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Taylor dispersion in the presence of cross flow and interfacial mass transfer TIRAS Y. LIN, ERIC S.G. SHAQFEH, Stanford University — Transverse velocity gradients can enhance the effective diffusion coefficient of a scalar in the primary flow direction a phenomenon known colloquially as Taylor dispersion. In this work, we perform Taylor dispersion analysis on a pressure-driven flow in a channel with a cross flow, using both perturbation theory and Brownian dynamics simulations. Moreover, we illustrate how mass transfer at the wall affects the evolution of the scalar. We elucidate how the effective diffusion coefficients, effective advective velocities, and effective mass-transfer rates depend on the strength of the cross flow and the wall transfer coefficient, and we perform an asymptotic analysis to investigate the limit of strong cross flow. We discuss a few applications where our results may be useful. For example, in the treatment of a cancerous tumor using nanoparticles, interactions with red blood cells drive nanoparticles in the transverse direction toward the porous blood vessel wall, where they can then be transferred through the wall. Additionally, it has recently been shown that applied forces can cause particles to drift laterally in a viscoelastic channel flow. In both of these applications, our results can be used to understand the resulting particle dispersion.

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