COLLEGE OF ENGINEERING

University of Nebraska-Lincoln
Department of Chemical & Biomolecular Engineering

Sustainability & scale-up: an evolution in polymeric membrane manufacturing using green solvents and slot die coating for water treatment

Dr. Isabel Escobar

Chellgren Chair Endow Professor
Department of Chemical and Materials Engineering
University of Kentucky
Hosts: Nebraska Center for Materials and Nanoscience,
Dr. Shudipto Dishari (Chemical & Biomolecular Engineering)

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2:00pm-3:00pm
Location: Othmer B201

In light of increasing clean water insecurity, polymeric membranes are playing a major role as more efficient and scalable filters. A variety of techniques for polymeric membrane fabrication have been studied and implemented, with nonsolvent-induced phase separation (NIPS) being one of the most prevalent methods. However, the frequent use of hazardous solvents that are derived from nonrenewable resources hinders the safety and sustainability of NIPS; moreover, increasing regulations on traditional solvents have motivated commercial manufacturers to identify alternative solvents with green properties. While bench-scale studies on green solvent-based polymeric membranes have emerged, the next step of manufacturing scale-up to meet the needs of the commercial sector remains largely unstudied.This study addresses the next step by developing a novel scaled-up manufacturing NIPS method for green solvent-based polysulfone (PSf) membranes via slot die coating (SDC). The SDC setup was configured for continuous processing by using a roll-to-roll system. PSf dope solutions included Rhodiasolv® PolarClean and gamma-valerolactone (GVL), two nontoxic and biodegradable solvents that have been relatively understudied in membrane synthesis. Dope solution properties, including viscosity and surface tension, were analyzed to determine the optimal parameters for fabricating ultrafiltration (UF) membranes via SDC. A comparison study of filtration characteristics was conducted between PSf-PolarClean-GVL UF membranes fabricated via bench-scale blade-casting and SDC. Membrane morphology, surface composition, and hydrophilicity were characterized. Profiles of both membrane types were compared with those exhibited by PSf UF membranes derived from the traditional solvent N-methyl-2-pyrrolidone (NMP). Under dead-end filtration conditions, PSf-PolarClean-GVL membranes fabricated via SDC exhibited a high average deionized water permeability of 152.5 ± 27.3 LMH/bar and a maximum bovine serum album (BSA) rejection of 98.2 ± 1.4%, which indicated close agreement with a blade-casted counterpart. The complete results highlight the value of green solvents and SDC in bringing sustainable and scaled-up polymeric membranes closer to implementation.

Isabel Escobar teaches in the Department of Chemical and Materials Engineering, and she is the Director of the Chellgren Center for Undergraduate Student Excellence. Dr. Escobar holds a Ph.D., an M.S. and a B.S. degrees in Environmental Engineering from the University of Central Florida, Orlando, FL, where she was an EPA STAR Fellow. Escobar joined the University of Kentucky in August of 2015, after spending fifteen years at The University of Toledo. In 2009, Isabel Escobar became the Associate Editor of Environmental Progress and Sustainable Energy Journal, a quarterly publication of the American Institute of Chemical Engineers. In 2011, she received the American Institute of Chemical Engineers (AIChE) Separations Division FRI/John G. Kunesh Award. Dr. Escobar's research focuses on developing and/or improving polymeric membrane materials for water treatment and water reuse operations. In the field of membrane separations, she has been the PI of numerous nationally competitive research projects. Among her current projects is work on (1) multifunctional nanocomposite membranes, including using 2D materials functionalized on membranes to remove and destroy per-and polyfluoroalkyl substances (PFAS); (2) anti-microbial membranes; (3) biofouling mechanisms; (4) nanoparticle fouling mechanisms; (5) bio-derived membranes; (6) green membrane fabrication and scale up; and (6) photocatalytic membranes.