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Flow Transport in Microtubes Inspired by Insect Respiratory Systems YASSER ABOELKAASEM, ANNE STAPLES, Virginia Tech. — The mechanics of insect respiration and tracheal ventilation generally follow either highly discontinuous, or cyclic gas exchange patterns. In the former, gases are exchanged by diffusion, while in the latter, recent imaging of internal respiratory flow dynamics in insects performed at the x-ray synchrotron imaging facility at Argonne indicates that convective gas exchange is accomplished by changes in internal pressure due to rhythmic compressions of the tracheal tubes that comprise the respiratory network. These localized tracheal compressions are induced by global body movements and are used to enhance the oxygen transport to the tissue. Inspired by the dynamics of insect respiratory networks in the cyclic gas exchange regime, we study fluid transport in a mixed rigid/elastic microtube that undergoes localized single and multiple periodic collapses. The latter induces a streaming of flows and therefore enhances convection and flow transport in the tube downstream of the collapse site. The shape of the microtube, the material properties, and the compression and reinflation spatial and temporal profiles are selected to mimic those observed in insect tracheal tubes. A low Reynolds number assumption and lubrication theory are used to develop a mathematical model for the system. The effects of tube shape, collapse amplitude, collapse-to-collapse distance, and collapse phase lags on the net flow rate, pressure gradient, wall shear stress, velocity are investigated.

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