Georgia Tech | Brook Byers Institute for Sustainable Systems

Summary of Membrane Work at the Brook Byers Institute for Sustainable Systems

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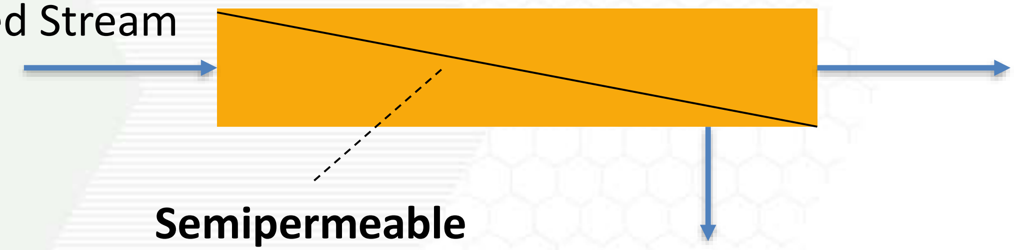
Aug 9th, 2018

Membrane Processes Introduction

- Membrane processes are physicochemical separation techniques using **differences in permeability (of water constituents)** as the separation mechanism.
- The membrane used is typically made of synthetic material less than 1mm thick and **semipermeable**.



- Our Research Directions
  - Fabrication and modification of High performance membrane Ultrafiltration and Forward osmosis membranes
  - Reduction of membrane fouling and its chemistry;
  - Membrane applications (Wastewater treatment; Desalination; Membrane bioreactor)

Research Directions

- **UF membrane** can remove small colloids and viruses by **size exclusion.**
  - ➢ Defect-free copolymer based self-assembly membrane with regular pore structure;
  - ➢ Low-fouling and low-cost PVC based membrane;
  - ➢ Tunable flux copolymer based membrane (pH-responsive membrane).

Performance Indicators:
- High flux
- High rejection rate
- Low reverse salt flux for FO
- Fouling

By target contaminant
- Suspended particles (sediment, algae, bacteria, etc)
- Dissolved solutes (Na^+, Cl^-, Ca^{2+}, NOM, etc.)

Microfiltration (MF)
Ultrafiltration (UF)
Nanofiltration (RO)
Reverse Osmosis (RO)
Forward Osmosis (FO)

By driving force
- Hydraulic pressure
- Osmotic pressure

We also study low fouling membrane for **Membrane Bioreactor (MBR)**

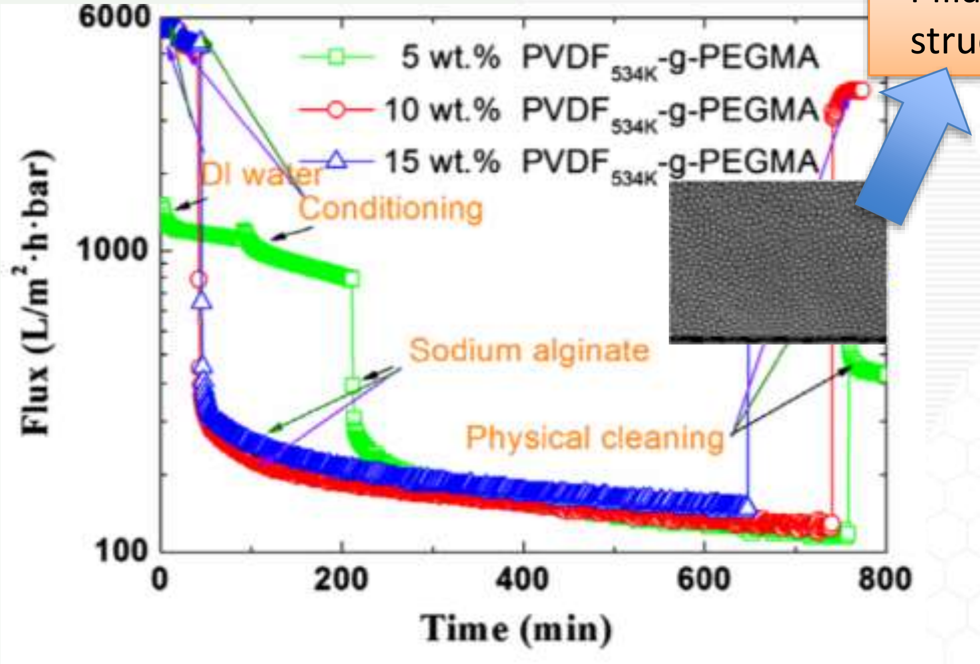
- **FO membrane** can remove dissolved solutes by diffusion differences.
  - ➢ Thin film nanocomposite membrane (with carbon nanotubes, TiO_2, GO, etc);
  - ➢ TiO_2 surface modification membrane;
  - ➢ Hydrophilic grafted copolymer based thin film composite membrane.

