New Generation

Ceramic Membrane

SEBASTIAN ANDREASSEN, CCO
Company overview

- Manufacture Silicon Carbide (SiC) ceramic UF membranes for OEM’s & System integrators within:
  - *Drinking water*
  - *Industrial waste/process water*
  - *Pre-RO*
  - *Produced water*
- Production facilities in Denmark - capacity of 70,000 m²/year
- Patented membrane technology
What our membranes do

Permeates:
- Clean water
- TDS

Rejects:
- TSS
- Turbidity
- Bacteria
- Oil
- Micro-organisms
Why use membranes?

• Recycling waste water (RO feed quality)
• Improved filtration performance
  • Sandfilters (20-300 µm)
  • Cartridge filters (low TSS and high replacement rate)
• Mechanical separation to avoid use of polymer based chemicals
• Robustness towards upsets in the feed water
Troubled water
Unique value propositions of our membrane

**Hydrophilic** → clean water flux of 2,500 Gallons/ft$^2$/day @ 14.5 psi

**Anti-clogging** → membrane repels negatively charged particles

**Chemically inert** → no degradation of membrane from any chemical or solvent

**Durable and robust** → 9 on Vickers hardness and can endure temperature of up 1,470°F
Product scope

- UF Silicon Carbide flat sheet
- Removes: NTU, TSS, Oil, Bacteria
- Outside-in filtration
- Asymmetric structure
- 50 sheets in vertical position
- 7,25 m² module
- Submersible
- 6 mm distance between sheets
- Embedded air-scouring module
- Compact: 200m²/m² footprint
- Framing of air-bubbles for optimal flux
- Stackable system
Cembrane installations
## Notable references

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity [GPH]</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>275 (38,500)</td>
<td>Drinking water from well</td>
</tr>
<tr>
<td>China</td>
<td>11,780</td>
<td>Pre-RO Semiconductor plant</td>
</tr>
<tr>
<td>Italy</td>
<td>385</td>
<td>MBR industrial</td>
</tr>
<tr>
<td>UAE</td>
<td>2,750</td>
<td>MBR from edible oil plant</td>
</tr>
<tr>
<td>United States</td>
<td>35,200</td>
<td>Produced water</td>
</tr>
<tr>
<td>United States</td>
<td>771</td>
<td>MBBR semiconductor</td>
</tr>
<tr>
<td>China</td>
<td>5,500</td>
<td>Laundry Water</td>
</tr>
<tr>
<td>South Africa</td>
<td>3,850</td>
<td>Drinking water from Surface</td>
</tr>
</tbody>
</table>
Produced water installation North America

- **Capacity:** 35,200 GPH
- **Purpose:** Removal of Ca$_2$Co$_3$ (3.5%) before Reverse osmosis
- **Challenge:** High scaling potential from barium, strontium, sulphates
- **Process:** Natural gas well $\rightarrow$ DAF $\rightarrow$ Aeration $\rightarrow$ Lime softening $\rightarrow$ UF $\rightarrow$ RO
Recycling semiconductor waste water from wafer production

Application overview
- Pre-RO Semiconductor UltraPure water plant
- Capacity: 11,780 GPH
- Flux rate: 300 GFD (500 LMH)
- pH: 9-10

Feed:
- 1.500 ppm Hydroflouric acid (HF)
- 100 ppm Hydrogen peroxide (H₂O₂)
- 300 ppm NH₃
- 20 ppm TSS MnO₂ + SiO₂
Replacement of PES membrane at edible oil plant, UAE

Process

- DAF \( \rightarrow \) Aeration \( \rightarrow \) UF \( \rightarrow \) RO
- MLSS: 4,000 ppm
- Temp: 100°F - 113°F
- Oil content: <50 ppm
- Capacity: 2,750 GPH
- Flux: 50 Gallons/ft\(^2\)/day
Manganese removal from ground water well Sweden

Pilot duration: 2 months - aim to replace sandfilters 38,500 GPH

Temperature: 40-50° F

Target: Removal of Mn from 0,13 ppm to below 0,05 ppm

Pre-treatment: KMnO₄ dosage to oxidize Mn

Results:

- Flux rate: 338 Gallons/ft²/day (575 LMH)
- Mn: <0,02 ppm
- Fe: <0,02 ppm
- Turbidity: <0,1 NTU
- BW frequency: Every 12 hours
- Recovery rate: >99%

Precipitated Fe & Mn deposited on membranes

<table>
<thead>
<tr>
<th>Analysresultat</th>
<th>Analys/Undersökning av</th>
<th>Resultat</th>
<th>Motsäkerhet</th>
<th>Enhet</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-EN ISO 11885-2:2009</td>
<td>Mangan, Mn</td>
<td>&lt;0.02</td>
<td>±0.003</td>
<td>mg/l</td>
</tr>
<tr>
<td>SS-EN ISO 11885-2:2009</td>
<td>Natrum, Na</td>
<td>13</td>
<td>±0.2</td>
<td>mg/l</td>
</tr>
<tr>
<td>Beräknad</td>
<td>Härhet tyska grader</td>
<td>4.6</td>
<td>±0.09</td>
<td>°dH</td>
</tr>
</tbody>
</table>

Bedömning: TJÄNLIGT (Quality: Potable)
## Technology Comparison 23,750 m³/d plant capacity

Rehabilitation of existing Groundwater Lime Soda-Ash Softening & Sand Filter Plant

### Project Costs CAPEX & OPEX [Mio. SAR]

<table>
<thead>
<tr>
<th>Technology</th>
<th>Lime Soda-Ash Softening &amp; Sand Filter</th>
<th>HMO &amp; Ceramic Flat Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPEX</strong></td>
<td>0.00 SAR</td>
<td>12.38 MM SAR</td>
</tr>
<tr>
<td></td>
<td>Existing operating plant which requires no capital expenditure</td>
<td>Removal of existing sand media, sand filter basin civil works modifications, implementation of total new equipment (piping, filtration pumps, instrumentation…), Ceramic Flat Membrane equipment, modifications of existing electric &amp; control Source: Bidding contractors</td>
</tr>
<tr>
<td><strong>OPEX</strong></td>
<td>1.11 SAR/m³ Chemical costs for Lime and Soda-Ash, power consumption, sand media replacement; Chemical consumptions set that equal filtered water quality to HMO &amp; Ceramic Flat Membrane is achieved (equal removal) Source: Plant operator / plant owner</td>
<td>0.15 SAR/m³ HMO chemical consumption, Ceramic Flat Membrane chemical cleaning, power consumption, complete service / maintenance / replacement of Ceramic Flat Membrane Source: Bidding Ceramic Flat Membrane providers</td>
</tr>
</tbody>
</table>
Thank you for your attention

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