

NEW MEXICO TECH
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Produced Water and Brackish Water Treatment via Advanced Membrane Process

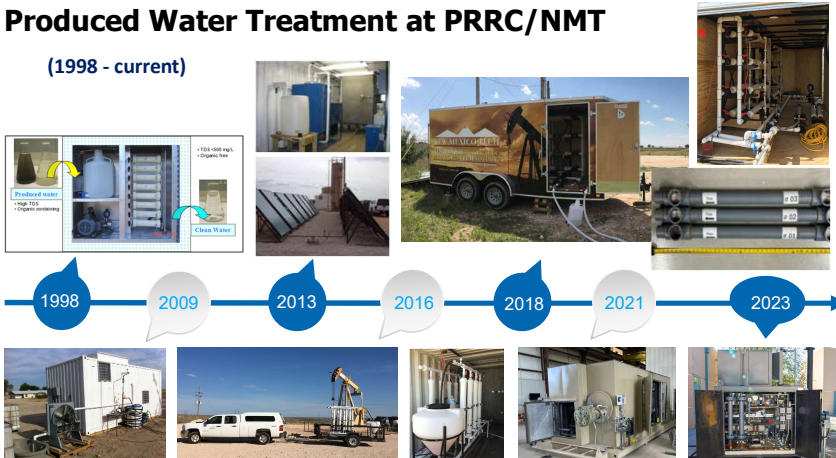
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August 11, 2026



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Produced Water Treatment at PRRC/NMT (1998 - current)



1998 2009 2013 2016 2018 2021 2023

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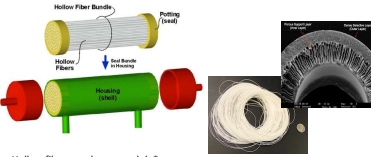
Objective: to develop **novel, portable, and scalable robust hollow fiber membrane-based separation processes** that convert brackish water and produced water into a **sustainable water resource**.

Hollow fiber membranes

- Organics removal
 - Ultrafiltration
 - Microfiltration
 - Membrane adsorption
 - Hybrid processes
- Desalination/Resource Recovery
 - Nanofiltration
 - Reverse/Forward osmosis
 - Membrane distillation
 - Hybrid processes

Compared to flat sheet membrane:

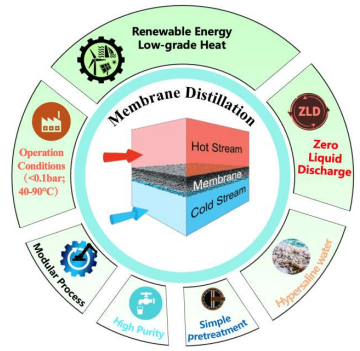
- ✓ **higher productivity per unit volume** (high packing density and large surface area)
 - For a 0.04 m³ membrane device:
 - HF membrane: 575 m² (90 mm in diameter);
 - Spiral wound flat-sheet membrane: 30 m²;
 - Tubular configuration: 5 m².
- ✓ **self-supporting**
- ✓ **small footprint, easy to scalable**



Hollow fiber membrane module*
* <https://www.permselect.com/membranes>

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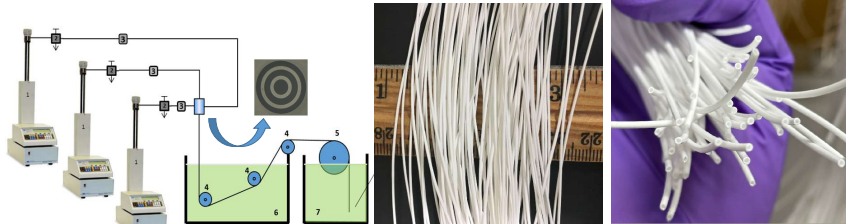
Direct Contact Membrane Distillation (DCMD)



- Very few **full-scale MD** tests have been reported in the world.
- Main challenges: (1) **lack of commercially available membranes** for particular use in DCMD; (2) energy consumption.

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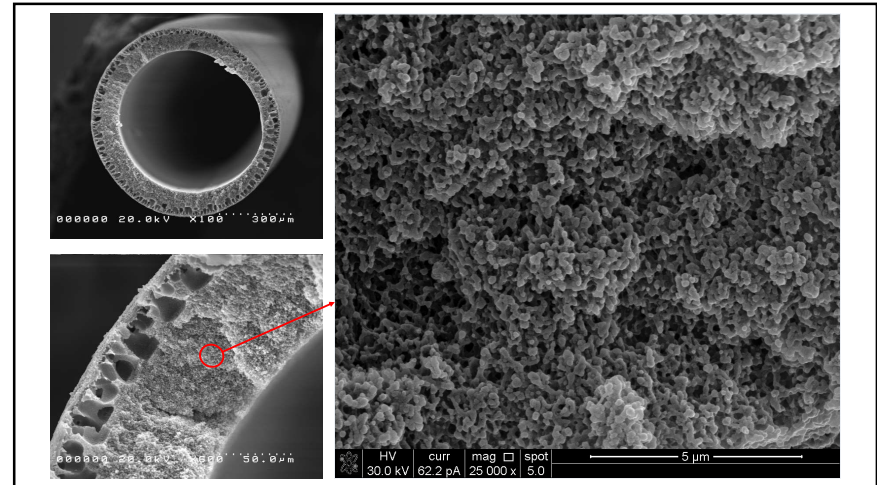
Hollow fiber membranes



