

Equipment for Reverse Osmosis Desalination Systems

Pumps • Energy Recovery Devices • Valves • Seals





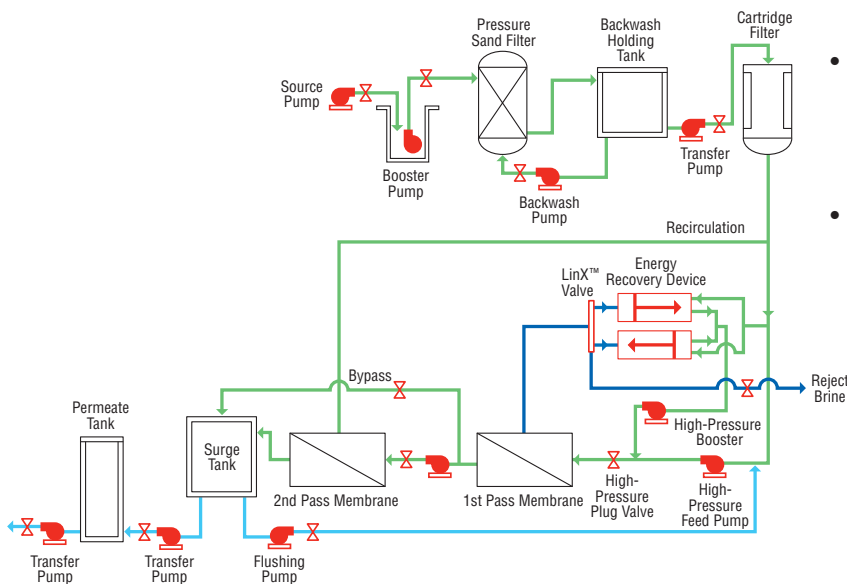
The Single Source for SWRO Equipment and Support

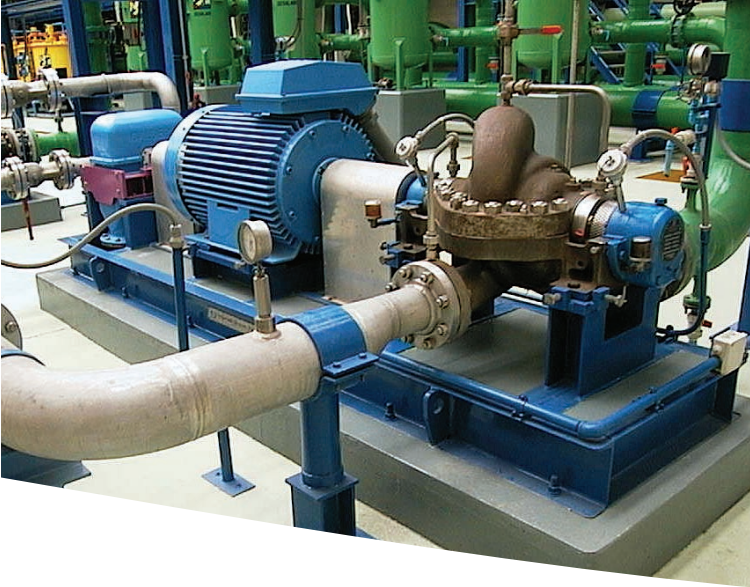
As worldwide demand for potable water rapidly grows and as energy costs continue to rise, municipalities and industries are looking for reliable, energy-efficient desalination solutions more than ever. The energy-efficient and scalable design of the seawater reverse osmosis (SWRO) process makes it the leading choice for potable municipal and commercial water supply. With the addition of Calder™ energy recovery devices and application expertise to its arsenal, Flowserve is uniquely positioned to address and meet the expanding needs of the global SWRO desalination market.

Complete, Integrated Solutions

By bringing together industry leading pumps, seals, valves, high-quality energy recovery devices, unmatched materials expertise and SWRO-specific application knowledge, the incorporation of Calder enables Flowserve to be a single source provider of complete, integrated flow control solutions to SWRO plants around the world.

