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The motion of a train of vesicles in channel flow[1] JOSEPH BARAKAT, ERIC SHAQFEH, Stanford Univ — The inertialess motion of a train of lipid-bilayer vesicles flowing through a channel is simulated using a 3D boundary integral equation method. Steady-state results are reported for vesicles positioned concentrically inside cylindrical channels of circular, square, and rectangular cross sections. The vesicle translational velocity U and excess channel pressure drop Δp^+ depend strongly on the ratio of the vesicle radius to the hydraulic radius λ and the vesicle reduced volume υ. "Deflated vesicles" of lower reduced volume υ are more streamlined and translate with greater velocity U relative to the mean flow velocity V. Increasing the vesicle size (λ) increases the wall friction force and extra pressure drop Δp^+, which in turn reduces the vesicle velocity U. Hydrodynamic interactions between vesicles in a periodic train are largely screened by the channel walls, in accordance with previous results for spheres and drops. The hydraulic resistance is compared across different cross sections, and a simple correction factor is proposed to unify the results. Nonlinear effects are observed when β – the ratio of membrane bending elasticity to viscous traction – is changed. The simulation results show excellent agreement with available experimental measurements as well as a previously reported "small-gap theory" valid for large values of λ.

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