INNOVATIVE NANOSTRUCTURED MEMBRANES FOR REVERSE OSMOSIS WATER DESALINATION

Faculty and PostDoc Sciences and Engineering

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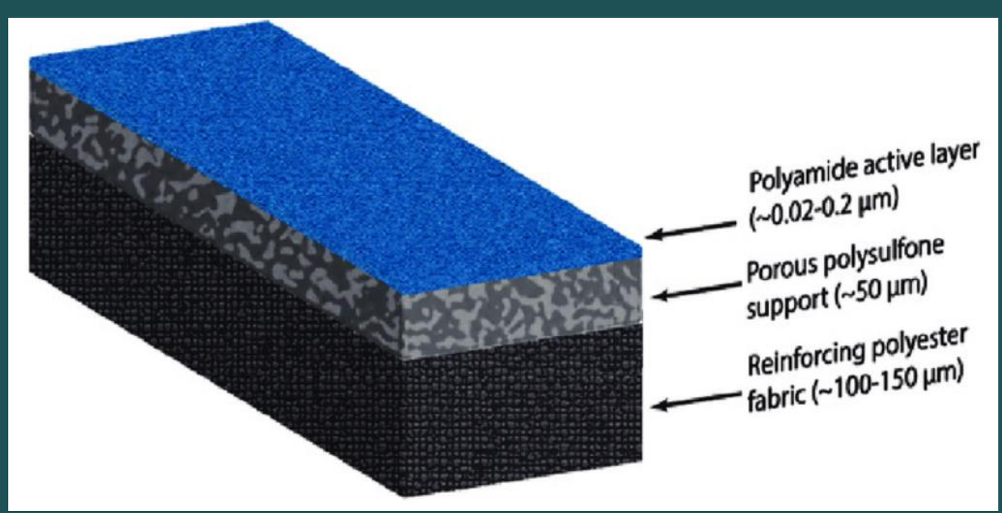
Introduction

- Reverse osmosis(RO) is considered as the most widely utilized desalination technique worldwide for water treatment.
- Significant progress has been made in the development and modification of RO membranes by various groups.
- However, the commercial thin-film composite (TFC) membranes, which are normally made of polyamide (PA) through interfacial polymerization (IP), still experience certain major issues with respect to performance and fabrication.
- The spin assisted layer-by-layer(SA-LbL) technique was established for overcoming some drawbacks with commercially available PA membranes.
- Also, recent investigations have recognized the inclusion of nanoparticles into the selective layer as a powerful technique for improving the efficiency of the membrane.