- Pumps
 - Source water intake
 - High-pressure membrane feed
 - High-pressure booster
 - Filter feed
 - Chemical dosing
 - Brine transfer
- Energy recovery devices
 - Energy recovery turbines (ERT)
 - Dual work exchange energy recovery (DWEER™)
- Valves
 - Plug
 - Butterfly
 - Ball





Leaders in Desalination Technology

Responsible for many advancements in water-handling technology, Flowserve and Calder have supplied proven equipment and systems that are reliable, corrosion-resistant and energy-efficient to the desalination industry for more than half a century. Flowserve offers SWRO plant owners and operators the following benefits:

- Worldwide sales and services network with offices in more than 55 countries
- Single point of contact and responsibility for all major equipment including pumps, energy recovery devices, valves and mechanical seals
- Engineering and technical resources for application support and ongoing life cycle cost reduction services
- Unparalleled expertise and experience in the design and operation of high-efficiency fluid motion and control systems
- Maintenance contracts that guarantee performance and availability of the equipment for a fixed fee



Committed to the Complete Pump System Life Cycle

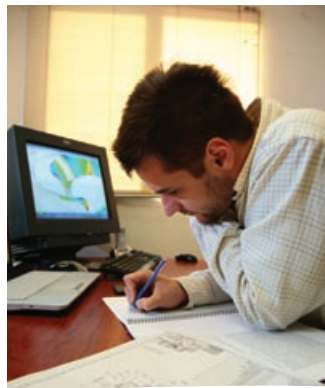
For more than two centuries, Flowserve has served industries requiring solutions that add value and reduce costs throughout the life cycle of a pumping system.

- Water
- Power
- Oil and gas
- Chemical
- General industry



Flowserve partners with customers to respond to the dynamic business conditions that affect them. Flowserve works with customers to improve efficiency, maximize throughput and control process quality. Whether customer needs involve on-site technical assistance, equipment upgrades or broader project planning with full turnkey responsibility, Flowserve delivers professional, reliable results.

Flowserve engineers possess the application and system know-how to help customers solve difficult SWRO process problems.



Experience That Adds Value

Paramount in the selection of equipment and systems for any SWRO plant are energy efficiency, corrosion resistance, proven performance and maintenance support. Having equipped desalination plants around for more than a half century, Flowserve is uniquely positioned to address and meet these challenges.

Energy Efficiency

In designing modern desalination water plants, high efficiency is a major goal. This includes efficiency not only in energy consumption but also in energy recovery. Complementing its portfolio of pumps for the reverse osmosis process, Flowserve acquired the Swiss company Calder in 2009. Calder develops the world's highest-efficiency energy recovery equipment for reverse osmosis desalination. Calder's dual work exchanger energy recovery (DWEER) technology and energy recovery turbines (ERT) enable Flowserve to deliver a complete and integrated desalination flow control solution.



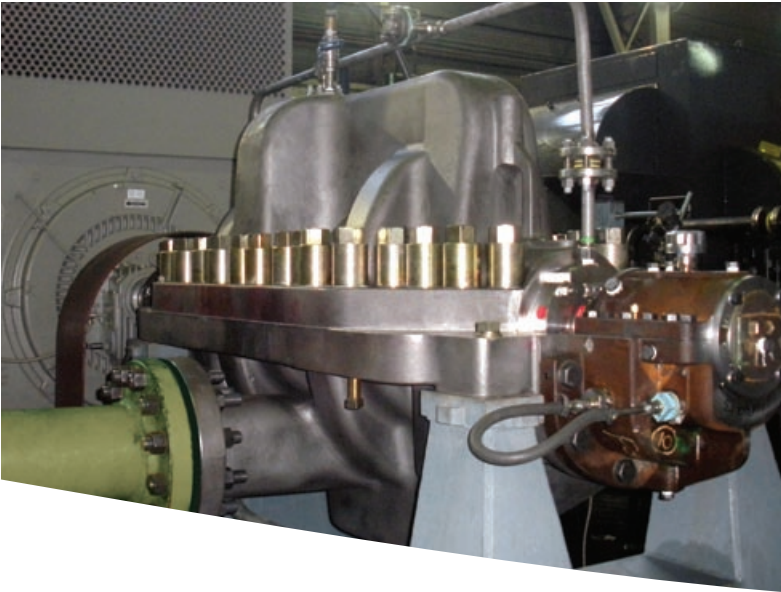
Materials Expertise

Flowserve offers its customers a broad range of corrosion-resistant materials – both metallic and non-metallic – along with materials application expertise to provide the safest, lowest total cost solutions for the difficult services found in desalination plants.

Pitting, crevice corrosion and stress corrosion cracking are major concerns in processing seawater and brackish water. Flowserve effectively addresses these issues with its broad range of materials, including proprietary super austenitic stainless steels, duplex stainless steels, super duplex bronze alloys, nickel alloys, and Ni-Resist metals along with its complete range of engineered polymers. For assured quality, Flowserve maintains its own steel, nickel and light reactive alloy foundries.

