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The role of nanomaterials in enhancing the performance of polymeric membranes for water treatment

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Abstract

Thin-film nanocomposite (TFN) membranes are the third generation membranes being investigated for pressure driven and osmotic driven membrane processes alike. The incorporation of nanofillers in the dense selective polyamide (PA) layer is seen to improve the trade-off between permeability and selectivity. The challenge of a commercial scale implementation of the TFN membranes- the poor dispersibility and compatibility of the nanofillers; which makes it difficult to prepare a defect free, high performance membranes. Nanofiltration membranes incorporated with 0.4 wt.% Zn/Al LDH in the PA layer displayed improved hydrophilicity (lower water contact angle), > 94.5 % rejection of cationic dye (Methylene blue), > 91 % rejection of inorganic salt (CaSO4) with an 80 % flux recovery after long-term filtration. Nano-zinc anchored siliceous mesostructured cellular foams using polydopamine containing membranes have shown an 86-92% rejection of monovalent NaCl ions from a 2000 ppm feed solution while maintaining high permeability when operated at low pressures of 6 bar. Ferrites of Zn and Mg nanoparticles were used to fabricate TFN membranes intended towards treating effluents from food and fermentation industries that contain high concentrations of glucose. These membranes were displayed a glucose rejection of 96.52 ± 2.35 % at 10 bar, 25 ⁰C and were proven to be efficient in long-term studies and exhibited good reproducibility. The anti-bacterial ability of the metal ferrites was not prominent in the TFN membranes which could be due to their lower accessibility to the bacteria. Forward osmosis TFC membranes (polyethersulfone support), incorporated with mesoporous silica on mixed metal oxides of Ca and Al showed very low reverse solute flux <1 g/m2 h with moderate flux of 12 LMH using 1M NaCl as a test draw solute..

Biography:

Dr. Noel Jacob Kaleekkal is currently an Assistant Professor at the National Institute of Technology Calicut, India, and also leads the Membrane Separation Group (MemSepGrp). His research interests lie in the development of novel membranes for different applications. His initial focus was on the development and evaluation of membranes for hemodialysis applications. He has also worked on the pressure-driven membrane process for water treatment, including removing heavy metals, humic substances, separation of oil-water emulsion, etc. He has collaborated on a project involving the development and characterization of proton exchange membranes for direct-methanol fuel cells. His most recent research focuses on low-pressure, novel membrane technologies that aim to address diminishing water and energy resources. His research group is working on government-funded projects for developing novel forward osmosis membranes and superhydrophobic membranes for Membrane Distillation for the recovery and reuse of wastewater and seawater.

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