Properties of the fabricated Janus hollow fiber membrane.

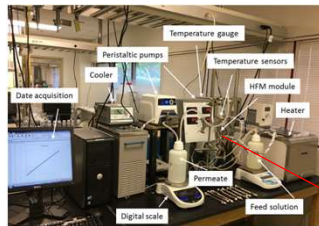
OD/ID/WT (μm)	Bulk Porosity (ϵ , %)	Effective surface porosity (ϵ_e , m^2)	Mean pore size (d_m , μm)	Bubble point pore size (d_{bp} , μm)	LEP (bar)
1088/767/135	80.6 $\pm$ 0.4	6471.3	0.27	0.40	1.95

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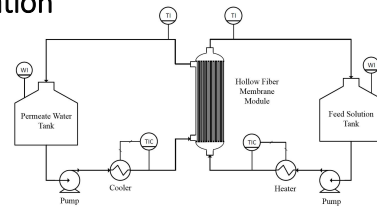


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DCMD Process for PW Desalination



Apparatus of hollow fiber membrane-based DCMD process for high-salinity brines desalination.

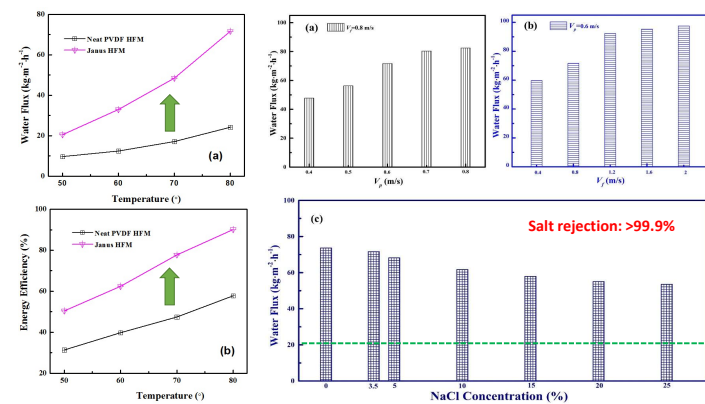


Membrane modules assembled for the DCMD experiments.



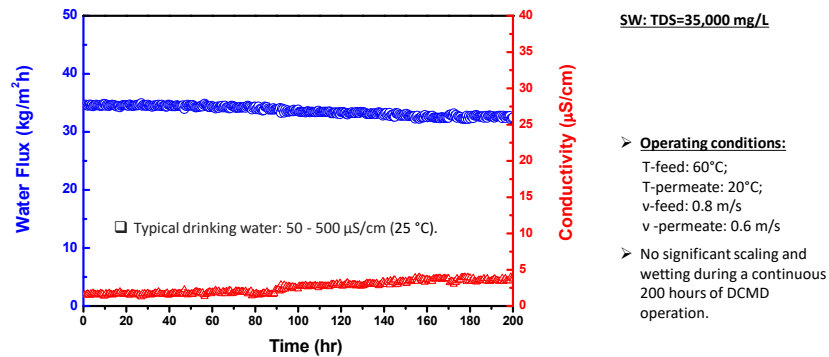
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Desalination Performance Evaluation

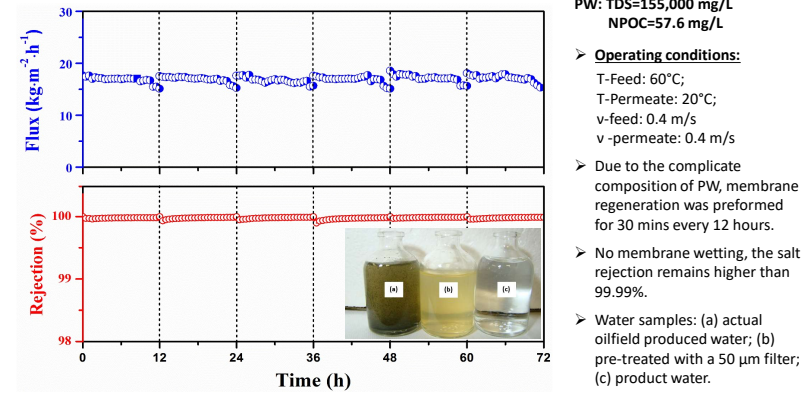


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Long-term desalination performance evaluation