Proven Performance

Moving saline water from its source through desalination and distribution facilities requires dependable, high-volume equipment and systems with proven performance. Flowserve pumps, valves, energy recovery devices and mechanical seals have that proven performance. And, Flowserve engineers possess the application and system know-how to help customers solve difficult SWRO process challenges.

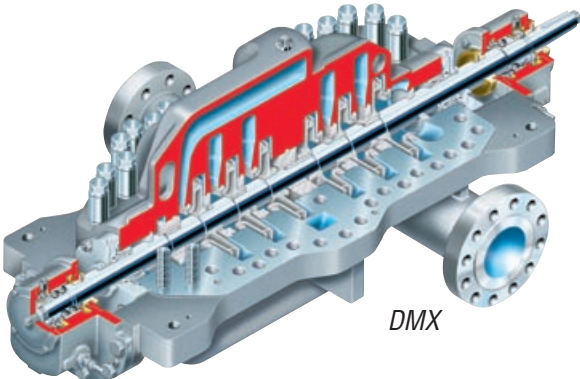


Pumps for SWRO

Flowserve is the driving force in the global industrial pump marketplace. Flowserve offers the industry's widest selection of pump types in a full range of hydraulics to maximize efficiency. It also is imperative to select materials with low corrosion rates and good thermal properties. Flowserve is unique in providing this combination of hydraulic and materials expertise.

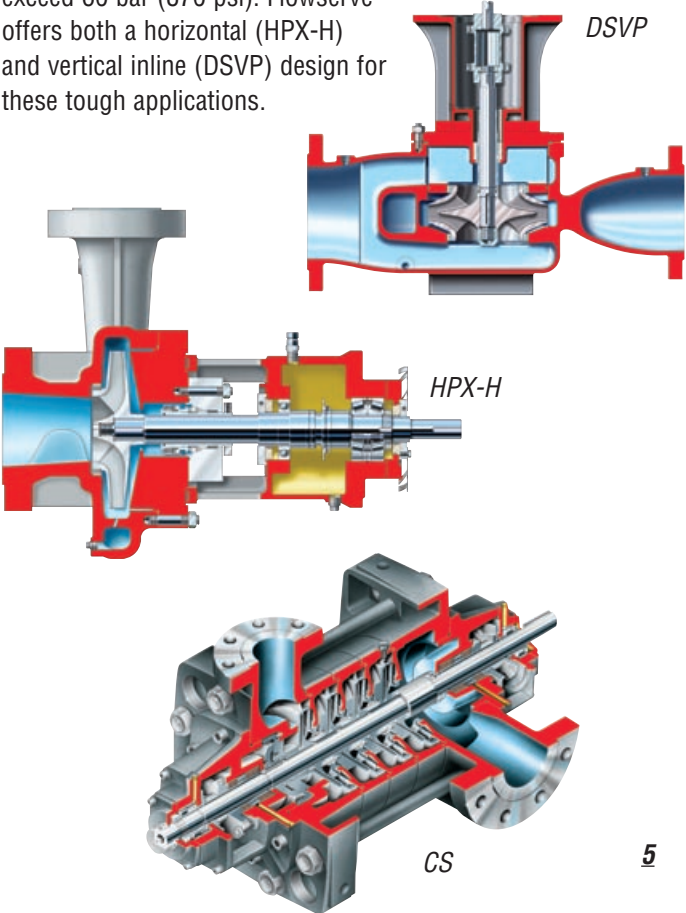
High-Pressure Membrane Feed Pumps

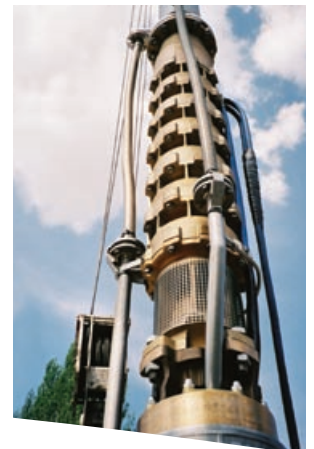
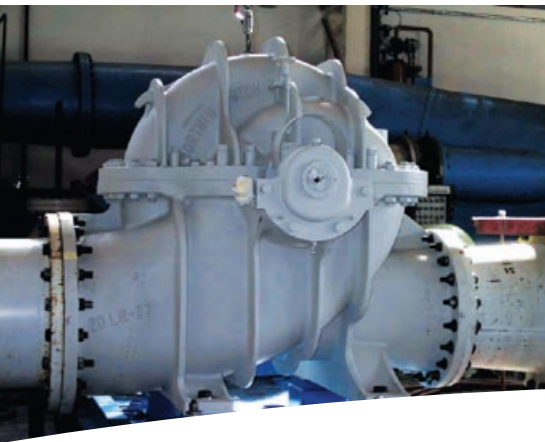
The heart of the SWRO system is the high-pressure membrane feed pump. Flowserve offers high-efficiency membrane feed pumps, all utilizing the latest technology, including Computational Fluid Dynamics, to provide best system performance. These critical pumps are manufactured in corrosion-resistant materials to ensure long performance life without degradation. Whether the design is horizontal split case (DMX) or ring section type (CS or WDX), Flowserve has the pump for this service.



