

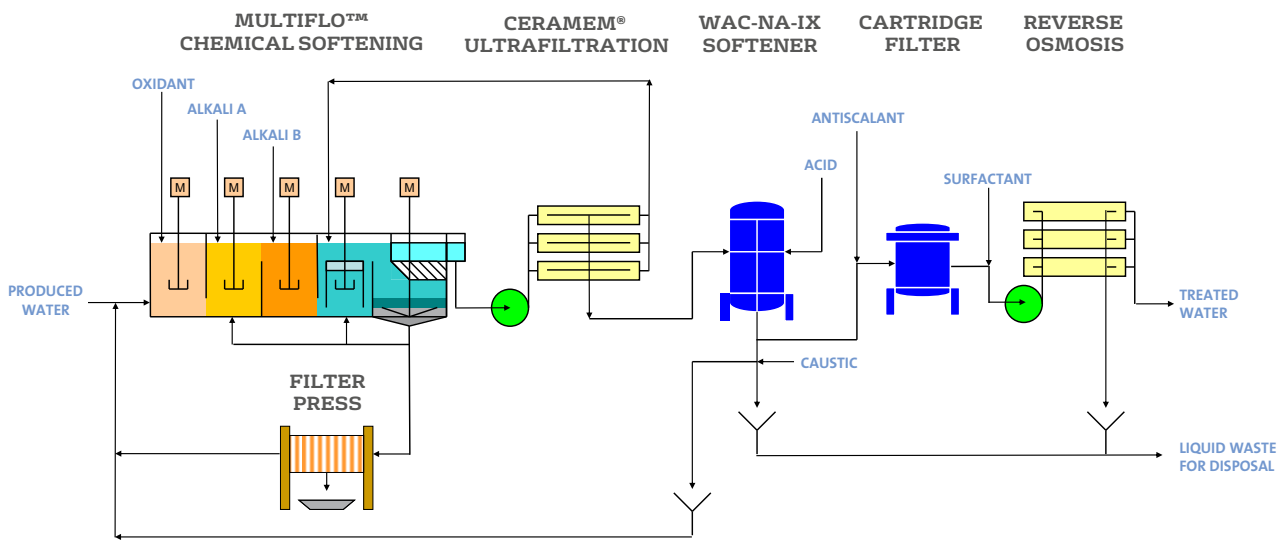
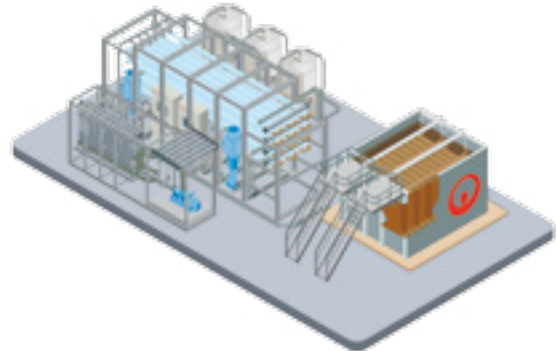
OPUS® II

Our latest innovation of Optimized Pretreatment
and Unique Separation Technology

WATER TECHNOLOGIES

OPUS® II technology is a proprietary Optimized Pretreatment Unique Separation technology developed to achieve high recovery of clean water for reuse or discharge. This new generation of OPUS technology is a compact design that results in lower installed costs than comparable systems.

Developed by Veolia Water Technologies, this unique technology utilizes our proprietary CeraMem® ceramic membranes with chemical and ion exchange softening as pretreatment to a reverse osmosis (RO) process operated at an elevated pH. The result is a compact treatment system that provides high quality water suitable for reuse in industrial processes or replenishment of raw water sources.