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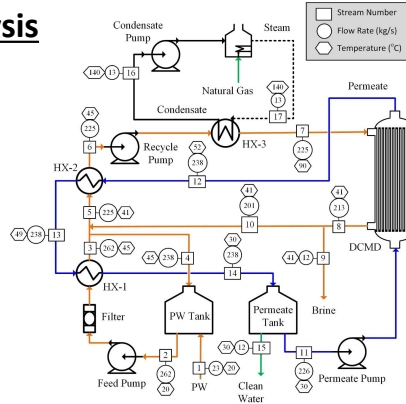


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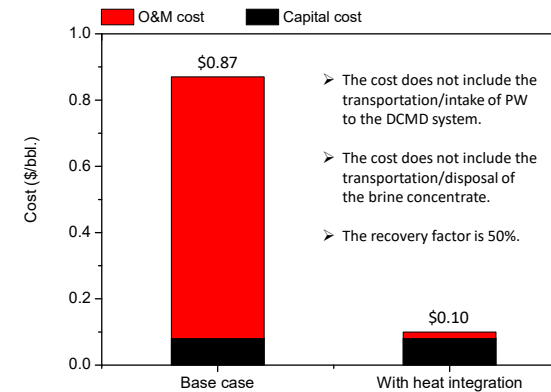
Tech-economic analysis

- Assumptions:

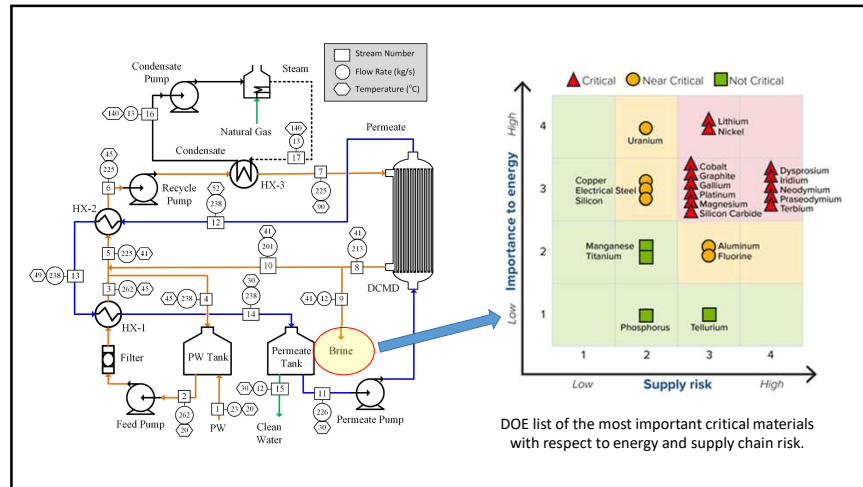
- ✓ Plant capacity: 500,000 GPD;
- ✓ Plant lifetime: 30 Years;
- ✓ Plant availability: 90%; **100,000 mg/L**
- ✓ PW - initial TDS;
- ✓ PW - concentrated brine: **200,000 mg/L**;
- ✓ PW - recovered: **<500 ppm**;
- ✓ Water recovery: **50%**;
- ✓ Membrane cost: \$20/m²;
- ✓ Membrane replacement: 20%/year;
- ✓ Pretreatment: \$80/m³/day;
- ✓ Electricity cost: \$0.069/kwh;
- ✓ Steam price: \$0.008/kg