Booster Pumps

Flowserve high-pressure booster pumps are designed to efficiently operate under SWRO system pressure where suction conditions can exceed 60 bar (870 psi). Flowserve offers both a horizontal (HPX-H) and vertical inline (DSVP) design for these tough applications.





Source Water Intake

SWRO source water intake requires pumps that are corrosion resistant and have the versatility to fit various intake methods. Flowserve offers several highly efficient vertical and horizontal pump models with proven performance to suit application needs.

Flowserve vertical source water intake pumps include conventional lineshaft or submersible motor, both offering wide-capacity ranges to effectively maximize system efficiency while minimizing initial cost. Flowserve also offers horizontal pumps for dry-pit installation or space-saving vertical configurations which provide the same premium efficiency with a reduced footprint.

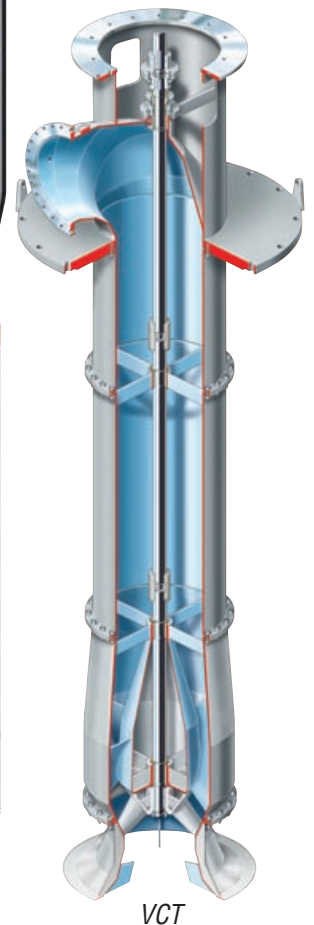
Vertical, Wet-Pit Pumps

- Submersible pumps with oil or water filled motor (Pleuger SUBM)
- Single-stage and multistage pullout and non-pullout mixed flow models (VCT)

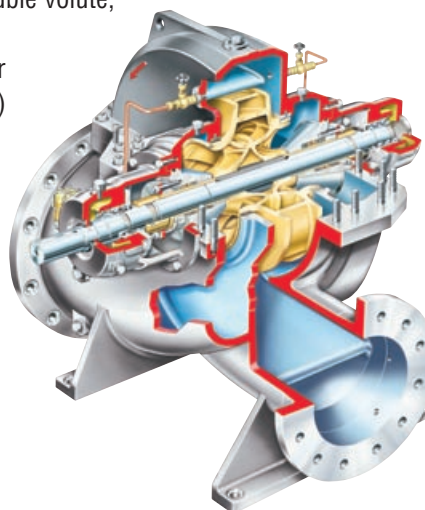
Horizontal, Dry-Pit Pumps

- Between bearings, axially split, double volute, double-suction pumps (LNN)
- Vertical configurations available for limited space requirements (LNNV)