Membrane Technology Research Results

Ultrafiltration Membrane - Copolymer Based

Flux behavior of PVDF blending with its derivative polymer PVDF-g-PEGMA

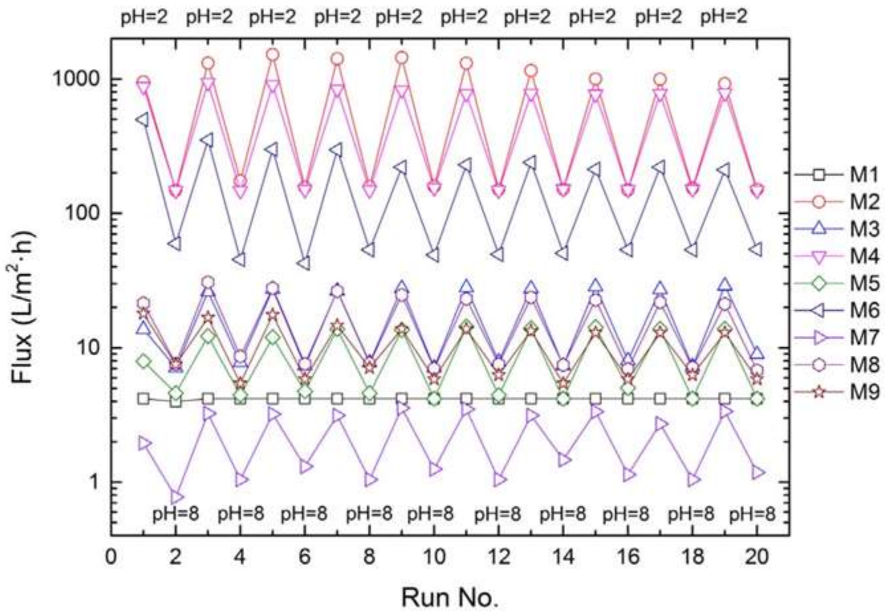
“Pillar-like” structure



- Highest pure flux: 5170 (LMH bar) under low pressure 0.07 Mpa;
- Sodium alginate(SA) rejection rate: 87%

B Liu et al., 2013

Tunable flux behavior of PVDF blending with its dericativePVDF-g-PMAA membrane



- Tunable flux between 1-2000 LMH by changing membrane solution recipe(polymer concentration, solvent etc.).
- Potential use for wide range membrane applications.

B Liu et al., 2017

Membrane Technology Research Results

Forward Osmosis - Nanocomposite Membrane

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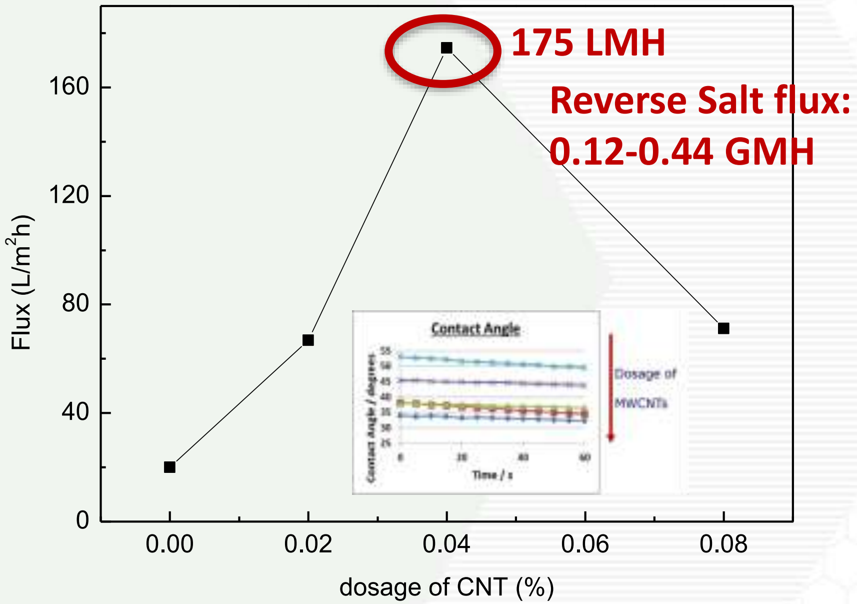
Flux behavior of COOH-MWCNT/Polyamide Thin Film Nanocomposite membrane