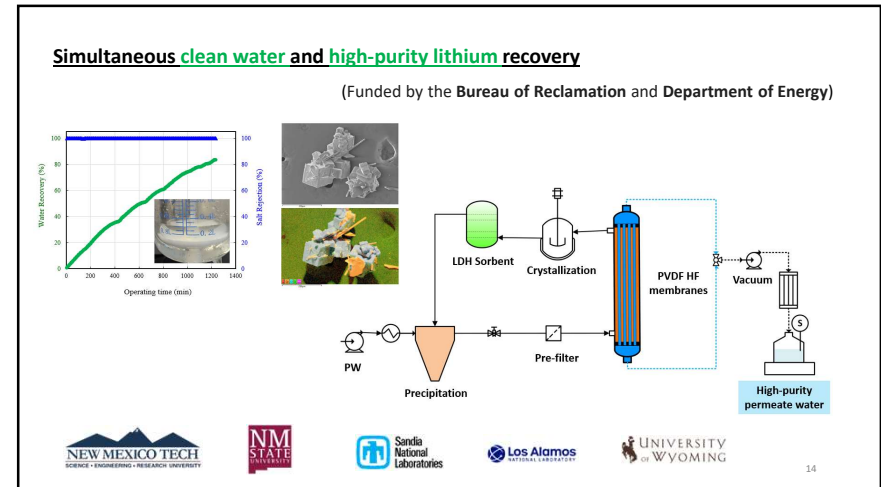
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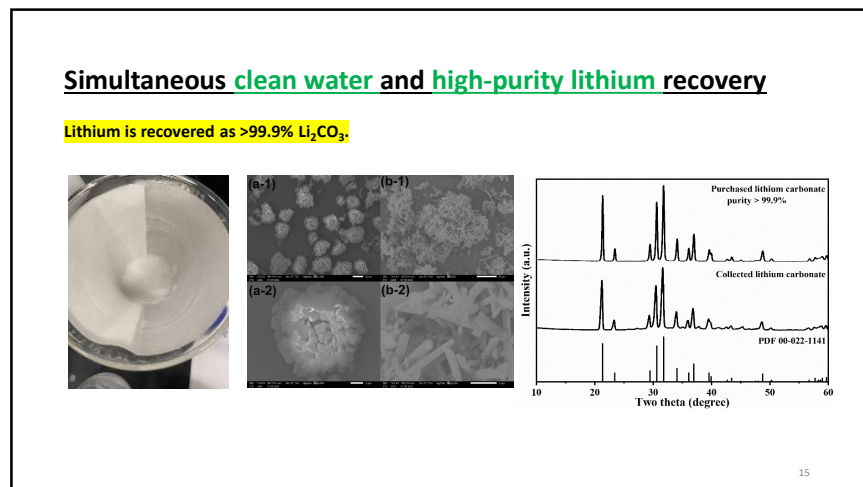
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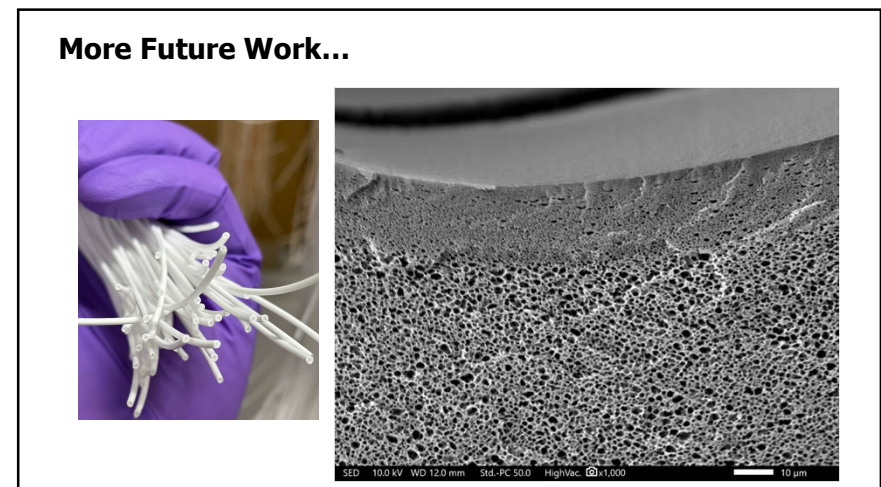
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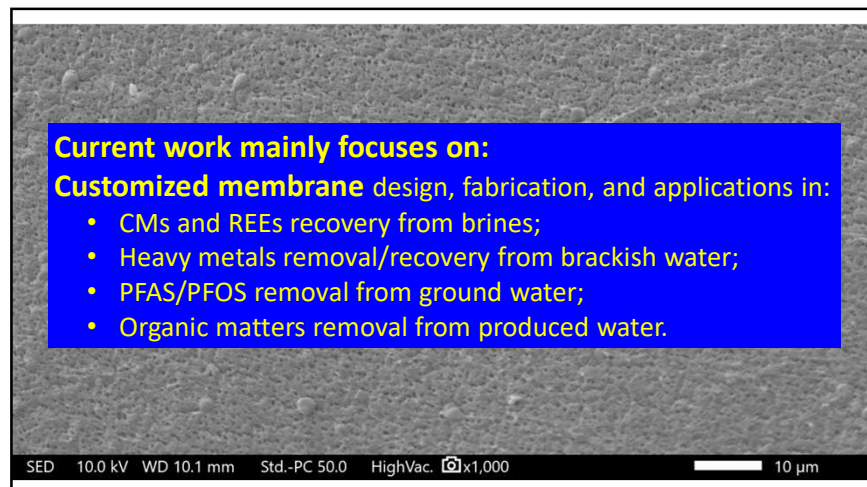
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