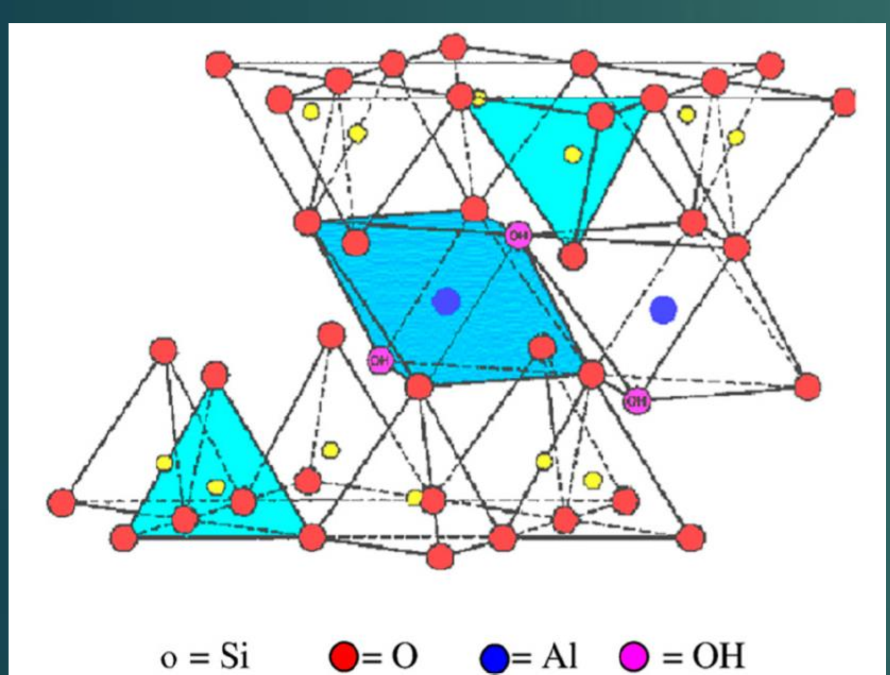


Structure of a typical membrane

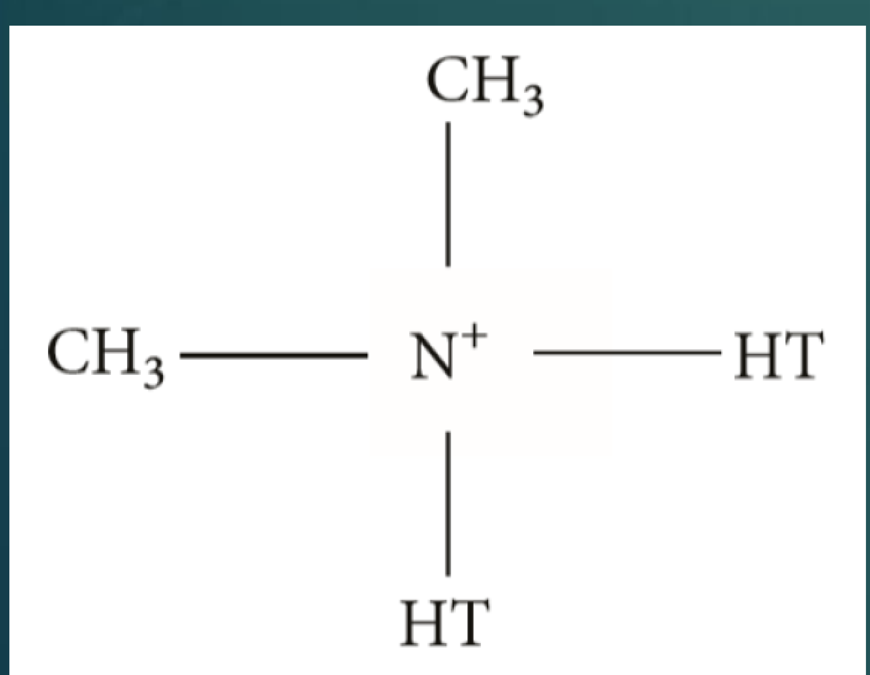
Objective

- The objective is to improve the membrane performance using two different
- (1) The incorporation of nanoclays into the membranes during IP process to develop TFC membrane. Two types of nanoclays, namely cloisite(CS)-15A and montmorillonite(MNT), were incorporated to enhance the separation efficiency
- (2) SA-LbL technique to fabricate TFC membrane by the deposition of alternate ultrathin layers of different polyelectrolytes on polysulfone(PSF) commercial ultrafiltration membrane

Nanoclay - montmorillonite (MNT)

