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Swimming sheet in a viscosity-stratified fluid RAJAT DANDEKAR, AREZOO ARDEKANI, Purdue University — In this work, we theoretically investigate the motion of a Taylor swimming sheet immersed in a viscosity-stratified fluid. The propulsion of the swimmer disturbs the surrounding fluid which influences the transport of the stratifying agent described by the advection-diffusion equation. We employ a regular perturbation scheme to solve the coupled differential equations of motion up to the second order with the small parameter given by the ratio of the wave amplitude and the wavelength. The expression for the swimming velocity is linear in the magnitude of the viscosity gradient, while depending on the Peclet number in a non-monotonic way. Interestingly, we find that the Peclet number governs the propensity of the sheet to propel towards regions of favorable viscosities. For small Peclet numbers ($0<Pe<3$), the swimmer prefers regions of low viscosity while for high Peclet numbers ($Pe>3$), the swimmer prefers regions of high viscosity. Our analysis shows that purely hydrodynamic effects might be responsible for the experimentally observed accumulation of swimmers near favorable viscosity regions. We find that viscosity gradients influence other motility characteristics of the swimmer such as power expenditure, hydrodynamic efficiency and provide analytical expressions for both.

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