Fouling-Resistant Membranes for Treating Concentrated Brines

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3. Objectives – Technology Transition from Concept to Developmental Stage

Project Objectives:
- Demonstrate the efficacy of membrane distillation (MD) as a cost-savings technology to treat concentrated brines that have high levels of total dissolved solids (TDS) for beneficial water reuse.
- Develop a novel, fouling-resistant nanocomposite electrically conductive membrane that will reduce the need for chemicals to address membrane scaling due to the precipitation of divalent ions in high-TDS wastewaters.

4. Methods – CNT Modification to Develop ECMD Membranes

- Modification via CNT-OH and polyvinyl alcohol cross-linked atop a MD membrane support.
- Membranes are permanently bonded between the carboxyl groups on the CNTs and the hydroxyl groups on PVA.
- Cross-linking results in reaction that fixes the CNT network to the membrane surface. Porous network leaves original membrane permeability intact.

5. Accomplishments – Successful CNT Grafting to PVDF Membranes

- Smooth and robust: Roughness = 12 ± 2 nm
- High electrical conductivity ~2000 S/m

6. Accomplishments – ECMD Test Cell Design and Fabrication

- Schematic representation of the ECMD test cell, electrodes, and CNT modified MD membrane. Arrows indicate flow direction of the hot/cold streams. Dotted arrows represent vapor flux across MD membrane.

7. Project Status – Experimental Setup Complete, Testing In Progress

ECMD Test Bed Experimental Setup
- ECMD test cell leak-tested, commissioned, and connected to power source.
- Experimental test plan to first evaluate synthetic scaling solutions based on salts of calcium, sulfate, strontium, and barium, followed by real high TDS brines.
- Performance targets are to double flux performance time on stream (relative to no applied current) at given scaling condition.

8. Anticipated Impact and Benefits

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Ion Exchange</th>
<th>Reverse Osmosis (RO)</th>
<th>Nanofiltration (NF)</th>
<th>Crystallization</th>
<th>Membrane Distillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Expenditure</td>
<td>$3,000</td>
<td>$5,000</td>
<td>$2,000</td>
<td>$5,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>O&amp;M Expenditure</td>
<td>$1,000</td>
<td>$2,000</td>
<td>$1,000</td>
<td>$2,000</td>
<td>$1,000</td>
</tr>
<tr>
<td>Product Water TDS</td>
<td>100–500 mg/L</td>
<td>80–300 mg/L</td>
<td>100–1,000 mg/L</td>
<td>80–300 mg/L</td>
<td>120 mg/L</td>
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<tr>
<td>Salts for MD/RO/High TDS wastewater</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>1.0 kW</td>
<td>2.0 kW</td>
<td>1.0 kW</td>
<td>2.0 kW</td>
<td>1.0 kW</td>
</tr>
</tbody>
</table>

Scale formed on membranes reduces process performance, and requires chemical cleaning that significantly increase treatment costs and reduces reliability. Successfully addressing this challenge would address the operational uncertainty encountered during the treatment of these high TDS wastewaters, and has the potential to make MD a viable treatment option.

Project Period of Performance (2 years) 10/1/2014 to 9/30/2016

9. About RTI

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More Information
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