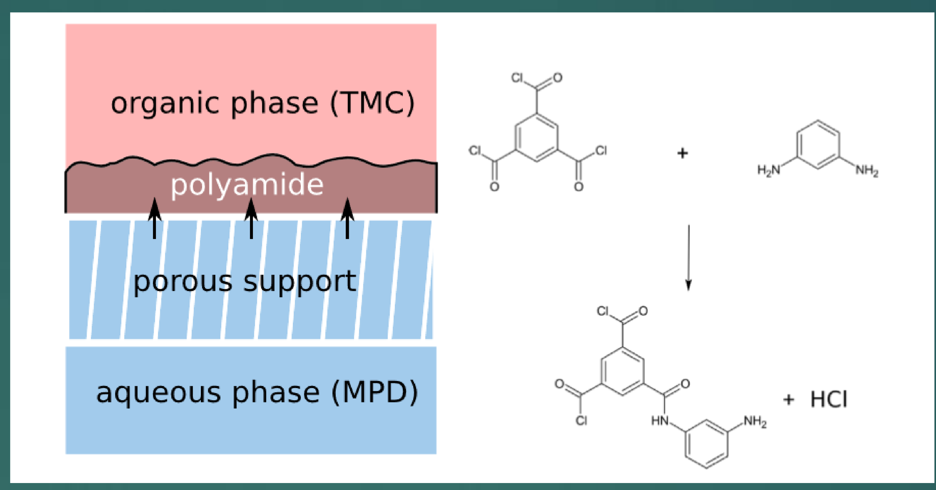


Cloisite-15A modifier

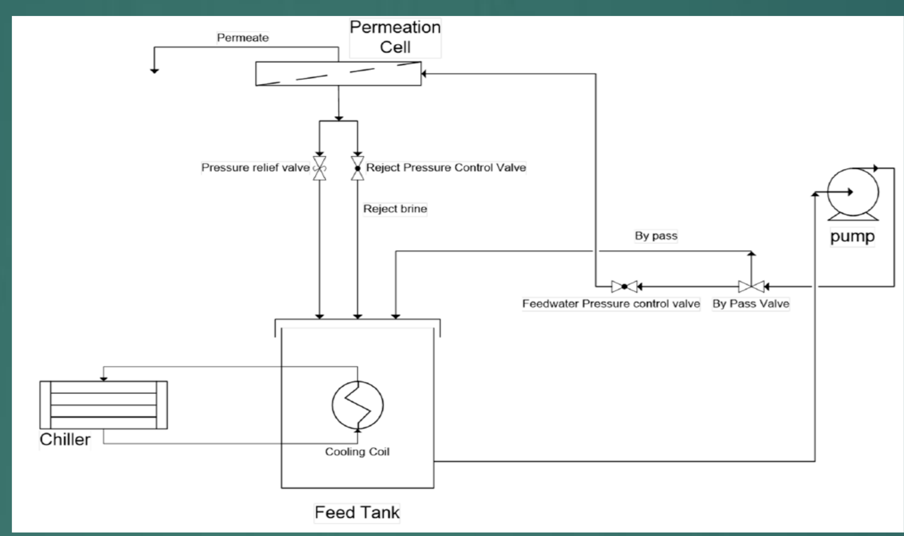


option

Study 1: Interfacial Polymerization

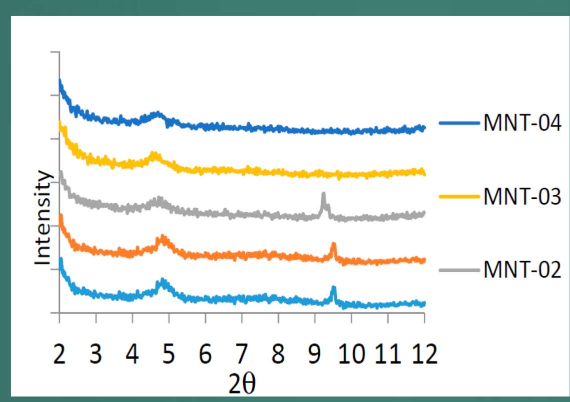


Cross-flow filtration system

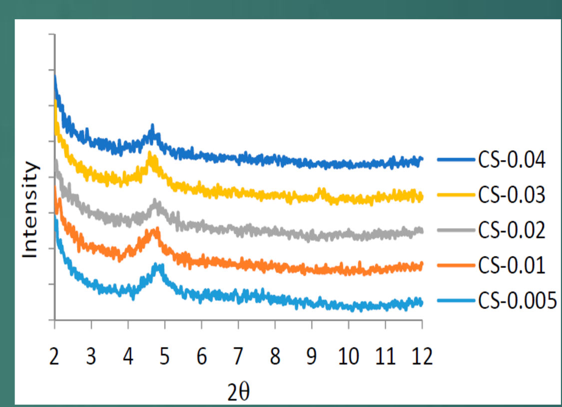


- Water flux and NaCl rejection were assessed by a cross-flow filtration system
- The permeation cell analyzed an active membrane surface area of almost 42 cm^2.
- The test was performed at a pressure of 40 bars, pH of 6, and at 2000 ppm feed NaCl concentration.

