Department of Mathematics and Statistics

Colloquium Series

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Small-Scale Fluid Dynamics: From Microfluidics to Microfiltration

Abstract: Understanding microscale fluid and particle transport is critical to perfecting the manufacturing and use of microfluidic technologies in medical, industrial, and environmental engineering applications. In this talk, I will discuss two projects concerned with solute transport and diffusion at the microscale tackled via analytical and experimental approaches.

Many wastewater management facilities aimed at water purification in the United States utilize hollow-fiber micro- or ultra-filtration. In these systems, pipes are split into thousands of micro or nanometer-scale capped tubes with permeable walls. As wastewater flows through the filter, foulants are captured by the membraned walls, allowing clean water to exit. I will discuss a first step towards understanding the fluid dynamics of these systems through the development of a 2D model for the flow of wastewater through a single hollow-fiber. Resolving the fluid dynamics details of filtration would allow for better control of the fouling process and could improve its efficiency.

In the latter part of the talk, I will focus on passive diffusion into microchannels with dead-end pores, which are ubiquitous in natural and industrial settings. I will describe a repeatable and accessible experimental protocol developed to study the passive diffusion process of a dissolved solute into dead-end pores of rectangular and trapezoidal geometries. The experimental data is compared directly to analytical solutions of an effective 1D diffusion model: the Fick-Jacobs equation. The role of the pore geometry on the passive diffusion process will be highlighted. Ongoing and future directions will be discussed.

Keywords: microfluidics, Stokes flow, permeability, passive diffusion, experiment.

Wednesday, March 20, 1:05 – 1:50 pm in 4-2-314