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Nanoparticle-Assisted Sustainable Regeneration of Spent Dialysate

Introduction

Background:
Hemodialysis is a life-saving therapy for patients with end-stage renal disease, but it is resource-intensive, especially regarding water consumption and dialysate preparation.

Challenge:
Conventional dialysate regeneration methods are not sustainable, and selective removal of urea and other solutes remains a significant technical hurdle.

Objective:
To develop a sustainable, efficient, and scalable platform for dialysate regeneration by integrating advanced nanomaterials and membrane technologies (Figure 1).

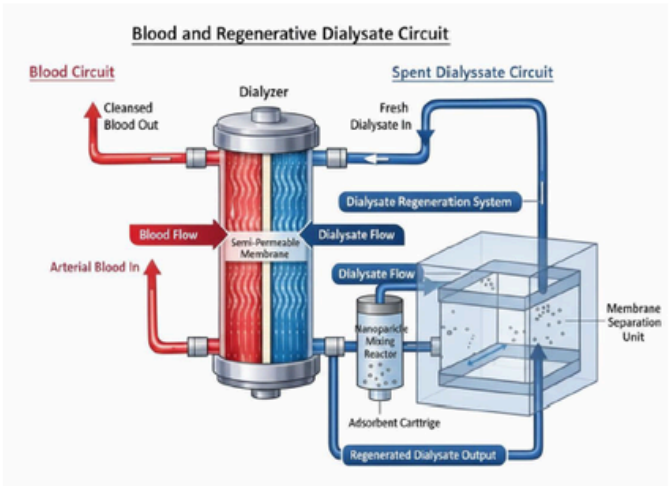

Figure 1. Schematic Procedure for Urea Removal and Regeneration of Spent Dialysate.

Results

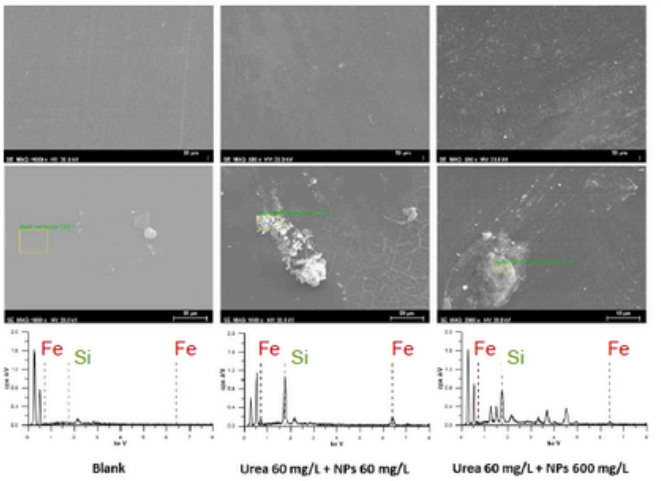

Figure 2. SEM-EDX analysis on the NPs and membrane used in the mixture experiments

- ✓ The successfully fabricated MHM features a dense and highly compact top surface with a Si–O–C hybrid network, effectively acting as a physical barrier against nanoparticle passage.
- ✓ The successful synthesis and characterization of Core-Shell NPs, confirms the formation of a well-defined hybrid structure exhibiting superparamagnetic behavior.
- ✓ The results showed that the Integrated system can remove urea effectively, especially at higher nanoparticle loading.

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Experimental Work

- Optimization of Monophasic Hybrid Membrane (MHM) property for improved flux and selectivity.
- Functionalization of the Nanoparticles (NPs) to achieve greater selectivity at their surface.
- Testing the system using simulated spent dialysate and measuring urea removal by UV-Vis spectrophotometry at different nanoparticle concentrations and pH values.

Future Work

- Recovery and Reutilization of NPs.
- Transition from batch to continuous dialysate loops.

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