X-Ray Diffraction results

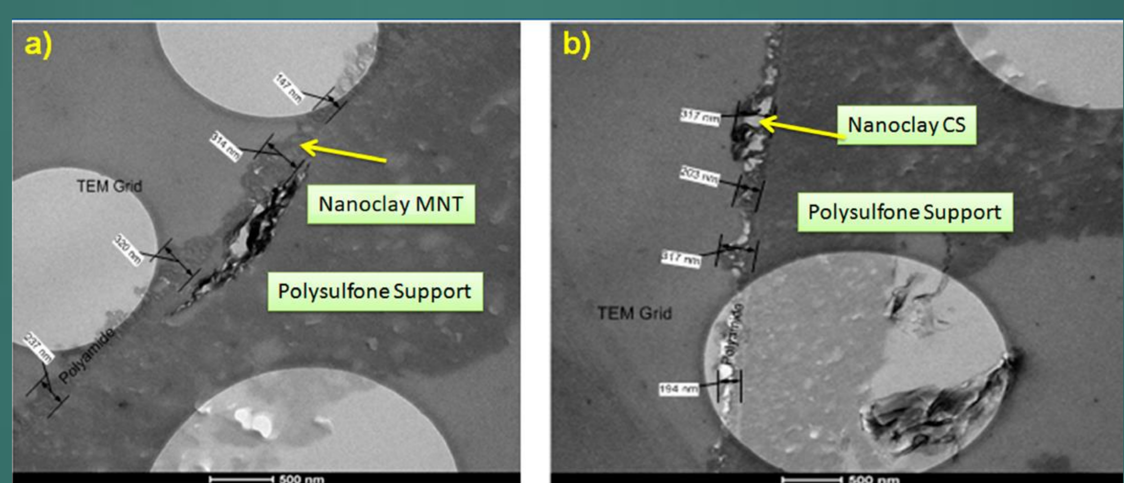


MNT-filled PA membrane



CS-15A-filled PA membrane

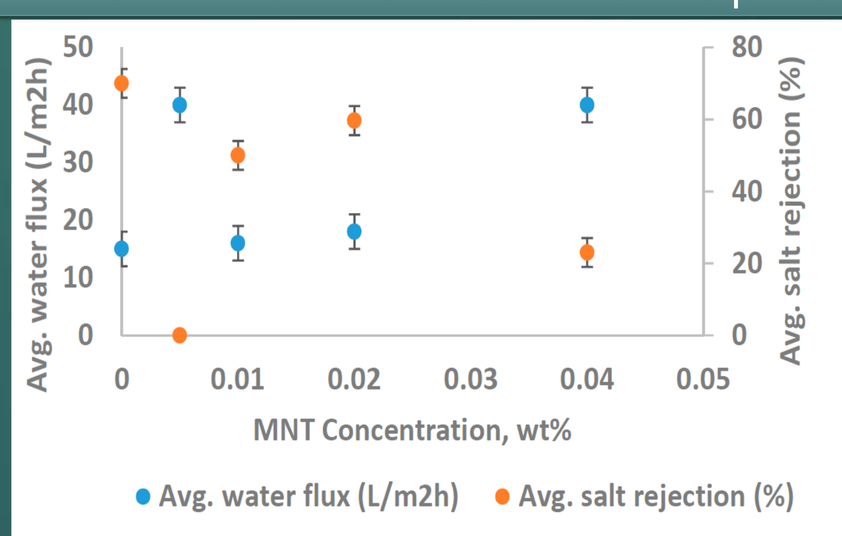
TEM results



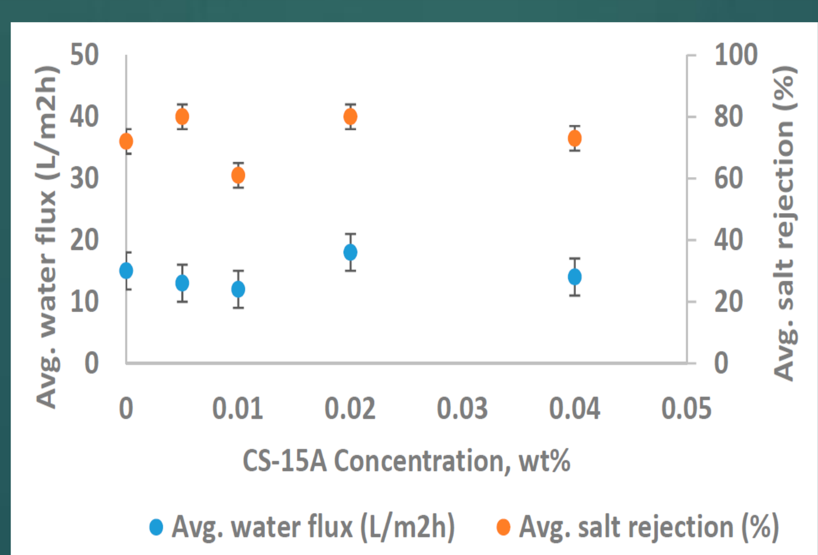
CS-15A is hydrophobic as compared to MNT, it shows better dispersion in the TMC solution, so that the uniform deposition of CS-15A occurs into the PA layer

