HOLLOW FIBER VS. FLAT SHEET TECHNOLOGY

(A CASE STUDY)

Presented By: Samer K. Mazloum
OVERVIEW

• MEMBRANE TECHNOLOGY OVERVIEW.

• ACTUAL DESIGN CASE STUDY COMPARISON.
MEMBRANE CONFIGURATIONS

Reinforced Hollow Fiber

Non-Reinforced Hollow Fiber

Flat Plate Sheet

Spiral Wound Sheet
FLAT SHEET TECHNOLOGY

• Immersed Membrane
• Microfilter (0.4 Nominal Pore Size)
• PVC Membrane Chemistry.
• Recognized for Title 22 in California (Water Re-use)

Cross Flow Filtration
Mixed liquor flows parallel to the membrane surface, while water permeates through the membrane. Cross flow prevents the membrane surface from fouling.
MEMBRANE PLATES

- Both types of cartridges are placed into the case as shown.
- Both types of cartridges are used for the same type applications.
FLAT SHEET CONFIGURATION

K-400 Double Stack

E-150 Single Stack

Separate Headers for top & bottom membranes
FLAT SHEET MEMBRANES

Single Plate Membrane Case
INSTALLATION AND ORIENTATION

Lifting tool
A tool for easily keeping balance when the submerged membrane unit is lifted up and down.

Guide groove

Guide tool
To be used for fitting the submerged membrane unit into the guide rail.

Guide rail
To be used for lifting up and down the submerged membrane unit. Fitting the guide groove on the side of the submerged membrane unit into the guide rail.

Single Plate Membrane Case
FINAL ARRANGEMENT

Installation example of submerged membrane unit, Type A

Single Plate Membrane Case
HOLLOW FIBER CONFIGURATIONS

- Minimal prescreening
- Infrequent cleaning
- Mild cleaning required to keep fiber exterior clean
HOLLOW FIBER TECHNOLOGY

- Reinforced Hollow Fiber
- NSF Certified Ultrafiltration (UF)
- Outside – In Flow
- Immersed Shell-less Technology
- Recognized for Title 22 in California (Water Re-use)
HOLLOW FIBER MAGIFICATION

PORE SIZE
0.04 micron (average)
0.1 micron (maximum)

Electron microscope view of the UF membrane surface
BASIC HOLLOW FIBER MEMBRANE MODULE

Cassette Building Block (4 Hollow Fiber Elements)
HOLLOW FIBER SLIDING ELEMENT ARRANGEMENTS
HOLLOW FIBER MEMBRANE INSTALLATION

Concrete Tank Section with Backwash Troughs
HOLLOW FIBER MEMBRANE INSTALLATION
HOLLOW FIBER MEMBRANE INSTALLATION

CONCRETE TANK SECTION WITH PIPING
HOLLOW FIBER MEMBRANE INSTALLATION

CONCRETE TANK SECTION COMPLETE WITH HANDRAILS & GRATING
ZW 2000 Concrete Tank
Detail: Permeate and Air Headers

- Permeate isolation valve
- Air release valve
- Pressure transmitter
- Air solenoid valve
- Norma connector
HOLLOW FIBER MEMBRANE INSTALLATION

ZW2000-3x16 cassettes (typical of 6)

ZW 2000 – ZenoBox Design
FINAL ARRANGEMENT
BACKPULSE CAPABILITY

**Reinforced Hollow Fibre**
- Full Backpulse Capability (if needed) to control fouling
- Air Scouring is used to control fouling

**Flat Sheet**
- Unable to backpulse membranes
- Air Scouring is used to control fouling
MEMBRANE CLEANING

Reinforced Hollow Fiber
- Up to 2000 ppm NaOCl
- Citric Acid
- Maintenance Cleaning once per 1-2 weeks
- Recovery Cleaning 2-3 times per year

Flat Sheet
- Up to 5000 ppm NaOCl
- Oxalic Acid
- Recovery Cleaning 2-3 times a year
BASIC MEMBRANE TERMINOLOGY