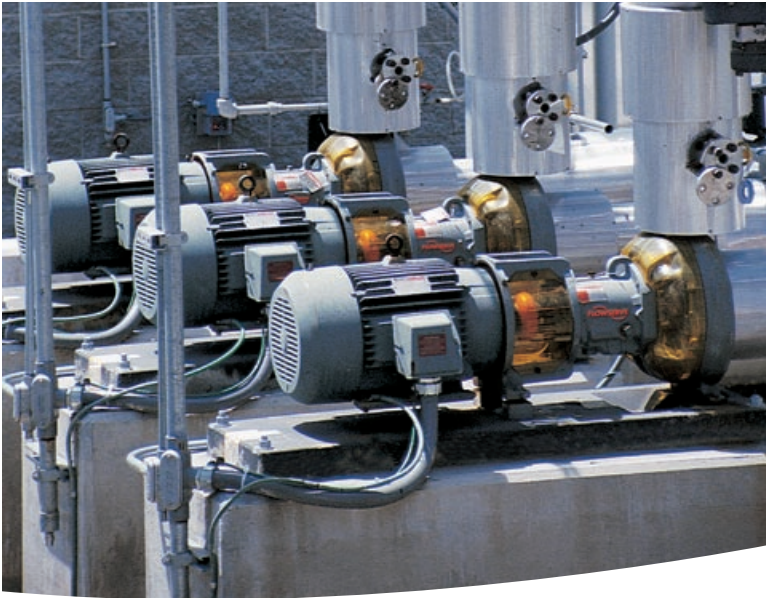
Pleuger
SUBM



LNN



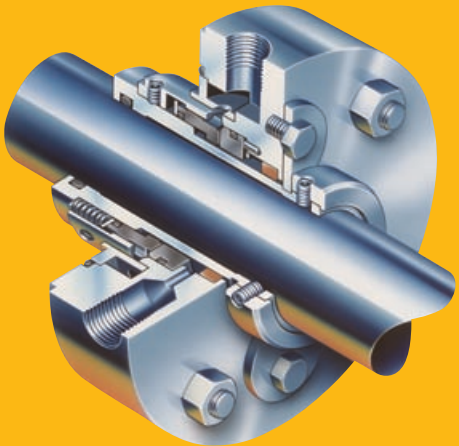
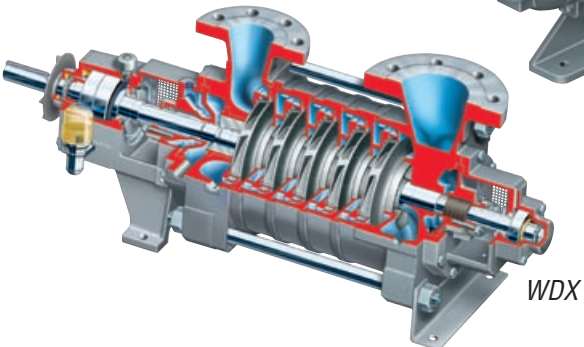
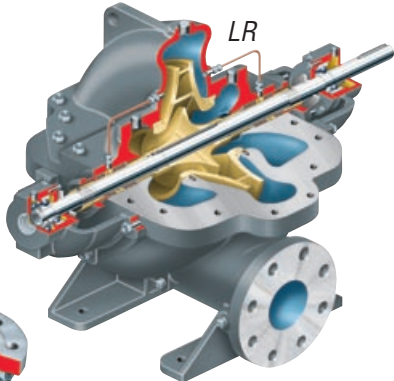
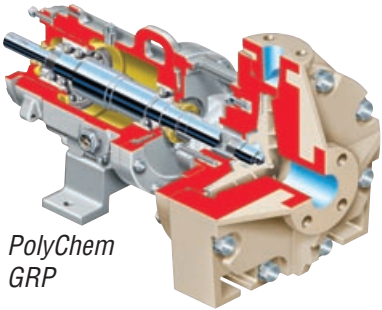
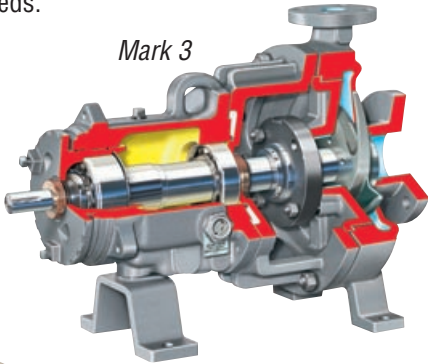
VCT



Auxiliary Pump Services

Flowserve can provide pumping solutions for virtually all desalination plant support services. Pumps are available in various configurations and materials of construction to meet application needs.

- Filter feed
- Filter backwash
- Chemical dosing
- Brine disposal
- Brine transfer
- Product transfer



Advanced QB Seal Technology

The Flowserve QB Series balanced pusher seal is available in single and dual seal configurations. The QB Series seal is fully compliant with ISO 21049/API 682 Type A requirements.