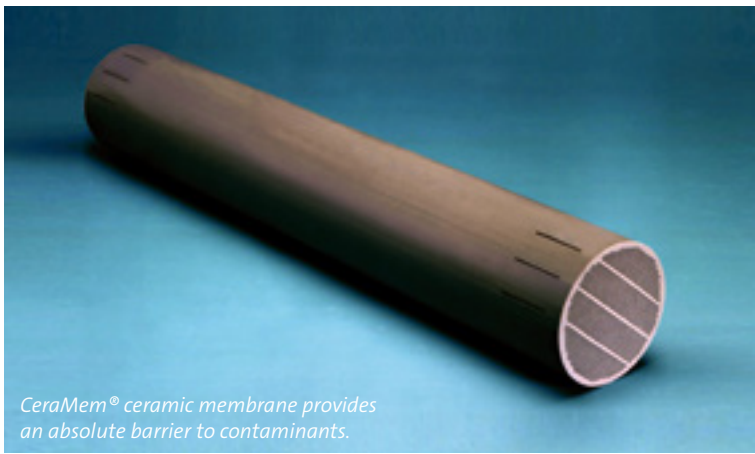
Technology Description

OPUS II technology consists of multiple treatment processes involving chemical softening, membrane filtration, ion exchange softening and reverse osmosis operated at an elevated pH. The pretreatment processes ahead of the RO are designed to reduce free oil, 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, organics and boron.

In the OPUS II technology, the feed water is subjected to chemical softening, free oil and solids removal in a pretreatment process that uses CeraMem ultrafiltration technology. This process consists of a series of reaction tanks followed by a crystallization tank fitted with our patented Turbomix® mixing technology, which facilitates precipitation of hardness and metals in the feed water and crystallization of the solids generated by

precipitation. The softened water and crystalline solids are then processed through the ceramic membrane ultrafiltration system operated in cross-flow mode for removal of free oil, total hardness and suspended solids to lower concentrations. The solids waste from the CeraMem process is continuously recycled to the crystallization tank and purged intermittently for dewatering and subsequent hauling to landfill for disposal.

The filtrate from the CeraMem process is further treated with ion exchange softening utilizing Weak Acid Cation (WAC) resin in sodium form for further removal of hardness and metals to lower concentrations, without pH correction. Any remaining particulates are removed by cartridge filtration. The pretreated water is then pressurized through the RO, operated at an elevated pH in single or double pass mode, to reduce the TDS, boron and organics.



CeraMem® ceramic membrane provides an absolute barrier to contaminants.



Our mobile pilot systems are available for deployment.

Technology Benefits

- >90% recovery rate up to 7,500 ppm influent TDS
- Compact, modular systems with low field installation costs
- Prevents scaling caused by silica, calcium and metal salts
- Controls fouling due to organics and particulates
- Achieves salt rejection removal rates of >99.4% boron, >99.7% silica and >99% TOC
- Continuous Clean-In-Place (CIP) process minimizes RO cleaning frequency
- 3-year, pro-rated membrane life warranty
- Robust treatment approach with minimal system downtime
- Effectively handles variations in feed water quality

Applications

- Oil and Gas Field Produced Water
- Power Plant Cooling Tower Blowdown
- Reuse of Industrial Wastewater to Achieve Zero Liquid Discharge

Guaranteed Performance

Veolia Water Technologies offers a performance guarantee after testing OPUS II technology using 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 and maintenance contracts are also available to ensure continued optimization of your system and extend the performance guarantee for the life of the contract.

Flexible Project Delivery Options

Our project delivery can be tailored to your purchasing preferences:

- Engineer / Procure
- Design / Build
- Design / Build / Operate / Maintain
- Design / Build / Operate / Guarantee*

Typical Performance Data

| Constituent | Feed Water | CeraMem® Ultrafilter Filtrate | Double Pass RO Permeate | Removal Efficiency |
|--|------------|-------------------------------|-------------------------|--------------------|
| Free Oil (>20µ), ppm | 100 | <0.2 | Non-Detect | >99.9% |
| Total Suspended Solids, ppm | 100 | <0.2 | Non-Detect | >99.9% |
| Total Hardness, ppm as CaCO ₃ | 236 | <10 | Non-Detect | >99.9% |
| Calcium, ppm | 65 | <3.2 | Non-Detect | >99.9% |
| Magnesium, ppm | 18 | <0.5 | Non-Detect | >99.9% |
| TDS, ppm | 2,200 | 2,500 | <15 | >99.3% |
| Boron, ppm | 8.6 | 8.6 | <0.03 | >99.7% |
| Silica, ppm | 220 | <50 | <0.03 | >99.9% |
| Organics, ppm | 210 | 210 | <0.99 | >99.5% |

* Veolia is the only water treatment company that offers DBOG project delivery. Long-term operation contracts include facility maintenance, treatment chemicals and guaranteed system performance for the life of the contract. DBOG contracts eliminate risks associated with rising costs, performance and availability.

