Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Effect of oscillatory core-flow on a viscoelastic fluid layer coating the inner surface of a tube.[1] HIDEKI FUJIOKA, University of Michigan, DAVID HALPERN, University of Alabama, JAMES B. GROTBERG, University of Michigan — Surface tension on an air-liquid interface induces liquid flows, which may cause the lung's airways to close due to the formation of a liquid plug as a result of drainage of the liquid lining coating the airways. The stability of the liquid layer is also influenced by the air core flow as well as the rheological properties of the liquid. In this study, we develop a computational model of a liquid-lined tube with an oscillatory core flow along the axis of the tube: a Newtonian fluid flows through a cylinder whose inner wall is coated by an upper-convective Maxwell fluid. When no core flow is present, the viscoelastic fluid layer grows faster and closure times are shorter than a Newtonian fluid layer with the same viscosity. When an oscillatory core flow is present, the liquid bulge that develops after the initial growth translates back and forth along the tube axis with an amplitude that increases with elasticity. If this amplitude is large enough, the minimum core radius approaches a non-zero value implying that a liquid plug has not formed. The effects of core flow frequency and amplitude on this instability are discussed.

[1]This work is supported by NIH grant HL84370, and NASA grants NAG3-2740 and NBEI NNC04AA21A.

Hideki Fujioka
University of Michigan

Date submitted: 03 Aug 2007 Electronic form version 1.4