- Rugged, cartridge design provides the highest reliability and simple installation
- Heavy-duty seal faces remain flat during operation to minimize leakage
- Multiport flush design improves heat dissipation for uniform face cooling
- Patented spring holder pumping ring design flushes spring area
- Seal flange metallurgy selected to match the pump casing material and corrosion for resistance

Flowserve is a world leader in the manufacture and supply of the most efficient energy recovery devices for the SWRO desalination process.



Energy Recovery Devices for SWRO

Energy is generally the biggest cost driver in any SWRO desalination facility, thereby making energy-recovery equipment critical to the process. Flowserve is a world leader in the manufacture and supply of the most efficient energy recovery devices for the SWRO desalination process.

DWEER

The DWEER is the most efficient energy recovery device ever developed. It can recover up to 98% of the energy in the brine waste stream, which is then used to pressurize raw water and reduce the energy input for the high-pressure feed pumps up to 60%.

With the DWEER, the high-pressure pump does not have to be connected to the energy recovery device. This permits the use of fewer but larger, more efficient pumps.

The DWEER Operating Principle

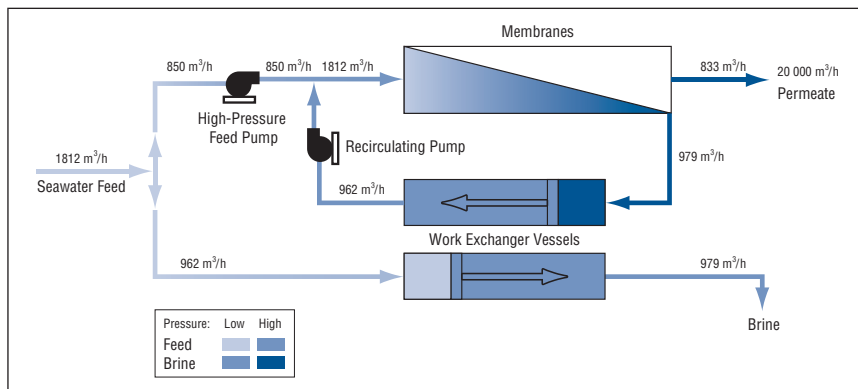
Power recovery is independent of the high-pressure pump flow rate so there is no critical best efficiency point with the DWEER. Because of its flat efficiency curve, the DWEER is able to efficiently operate under the varying range of flow and pressure found in any SWRO plant without adjustment.

In a DWEER, the high-pressure pump flow rate is equal to the product water flow rate plus system losses. The high-pressure brine from the membranes is directed to a DWEER work exchanger vessel that is filled with seawater. The work exchanger vessel pressurizes the seawater to brine pressure.

A small recirculation pump is used to equalize the pressure of the seawater leaving the work exchanger with that of the high-pressure pump, overcoming membrane and system losses. The seawater then joins the flow from the high-pressure pump to form the membrane feed flow.

The seawater then joins the flow from the high-pressure pump to form the membrane feed flow.

As the end of this half-cycle nears, the patented LinX™ valve diverts the high-pressure brine to the opposite work exchanger vessel. The low-pressure seawater (from the same source feeding the high-pressure pump) then fills the spent work exchanger vessel displacing the brine to discharge and the cycle repeats.



Typical flow diagram of a DWEER



Energy Recovery Turbines

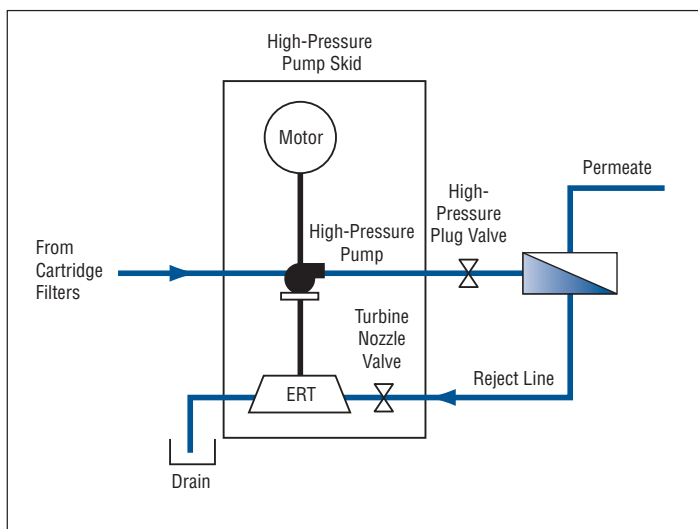
Calder energy recovery turbines (ERT) are designed and manufactured specifically for reverse osmosis desalination. They can recover as much as 90% of the hydraulic energy remaining in the brine stream, converting it into rotary power for the high-pressure pumps. Highly efficient and reliable, Calder ERTs are installed in nearly 1000 seawater and brackish water reverse osmosis plants worldwide, with a total installed capacity in excess of 350 MW.

