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Oxygen transport and mixing dynamics in thin films of aerotactic bacteria AMIR ALIZADEH PAHLAVAN, DAVID SAINTILLAN, Department of Mechanical Science & Engineering, University of Illinois at Urbana-Champaign — We investigate the dynamics in suspensions of aerotactic bacteria using two different kinetic models: a gradient-detecting model, in which the bacteria detect the local oxygen gradients instantaneously, and a run-and-tumble model, in which the bacteria change their run-and-tumble frequency based on the recent temporal changes in the oxygen field. Using three-dimensional numerical simulations, we study the behavior of such suspensions in thin liquid films surrounded by oxygen baths on both sides. As the bacteria consume the dissolved oxygen, gradients form causing them to swim towards the free surfaces where the oxygen concentration is higher. In very thin films, a high oxygen concentration is observed in the liquid as a result of diffusion from the surfaces, but as the film thickness increases, a depletion layer forms in the center. The formation of this low-oxygen region is associated with the emergence of large-scale instabilities in the suspensions that enhance oxygen mixing into the liquid. These instabilities are accompanied by the formation of large plumes of high bacterial density. The bacterial migration towards the free surfaces is found to be slower in the run-and-tumble model.

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