
3M
Science.
Applied to Life.™
Quality water.
Powerful results.
3M™ Liqui-Cel™
Membrane Contactors
Advanced membrane degasification
technology for power plant water.

# Effective. Economical. Chemical-free.

## Advanced membrane technology for power plant water degasification.

Power plants generating steam balance cost, efficiency and reliability with environmental considerations while supplying energy to the world. Degasified water plays a critical role in generating the energy used to heat and cool homes and businesses while protecting vital capital equipment.

3M™ Liqui-Cel™ Membrane Contactors remove dissolved $O_2$, $CO_2$, and trace gases to industry-leading levels. With their chemical-free membrane technology, Liqui-Cel membrane contactors can help enhance the performance of water treatment systems and reduce the risk of downtime. They offer a cost-effective, easy-to-use and efficient degassing solution for power plants.

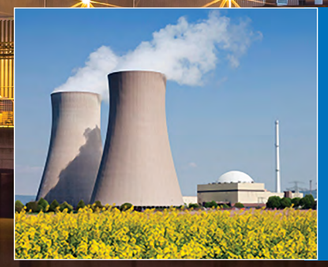


### 3M™ Liqui-Cel™ Membrane Contactors

Membrane contactors offer a reliable improvement over conventional degassing technologies such as steam deaerators, decarbonators, and chemical injection. With nearly 10x the effective surface area of conventional degassing towers, they produce virtually gas-free water at a wide range of flow rates—all without using chemicals or taking up vital square footage.

**14-inch Industrial System**

**$O_2$ levels <1 ppb  $CO_2$ levels <1 ppm**



**Applications**

- Steam-electric power stations
- Natural gas-fired power stations
- Heat recovery steam generators (HRSG)
- Nuclear power plants

# Clean, powerful water. Degasification for efficient power generation.

## Benefits of 3M™ Liqui-Cel™ Membrane Contactors

### Reduced Corrosion and Pitting

3M™ Liqui-Cel™ Membrane Contactors reduce $O_2$ to levels below 1 ppb and $CO_2$ levels below 1 ppm, helping prevent corrosion and pitting caused by oxidation and carbonic acid. In nuclear power plants, lower dissolved $O_2$ and $CO_2$ levels alleviate primary stress corrosion cracking. By minimizing long-term damage to pipes, heat exchangers, boilers and other equipment, Liqui-Cel membrane contactors help power plants reduce the high costs of capital equipment maintenance and replacement.

### Minimized Environmental Impact

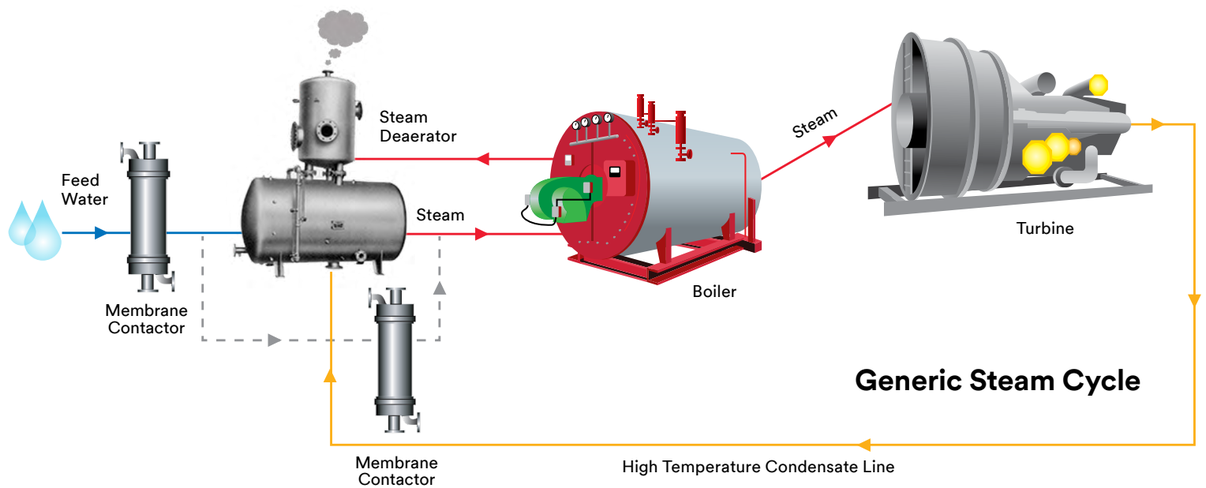
Liqui-Cel membrane contactors degas water without using chemicals. By producing water with very low $O_2$ and $CO_2$ levels, steam-generating plants often eliminate the need for oxygen scavengers and reduce the use of ion exchange regeneration chemicals. Reduced chemical use may also decrease the boiler blowdown frequency, saving water and energy. In nuclear power plants, low levels of $O_2$, $CO_2$, and $N_2$ may reduce the formation of radionuclides such as $^{14}C$ and oxides of $^{60}Co$ along with reduced Corrosion Related Unidentified Deposit (CRUD).

### Improved Deionization

Lowering dissolved $CO_2$ levels with Liqui-Cel membrane contactors reduces the total ionic load in water, enhancing the effectiveness of IX, EDI, and CDI purification technologies. With more efficient deionization, power plants can reduce costly bed regeneration cycles and increase the service life of deionization equipment.

