ME Seminar

Membrane technologies for sustainable separation solutions

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ABSTRACT

Membrane separations provide solutions to several critical problems: 60% of the global desalination capacity that provides fresh water to arid countries is based on membranes, and membrane-based hemodialysis saves the lives of 3 million patients around the world. In industry, membranes are increasingly being considered to replace thermally-driven technologies, such as distillation, due to their promise of being up to an order of magnitude more energy efficient. However, their incorporation in industrial applications is currently restricted by the relatively limited understanding of membrane transport and changes in membrane material under practical operating conditions, especially in applications involving non-aqueous media, relevant to several industrial applications. Scaling up of separations successful in the lab to a commercial scale also poses a challenge in several applications. In this talk, the speaker will provide an overview of her research experience in exploring membrane separations, spanning both ion-transport in a small coupon of membrane as well as system-level analysis and optimization, and using both numerical modeling and experimental approaches of investigation. The first part of the talk describes changes in the membrane performance in response to changes in feed temperature. The chief takeaways from this section include a description of the changes in membrane structural and charge-based properties with temperature, the resulting effect on permeate quality, and the introduction of an analytical framework to aid an industrial operator to improve inter-species selectivity with changes in temperature and other operating conditions. The second segment describes membrane-based recovery of an ionic liquid that has been proposed as a novel wood-pulping solvent in the paper-making industry. This project poses several new challenges with respect to membrane separations. For instance, this work is the first to investigate the selective removal of valorizable non-paper-making molecules released from wood to recover the ionic liquid; and the dilution of the incoming feed with organic solvents in order to reduce its viscosity requires stepping into the relatively new field of organic solvent reverse osmosis and nanofiltration (OSRO and OSN). Finally, the speaker will provide a motivation of the upcoming work in her group on organic solvent recovery using membrane technologies, which is a critical area of investigation for several sectors such as the pharmaceutical, petroleum and textile industries.

ABOUT THE SPEAKER

Dr. Yagnaseni Roy is an assistant professor in the Center for Sustainable Technologies (CST) at IISc. Prior to joining IISc in September 2020, she completed a 2-year stint as a post-doctoral research fellow in the Sustainable Process Technology (SPT) group at the University of Twente in the Netherlands. Her masters and PhD degrees were completed in Prof. John Lienhards group in the Mechanical Engineering department at the Massachusetts Institute of Technology (MIT). Membrane separations has been at the core of her research starting at her masters degree, and will continue to be a major focus of her activities as she develops her group at IISc. Her longstanding experience with membranes has allowed Dr. Roy to explore their behavior and applications from several perspectives: while her graduate work involved simulation-based analysis of ion transport through nanofiltration membranes for desalination applications, her post-doctoral work focused on experimental testing of reverse osmosis membranes for solvent recovery in the paper-making industry. At IISc, Dr. Roy will pursue membrane technologies as well as other separation technologies to develop sustainable, techno-economically optimized solutions for industrially and societally relevant separation and purification problems. Using her seed grant awarded by IISc, she plans to develop a membrane-based approach for industrial organic solvent recovery, which remains a critical issue for sectors such as the pharmaceutical, petroleum, and textile industries which currently use energy-intensive and high carbon footprint distillation technologies to recover solvents, or release used solvents into the environment.

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