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Innovative Cellulose Acetate Hybrid Membranes Combined with Integrating Magnetic Nanoparticle Adsorption for Urea Removal from Spent Dialysate

Abstract: Efficient urea removal from spent dialysate (SD) is a major challenge in the advancement of sustainable hemodialysis technologies. This study presents the development and characterization of an asymmetric cellulose acetate-based hybridmembrane, designed for selective urea separation, and its integration with Magnetic silica nanoparticle-assisted adsorption for enhanced removal performance.

The hybrid membrane was synthesized to achieve an optimized asymmetric structure, and its properties were thoroughly characterized using Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM),atomic force microscopy (AFM), mechanical strengthtesting, Raman spectroscopy, and hydraulic permeability measurements. These analyses confirmed the membrane's asymmetric architecture, well-defined surface morphology, and robust mechanical properties suitable for practical application in dialysis systems.

In the current phase of our research, we are investigating a two-step process: first, urea is adsorbed from SD using silica nanoparticles with high affinity for urea; second, the urea-laden nanoparticles are separated from the solution using the synthesized hybrid membrane. Preliminary characterization and membrane performance evaluations have been successfully completed, and ongoing experiments are focused on the adsorption and separation stages. The final results of these experiments, including urea removal efficiency and membrane retention performance, will be presented at the conference.
This work demonstrates the potential of combining hybrid membrane technology with nanoparticle- assisted adsorption as a scalable and energy-efficient strategy for advanced urea removal and dialysate regeneration. The proposed approach could significantly contribute to the development of next-generation hemodialysis systems with improved sustainability and cost-effectiveness.

Keywords: Hybrid cellulose acetate membrane,urea removal, spent dialysate, magnetic silica nanoparticles, adsorption, membrane technology.

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Biography:
Fahimeh Zare is a PhD candidate and researcher specializing in membrane technology, nanoparticle synthesis, and porous thin film characterization. She contributes to the HORIZON PHOTONGATE project, focusing on advanced photonic multi-sensing systems.Fahimeh has presentedat various international conferences and published four peer-reviewed articles, with another under review. Her work appears in top journals like Membranes, Sensors, and Hydrogen Energy. She received several honors, including the BIC France-Portugal scholarship. Her researchtargets advanced membranematerials, uremic toxin removal, and hydrogen production technologies, aiming to drive innovation in separation science and sustainable energy through collaborative, high-impact research.