### Reduced Blowdown Frequency

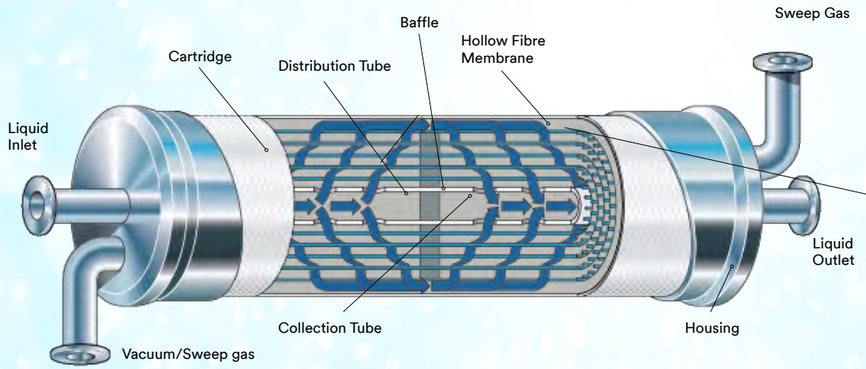
Blowdown cycles in steam generation plants can add significant costs due to extra water, energy and chemical use. By removing dissolved oxygen to low levels, Liqui-Cel membrane contactors can help reduce blowdown frequency and boiler operating costs.

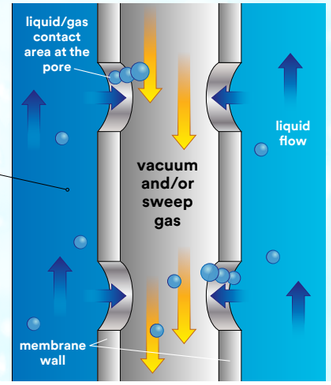



**Generic Steam Cycle**

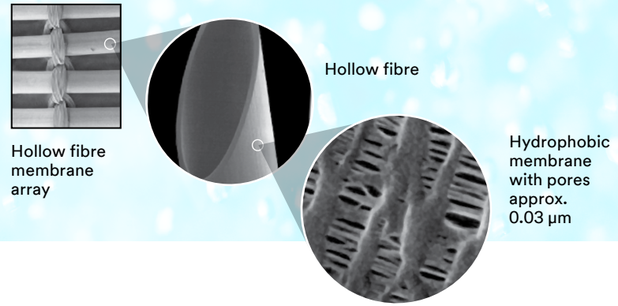
# Inside the Technology

Water flows around the outside of the hollow fibre membrane while a vacuum or sweep gas is applied to the inside of the fibre. The resulting difference in gas concentration levels between the inside (gas/vacuum phase) and outside (liquid phase) of the hydrophobic membrane drives highly efficient dissolved gas removal, producing water with very low gas concentrations.




Scanning electron microscope images of Liqui-Cel membranes. Membrane arrays in a contactor have nearly 10x the surface area of a traditional vacuum tower.




# Streamlining Savings

**Building long-term efficiency into power water treatment systems.**

## Flexible

- Small footprint
- Enables custom and mobile system designs
- Expandable for increased capacity
- Lower installation and construction costs

## Economical

- Reduce plant chemical use
- Low electrical cost
- Save ion exchange resin regeneration costs
- May reduce energy and water losses by reducing frequency of boiler blowdowns

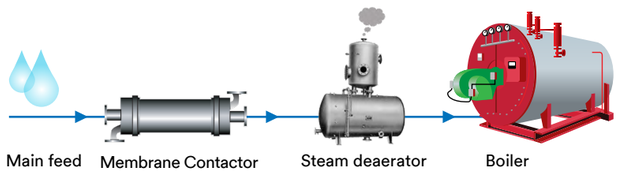
## Performance and Reliability

- Dissolved $O_2$ <1ppb and dissolved $CO_2$ <1ppm
- Improved EDI water quality
- Can be designed for redundancy
- Operation at a wide range of flow rates

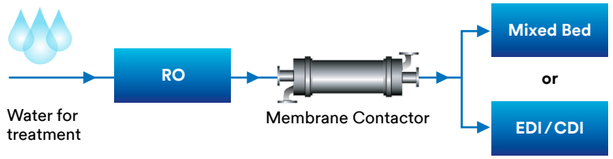
# Common Installation Scenarios

## Traditional steam generation plants

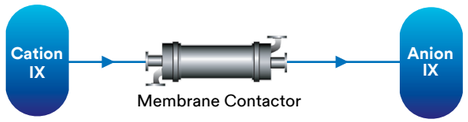

$CO_2$ removal between RO passes to reduce caustic use




Dissolved oxygen removal from boiler make-up water




$CO_2$ removal with Liqui-Cel membrane contactor between RO and IX

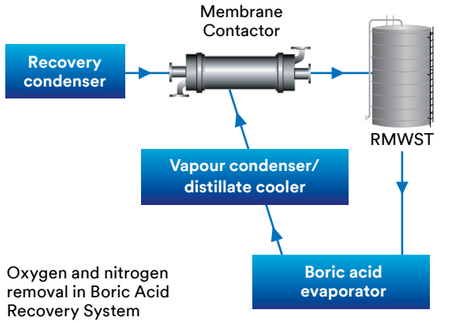



$CO_2$ removal with Liqui-Cel membrane contactor between IX resin beds

## Nuclear power plants



Degassing reactor make-up water




Oxygen and nitrogen removal in Boric Acid Recovery System

# Support at Every Step

Systems utilizing 3M™ Liqui-Cel™ Membrane Contactor technology are operating around the world in many applications. Whether you need help assessing the application of membrane contactor technology or discussing design details, 3M has the knowledge and experience to support your next project.

# Maintenance

Liqui-Cel membrane contactors typically require little maintenance. With proper system design, this technology can be operated with limited support from operators and maintenance personnel.

Visit our website to download technical bulletins, mechanical drawings, case studies and more!

**3M.com/Liqui-Cel**

## Expansion and Reconfiguration

The variety of compact Liqui-Cel membrane contactors means that membrane contactors can be easily added and/or reconfigured as power plant water demands change.



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