• Flux
  – Flow rate per membrane area
  – Measured as Liters per m² per hour (lmh) or gallons per ft² per day (gfd)

• Trans-membrane Pressure (TMP)
  – Pressure difference across the membrane
  – Measures the relative degree of membrane fouling

• Permeability
  – Flux rate per unit pressure (lmh/bar or gfd/psi)
ACTUAL CASE STUDY

• Project Name: Almarai CPP2 ETP
• Location: Alkharj – Haradh Road
• Type: Dairy Waste Treatment

The Existing conventional system handles maximum peak flow of 2000 m3/day and 4100 KgCOD/day.

The upgrade strategy is to allow to handle the following design, keeping minimum footprint and optimum cost.
### ALMARAI DESIGN CRITERIA

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<thead>
<tr>
<th></th>
<th>2011</th>
<th>2016</th>
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<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Peak</td>
</tr>
<tr>
<td>CPP1, Volume m³/day</td>
<td>1,520</td>
<td>1,900</td>
</tr>
<tr>
<td>CPP2, Volume m³/day</td>
<td>1,040</td>
<td>1,300</td>
</tr>
<tr>
<td>Total Volume m³/day</td>
<td>2,560</td>
<td>3,200</td>
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<tr>
<td>CPP1, Load kgCOD/day</td>
<td>4,800</td>
<td>7,000</td>
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<tr>
<td>CPP2, Load kgCOD/day</td>
<td>2,200</td>
<td>3,000</td>
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<tr>
<td>Total Load kgCOD/day</td>
<td>7,000</td>
<td>10,000</td>
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## DESIGN COMPARISON

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
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<th>Note</th>
<th>Flat Sheet</th>
<th>Note</th>
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<tbody>
<tr>
<td></td>
<td><strong>Design Basis</strong></td>
<td></td>
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<tr>
<td>1</td>
<td>Average flow 2011</td>
<td>2,560 m³/day</td>
<td>permeate</td>
<td>2,560 m³/day</td>
<td>feed</td>
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<tr>
<td>2</td>
<td>Peak flow 2011</td>
<td>3,200 m³/day</td>
<td>permeate</td>
<td>3,200 m³/day</td>
<td>feed</td>
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<td>3</td>
<td>Average flow 2016</td>
<td>3,280 m³/day</td>
<td>permeate</td>
<td>3,280 m³/day</td>
<td>feed</td>
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<td>4</td>
<td>Peak flow 2016</td>
<td>4,100 m³/day</td>
<td>permeate</td>
<td>4,100 m³/day</td>
<td>feed</td>
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<tr>
<td>5</td>
<td>Average COD 2011</td>
<td>7,000 Kg/day</td>
<td></td>
<td>7,000 Kg/day</td>
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<tr>
<td>6</td>
<td>Peak COD 2011</td>
<td>10,000 Kg/day</td>
<td></td>
<td>10,000 Kg/day</td>
<td></td>
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<tr>
<td>7</td>
<td>Average COD 2016</td>
<td>8,400 Kg/day</td>
<td></td>
<td>8,400 Kg/day</td>
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<tr>
<td>8</td>
<td>Peak COD 2016</td>
<td>12,000 Kg/day</td>
<td></td>
<td>12,000 Kg/day</td>
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<tr>
<td>9</td>
<td>Liquid feed temperature</td>
<td>20 °C</td>
<td></td>
<td>37 °C</td>
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<tr>
<td>10</td>
<td>Max liquid feed Temp.</td>
<td>42 °C</td>
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<td>42 °C</td>
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# MEMBRANE OFFER COMPARISON