Flexibility

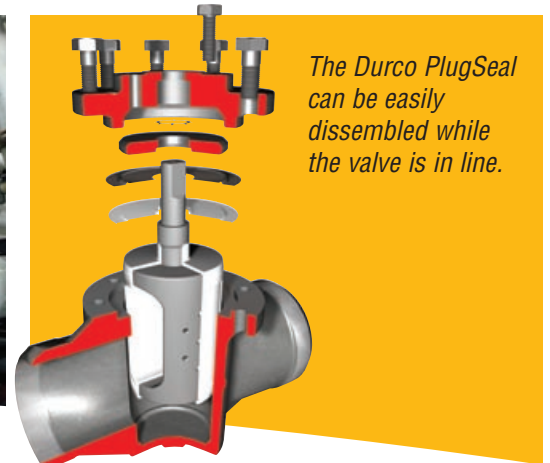
Calder ERTs are designed to operate with either centrifugal pumps or positive displacement pumps and may be direct coupled to motors or pumps at speeds up to 3600 rpm. A range of standard turbines are available with a power recovery potential up to 1.5 MW. Larger units are available as engineered product built to suit seawater and brackish water applications.

The ERT Operating Principle

Calder ERTs capture the high-pressure energy that remains in the concentrate (brine) from the reverse osmosis process. The high-pressure concentrate drives the ERT rotor which then produces rotating power used to assist the main electric motor in driving the high-pressure pump. The Calder ERT rotor and nozzle are optimized to convert the kinetic energy of the jet into rotating mechanical energy, enabling the turbine to operate at maximum efficiency. Because of this, smaller, less costly motors may be utilized to drive the high-pressure feed pump. It is possible to size the electric motor for as little as 60% of the total power required to drive the high-pressure pump.



Flowserve offers a complete range of valves to suit the diverse applications found in SWRO desalination.



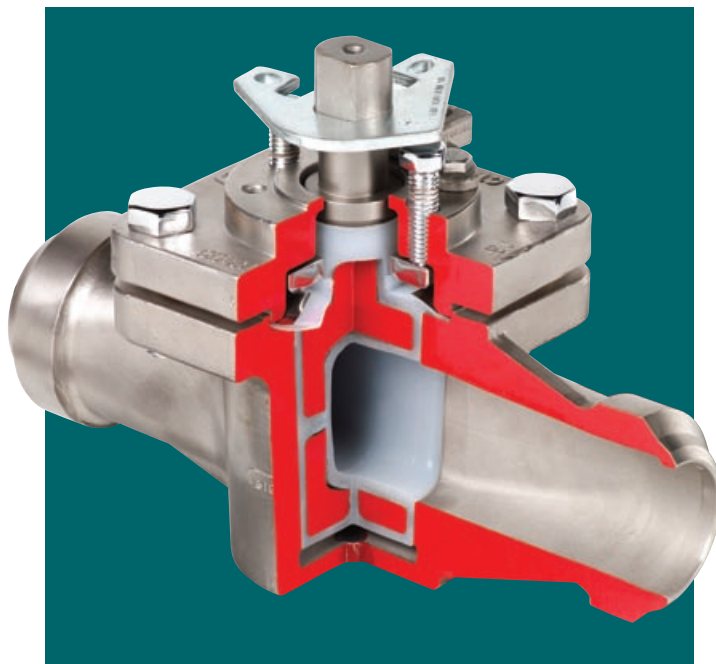
The Durco PlugSeal can be easily disassembled while the valve is in line.

Valves for SWRO

Reverse osmosis systems require numerous valves capable of handling large volumes of water at high-pressures. These valves must also be made of materials capable of resisting corrosion from the chloride-rich water and chemicals commonly used. Flowserve offers a complete range of valves to suit the diverse applications found in SWRO desalination.

High-Pressure Membrane Plug Valves

The most demanding application for valves in the SWRO process is in the high-pressure membrane area where both the pressure and the chloride content of the water are high. Available in sizes to 400 mm (16 in), the Durco PlugSeal valve has been specifically designed for the high-pressure membrane service in SWRO.



