. The liquid in the lung airways (so-called mucus) has non-Newtonian characteristics with shear thinning and yield stress. In this work, we numerically studied the plug propagation of non-Newtonian fluid laden with soluble surfactant in a two-dimensional liquid-lined channel. The non-Newtonian behavior is described by a power-law model with shear thinning characteristics similar as mucus, of the form $\mu = K\dot{\gamma}^{n-1}$, where $\dot{\gamma}$ is the shear rate and n<=1 is the power law index. For a given propagation speed, the deposited film thickness and pressure drop across the plug increase with decreasing n. Also, the wall pressure and shear stress increases with the decreases of n, which could lead to an increase of the damage of the cells lining the airways. This is mainly due to an increase in local viscosity in the plug domain. The effects of yield stress, plug speed, plug length and surfactant concentrations on plug flow pattern and wall stress distribution are discussed. This work is supported by NIH grant HL84370, NASA grant NAG3-2740 and NASA NBEI grant NNC04AA21A.

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