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Gas Permeable Membranes for Use in Deaeration

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Water Standard
Deaeration Technology

Why remove dissolved oxygen from water?

- Mitigate corrosion
- Minimize bacterial growth
- Extend the lifespan of equipment and pipelines
- Preserve the integrity of unique assets (e.g. offshore reservoirs)

Why MDA?

- Significantly reduce size and weight of equipment
- Superior dissolved oxygen removal performance
- Reliable operation and low maintenance
- Reduced chemical consumption

- Flexible and modular for quick installation and easy retrofit
- Competitive capital cost
- Minimize operating and life cycle costs
Technology Overview

Hollow fiber membranes remove gases from liquids:

- Liqui-Cel technology by 3M, commercially proven in industrial applications
- Liquid passes over the outside (shell) of hydrophobic membranes
- Dissolved oxygen is stripped using vacuum pumps and sweep gas inside the membrane fibers (lumens)

Advantages:

- Dissolved oxygen removal below 10 ppb
- Uninterrupted operation during cleanings
Offshore Water Injection

Technology Comparison

- MDA offers size, weight, and cost savings relative to vacuum towers.
- Example: 125,000 bbl/day (828 m³/hr) system
  - Size: 60%↓
  - Dry weight: 65%↓
  - Operating weight: 65%↓
  - CAPEX and OPEX: ~20%↓
MDA Applications

Remove oxygen from the following process streams:

- Oil reservoir injection water
- Water for gas turbine direct injection or washing
- Crude oil desalter wash water
- Boiler feed makeup water
- Other process/utility water
How it works

MDA TECHNOLOGY
MDA Technology

MDA Core Components

- Liqui-Cel Membrane Contactors
- Vacuum Pumps
- Nitrogen Generator
Lliqui-Cel Membrane Contactors

- Microporous hollow fiber array
- Hydrophobic material restricts water passage to gas side of membrane
- Allows pressurized operation and water recovery of 100%
- Removes dissolved oxygen to < 10 ppb without chemical oxygen scavenger
- Increased surface area for gas/liquid contact enables facility size reduction
- Installed in standard reverse osmosis pressure vessel (ASME code, 20 barg design pressure)
Vacuum Pumps

- Liquid ring vacuum type
- Once-through or recirculating seal water supply
- Separator tank
- Vacuum pressure of 50 – 100 mmHg(a) to balance treatment efficiency and size
Nitrogen Generator

- Pressure swing adsorption type
- Purity of 99.9%+ to optimize dissolved oxygen removal performance
- Dry air supply of ~4:1 feed air to generated nitrogen
Standard and Customized Packages

- **Standard Packages**: 30,000 – 80,000 bbl/day (200 – 530 m³/hr)
- Flexible and modular designs
- Packages can be multiplied or customized to meet flow rates outside of this range

### MDA® Product Detail

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity (bbl/day)</th>
<th>Weight (kg)</th>
<th>Footprint (m²)</th>
<th>Power (kW)</th>
<th>Nitrogen Purity</th>
<th>Vacuum Pressure (Torr)</th>
<th>Outlet Dissolved Oxygen (ppb)</th>
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<tbody>
<tr>
<td>WS MDA 4x4</td>
<td>30,000</td>
<td>5,600</td>
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- Membrane skid package with ASME coded pressure vessels
- Vacuum pump skid package
- Nitrogen generator package
- Piping, valves, instrumentation, and controls
- Optional Clean-in-Place package with tank, pumps, and filters
Offshore Gulf of Mexico (GoM) Project

- Reverse Osmosis (RO) and Membrane Deaeration (MDA) coupled with a demineralization process using Electrodionization (CEDI)
Questions?
Contact

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