<table>
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<th>Flat Sheet</th>
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<tbody>
<tr>
<td>1</td>
<td>Membrane type</td>
<td>ZeeWeed 500C</td>
<td></td>
<td>EK-400</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>unit surface area</td>
<td>23 m²</td>
<td></td>
<td>320 m²</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>No. of units per cassette</td>
<td>22</td>
<td></td>
<td>1</td>
<td>400 memb</td>
</tr>
<tr>
<td>4</td>
<td>No of cassets per train</td>
<td>3</td>
<td>expandable to 4</td>
<td>6</td>
<td>expandable to 8</td>
</tr>
<tr>
<td>5</td>
<td>no of trains</td>
<td>4</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Total effective area</td>
<td>6072 m²</td>
<td></td>
<td>3840 m²</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>pore size</td>
<td>0.04 um</td>
<td></td>
<td>0.4 um</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Design Net flux at Average flow</td>
<td>17 L/m².hr</td>
<td>0.408 m³/m².day</td>
<td>0.67 m³/m³.day</td>
<td>27.9 L/m².hr</td>
</tr>
<tr>
<td>9</td>
<td>Design Net flux at Peak flow</td>
<td>21.7 L/m².hr</td>
<td>0.5208 m³/m².day</td>
<td>0.83 m³/m².day</td>
<td>34.5 L/m².hr</td>
</tr>
<tr>
<td>10</td>
<td>Design net flux at chemical cleaning</td>
<td>22.7 L/m².hr</td>
<td>0.5448 m³/m².day (one train - 3 cassettes)</td>
<td>0.89 m³/m².day</td>
<td>37.037 L/m².hr (one deck - 3 units)</td>
</tr>
<tr>
<td>11</td>
<td>Design net flux at chemical cleaning</td>
<td>29.27 L/m².hr</td>
<td>0.7026 m³/m².day (one train - 3 cassettes)</td>
<td>1.11 m³/m².day</td>
<td>46.25 L/m².hr (one deck - 3 units)</td>
</tr>
<tr>
<td>12</td>
<td>Maximum TSS in MBR tank</td>
<td>15,000 mg/l</td>
<td></td>
<td>20,000 mg/l</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Parameter</td>
<td>Hollow Fiber</td>
<td>Note</td>
<td>Flat Sheet</td>
<td>Note</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------------------</td>
<td>------------</td>
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</tr>
<tr>
<td></td>
<td>Equipment spec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MBR air blowers</td>
<td>3 No. (2d/1s) - 1367 Nm3/hr @ 31 Kpa - VSD controlled (1025 Nm3/Hr for 2011)</td>
<td></td>
<td>3no. (2duty/1std. by) - 1250 Nm3/hr @ 55 Kpa - VSD controller</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Recycle pumps</td>
<td>4 no. (1 for each tank) - 274 m3/hr @ 120 Kpa TDH (221m3/hr for 2011)</td>
<td></td>
<td>3 no. 39 l/s @ 2m Head</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vacumm pumps</td>
<td>2nos 17m3/hr @ 74 Kpa vacuum</td>
<td></td>
<td></td>
<td>N/A</td>
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<tr>
<td>4</td>
<td>Permeate pumps</td>
<td>4 nos. one for each tank - duty point ranges from 31 m3/hr @ 105 kpa TDH to 72 m3/hr @ 105 Kpa TDH</td>
<td></td>
<td></td>
<td>N/A</td>
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# MBR BASIN COMPARISON

<table>
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<tr>
<th>No.</th>
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<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MBR Tanks</td>
<td>4 Nos (6mX3mX3.5m)</td>
<td>LXWXH</td>
<td>2 Nos (8.3mX4.1mX4.8m)</td>
<td>LXWXH</td>
</tr>
</tbody>
</table>

- **Flat Sheet**: 68 m²
- **Hollow Fiber**: 72 m²
For same average flux consideration (0.408 m³/m².day), Flat Sheet would require:

\[
\frac{2560 \text{ m}^3/\text{day}}{320 \text{ m}^2 \times 0.408 \text{ m}^3/\text{m}^2.\text{day}} = 19.6 \text{ elements, say 18 elements, which would result in a third basin as follows}
\]
THANK YOU

Q & A