Made of super duplex stainless steel to resist pitting and crevice corrosion, the Durco PlugSeal is an ASME Class 600 plug valve. Instead of a discrete seat which is difficult to replace if damaged, the PlugSeal features a PFA-lined plug that rides directly on the machined body. This design greatly facilitates maintenance as the valve can be readily disassembled and reassembled while in line. It also makes installation easier. The customer has the option of welding the complete, assembled valve into the pipeline or removing the heat-sensitive internal parts prior to welding so as to avoid potential damage.



Pretreatment Butterfly Valves

The pretreatment process consists of passing the seawater through a series of sand and cartridge filters to remove solids such as silt, sand and organic materials. This process requires a large number of butterfly valves ranging in sizes from 75 mm (3 in) to 2600 mm (104 in). Flowserve offers butterfly valves in a wide range of configurations and in numerous seat and disc materials, including Viton®, Halar®, Hypalon® and PTFE. Valves are available in seawater-resistant materials such as aluminum bronze, duplex stainless steel and super duplex stainless steel.

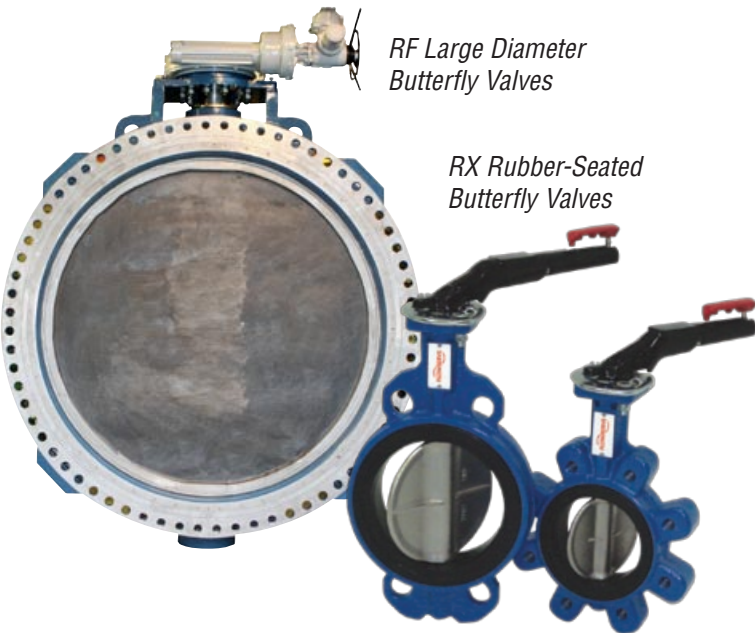
Automated Valve Systems

Flowserve offers a full range of rack and pinion, heavy-duty and electric actuators as well as electrical and pneumatic instrumentation including intelligent valve controllers. Flowserve also offers a comprehensive line of engineered special control circuits, solenoid valves, limit switches, positioners, and actuator mounting kits. This allows Flowserve to supply complete automated on-off or modulating packages to suit the exacting requirements of the SWRO process.

Auxiliary Valve Services

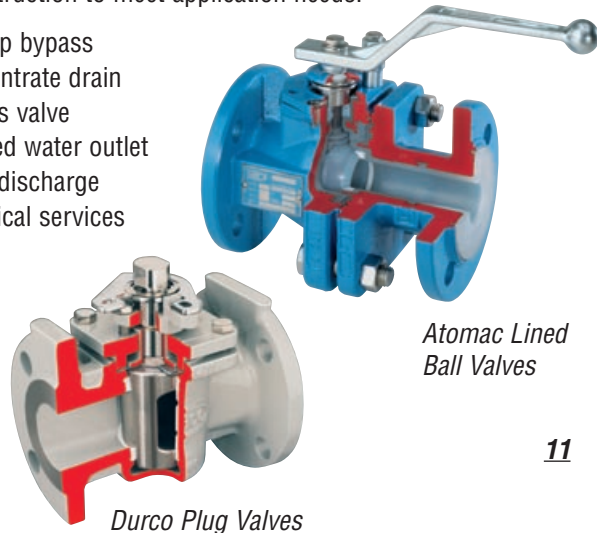
Flowserve can provide valves for virtually all SWRO general purpose and chemical service needs. Valves are available in various configurations and materials of construction to meet application needs.

- Startup bypass
- Concentrate drain bypass valve
- Purified water outlet
- Brine discharge
- Chemical services



RF Large Diameter Butterfly Valves

RX Rubber-Seated Butterfly Valves



Atomac Lined Ball Valves

Durco Plug Valves

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