OPUS®
Optimized Pretreatment and Unique Separation Technology for Surface Water Discharge or Reuse
OPUS® technology is a proprietary Optimized Pretreatment and Unique Separation process for desalination of feed water with high concentrations of silica, organics, hardness, heavy metals, boron and particulates.

OPUS® technology utilizes a reverse osmosis process operated at an elevated pH. By combining a proprietary high-rate chemical softening process known as MULTIFLO™ with filtration, ion exchange and reverse osmosis, this unique technology generates high quality water with a low waste volume.

Benefits
- Meets Stringent Discharge Standards
- High Water Recovery Rate
- Low Waste Volume
- Reliable Operation with Minimal Downtime
- Ability to Handle Variations in Feed Water Quality
- Effective Control of Fouling due to Organics and Particulates
- Effective Control of Scaling due to Calcium Salts, Silica and Metal Precipitates
- High Salt Rejection
- Continuous Clean-In-Place Process
- Low Energy Consumption

Guaranteed Performance
Veolia Water Solutions & Technologies offers a performance guarantee after testing of OPUS® technology in our mobile pilot system. Our pilot units, capable of treating 20 gallons per minute (685 barrels per day), are deployed to your site to demonstrate the process for your water characteristics before the full-scale system is designed, enabling us to optimize performance and minimize cost. Long-term operation & maintenance contracts are also available to ensure continued optimization of your system and extend the performance guarantee for the life of the contract.

Technology Description
The OPUS® technology consists of multiple treatment processes, involving chemical softening, media filtration, ion exchange softening and reverse osmosis (RO) technologies. The pretreatment processes ahead of the RO are designed to reduce the hardness, metals and suspended solids in the feed water. The RO process operates at an elevated pH, which effectively controls biological, organic and particulate fouling, eliminates scaling due to silica, and increases the rejection of silica and boron.

On feedwater applications with high dissolved gases and excess alkalinity, the feed water is subjected to degasification with the addition of an acid to reduce the quantity of solids generated in the downstream chemical softening process and the alkali demand associated with raising the pH. The degasified water is then softed in a multi-stage process using a proprietary high-rate chemical softening and thickening technology called MULTIFLO™ process.

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Flexible Project Delivery
Our project delivery can be tailored to your purchasing preferences:
- Engineer / Procure
- Design / Build
- Design / Build / Operate / Maintain
- Design / Build / Own / Operate / Maintain

Applications
- Mining
  Zero Liquid Waste Systems
- Power
  Cooling Tower Blowdown Treatment
  Cooling Tower Make-Up Water
- Industrial Wastewater Reuse
  Zero Liquid Waste Water Reuse
- Oil and Gas
  Produced Water Treatment
  Refinery Wastewater Treatment

Typical Performance Data

<table>
<thead>
<tr>
<th>Constituent Type</th>
<th>Feed Water</th>
<th>First Pass Brackish RO Permeate</th>
<th>Second Pass Brackish RO Permeate</th>
<th>% Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids, mg/l</td>
<td>6,500</td>
<td>538</td>
<td>25</td>
<td>99.6%</td>
</tr>
<tr>
<td>Total Hardness, BDL as CaCO3, mg/l</td>
<td>242</td>
<td>&lt;0.01</td>
<td>&lt;0.5</td>
<td>&gt;99.9%</td>
</tr>
<tr>
<td>Silica, mg/l</td>
<td>240</td>
<td>9.5</td>
<td>0.30</td>
<td>99.9%</td>
</tr>
<tr>
<td>Boron, mg/l</td>
<td>26</td>
<td>13</td>
<td>0.15</td>
<td>99.4%</td>
</tr>
<tr>
<td>Total Organic Carbon, mg/l</td>
<td>80</td>
<td>3.0</td>
<td>0.80</td>
<td>99.0%</td>
</tr>
<tr>
<td>Total Suspended Solids, BDL</td>
<td>100</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&gt;99.9%</td>
</tr>
</tbody>
</table>

BDL - Below Detection Limit

This process utilizes a proprietary draft tube mixing technology to assist in the formation of crystalline solids. These dense solids (6 to 10% by weight) are then removed in a settling zone using lamella plates.

The water from MULTIFLO™ process is then further treated with the media filtration, ion exchange softening, and cartridge filtration to reduce the hardness, metals and suspended solids to lower concentrations, without pH correction. Removal of total hardness and metals in the feed water eliminates the potential for scaling of the RO membranes due to calcium carbonate, calcium sulfate, calcium fluoride, barium sulfate, strontium sulfate, iron and manganese precipitates. The pretreated water is then pressurized through an RO system, operated at an elevated pH in either single pass or double pass mode, to reduce the total dissolved solids, silica, boron, and organics present in the feed water.
Veolia Water Solutions & Technologies is committed to delivering sustainable solutions and resource recovery based on three key principles:

**Service** is what we provide our customers. We offer customer care at its best, not only through operation and maintenance contracts and asset management, but also aftermarket field services and Hydrex™ chemicals.

**Value** is what we create for our customers. We seek opportunities for recycle and reuse of resources, product recovery and energy production as part of our water treatment processes. For each project, we look for ways to add value for our customers.

**Responsibility** is the cornerstone of all our business activities. As part of Veolia Environnement, the world’s largest environmental company, we understand the importance of our social responsibility to protect the resources of our planet for future generations. We utilize tools such as Carbon Footprint evaluation and Water Impact Index to help our customers achieve their corporate sustainability goals.

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