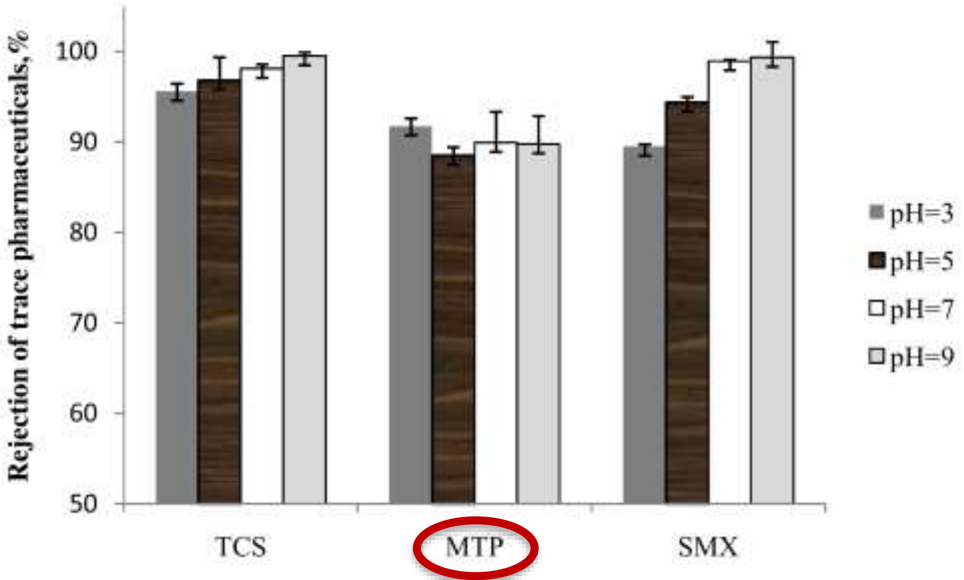


(under condition: Feed DI water; Draw 1M NaCl)

- Pure water flux was dramatically increased without sacrificing reverse salt flux;
- CNT nanocomposite membrane has the potential to overcome trade-off.

Y Li. et al., 2014

Trace pharmaceutical rejection rate of Nano-TiO_2 surface modified TFC membrane



(under condition: Feed TCS,MTP and SMX mixed solution 500ug/L; Draw 0.5M NaCl)

- Rejection of three pharmaceuticals were increased.
- For MTP, rejection rate was increased from 80% to 90%.

M Huang. et al., 2015

Membrane Technology Research Results

Low Fouling Membrane

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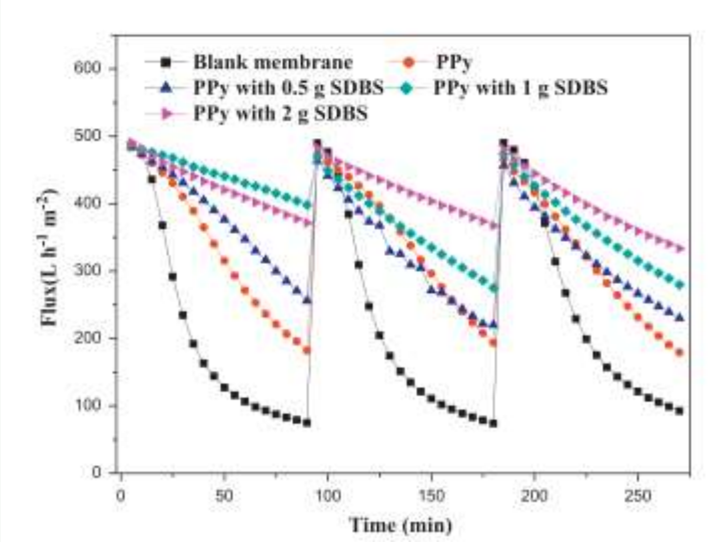
For MBR

Fouling behavior of membrane cathod with and without polypyrrole(Ppy) modification



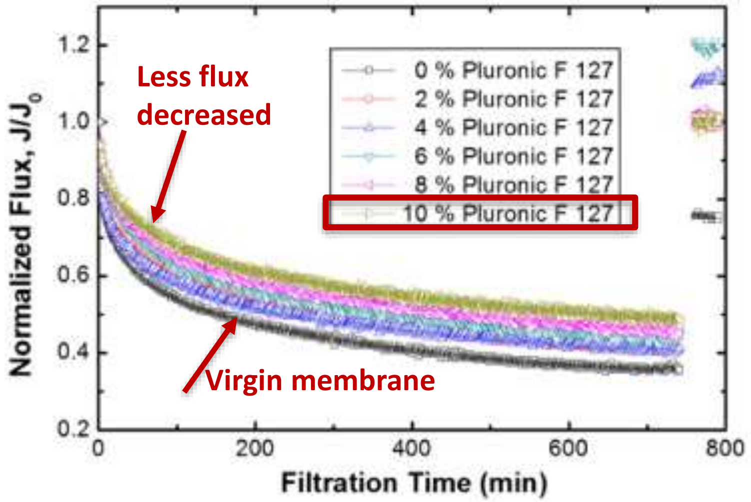
(under condition: TMP=8.14kPa, MLSS=4238 mg/L)

- Membrane electric conductivity, hydrophilicity and permeate flux were enhanced;
- Anti-fouling property was increased.

L Liu et al., 2013

For UF

Fouling behavior of membranes blending with Pluronic F-127



(under condition: TMP=10 psi, Feed = 10mM mg/L and 20 mg/L sodium alginate)

- Pluronic F-127 increased membrane hydrophilicity.
- Flux of PVC membrane with Pluronic F-127 decreased less than virgin PVC membrane.

B Liu et al., 2012