Performance Analysis

Impact of MNT concentration on the membrane performance

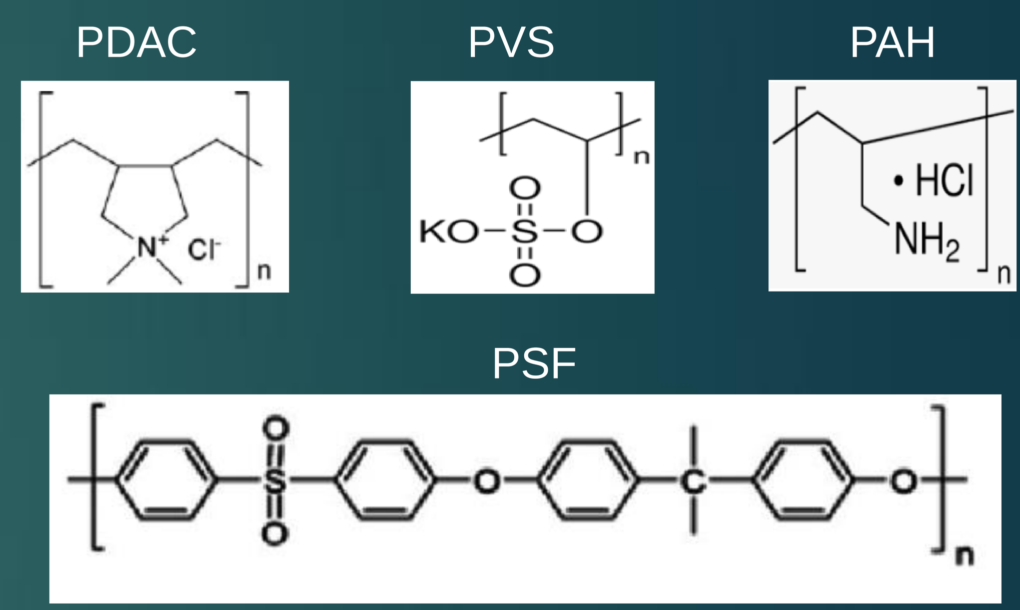


Impact of CS15A concentration on the membrane performance

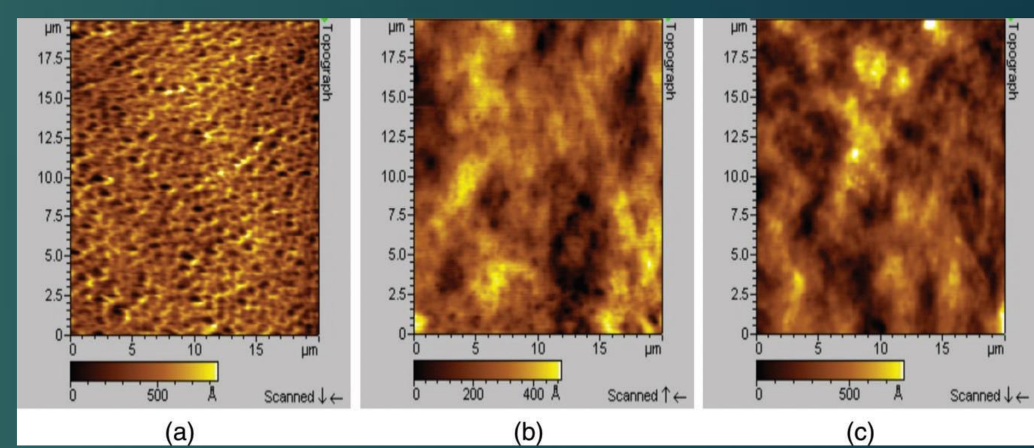


Study 2: Spin Assisted LbL Assembly

- This SA-LbL is an innovative method for the manufacture of RO desalination membrane.
- We employed the SA-LbL technique to fabricate multilayer thin films from the combination of two strong polyelectrolytes polydiallyl dimethyl ammonium chloride) (PDAC) and poly(vinyl sulfate) (PVS) and combination of weak–strong polyelectrolytes, poly(allyl amine hydrochloride) (PAH) and PVS.



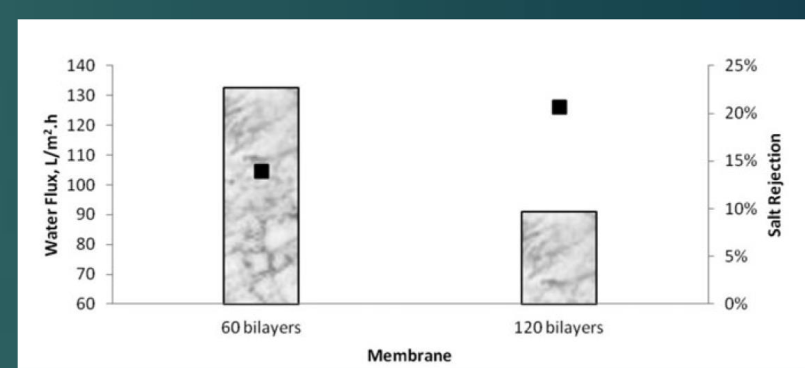
AFM Images



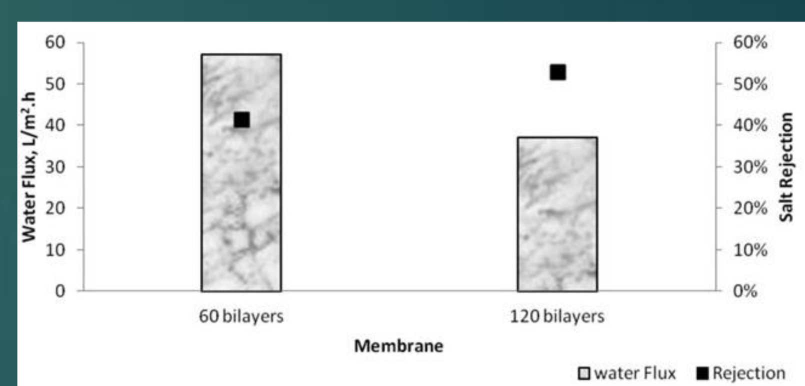
AFM images - a) uncoated PSF; (b) $[PDAC/PVS]_{60}$; (c) $[PAH/PVS]_{60}$

Permeation results

$[PDAC/PVS]_n$ - number of bilayers (n = 60 and 120)



$[PAH/PVS]_n$, - number of bilayers (n = 60 and 120)



PDAC/PVS multilayer membrane has higher water flux and lower salt rejection compared to PAH/PVS multilayer membrane at a given number of layers.

Conclusions

- The highest water flux of 40 L/m2.h with salt rejection of 80% relative to the control membrane was obtained for the membranes containing nanoclays.
- The permeation test of 120 bilayers of PAH/PVS on PSF substrate showed water flux of 37 L/(m2.h) and salt rejection of 53%, for a 2000-ppm salt solution feed

Acknowledgement

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Reference

Zaidi, Syed Javaid, et al. "Organically Modified Nanoclay Filled Thin-Film Nanocomposite Membranes for Reverse Osmosis Application." Materials 12.22 (2019): 3803.