

# A high level of consistency and control.

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

Gas transfer membrane technology that removes, adds or controls dissolved gases in liquids. Dissolved gas control can help improve operating efficiency in high purity water treatment applications. Help reduce corrosion in industrial facilities. And even add the right amount of “fizz” to your favorite beverage.

# Precision gas control. Enabling ultra-pure water and extra-bubbly beverages.

Advanced membrane technology for dissolved gas control

*The presence of dissolved gases in a liquid can mean the difference between high quality and headaches. The same gases that give beverages their distinctive flavor and fizz can corrode boiler equipment or cause defects in microelectronics.*

*For over 20 years, 3M's advanced gas transfer membrane technology has been used to precisely control dissolved gases in many applications.*

## 3M™ Liqui-Cel™ Membrane Contactors

3M™ Liqui-Cel™ Membrane Contactors provide precision dissolved gas control for a wide variety of industries – from oil production and power plants to pharmaceutical, food and beverage industries. These leading gas transfer devices help facilities around the world improve water treatment process performance and product quality by:

- Reducing corrosion in boilers and piping
- Improving process efficiency
- Enabling ultra-pure water for high-technology processes
- Improving beverage shelf life and taste

Capable of both adding and removing dissolved gases, Liqui-Cel membrane contactors are commonly used for carbon dioxide removal, deoxygenation, nitrogenation and carbonation. Highly compact and efficient, they use microporous membranes with nearly 10x the gas exchange surface area of conventional vacuum towers. The modular nature of Liqui-Cel membrane contactors makes it easy to incorporate them into skidded systems, helping to lower installation costs. Even after initial installation, Liqui-Cel membrane contactors can be readily expanded to meet growing capacity.





## Degassing and debubbling

Dissolved gases such as oxygen and carbon dioxide can cause any number of difficulties in industrial processes. They can oxidize and corrode metal piping and critical equipment, resulting in extra costs and downtime for maintenance. In industries such as pharmaceutical or semiconductor manufacturing – which depend on ultra-pure, de-aerated water – dissolved gases can affect both production efficiency and product quality.

Air bubbles in liquid can lead to process interruptions and surface defects, such as in ink and coating applications. Bubbles can also negatively impact measurement reliability in laboratory analysis.

3M™ Liqui-Cel™ Membrane Contactors achieve low levels of dissolved gas concentration (<1 ppm CO<sub>2</sub> and <1 ppb O<sub>2</sub>) that can be difficult to reach with conventional gas removal processes. Liqui-Cel membrane contactors have a smaller footprint and typically weigh less than vacuum towers and forced draft deaerators. In addition, Liqui-Cel membrane contactors help achieve an effective alternative to chemical treatment.

## Adding dissolved gas for fizz, foam and flavor

The food and beverage industry adjusts nitrogen, CO<sub>2</sub>, and alcohol levels to give many of our favorite drinks the sparkle, taste, and texture that we love. Beverage manufacturers use processes such as nitrogenation, carbonation and deoxygenation to reduce bacteria, prevent spoilage, and enable long-term storage of liquids.

Adding gases to liquids is also a critical consideration in various water processes. In the beverage industry, control of nitrogen and CO<sub>2</sub> levels is important because they impact the sparkle, taste, and texture of many of our favorite drinks. Using Liqui-Cel membrane contactors to add dissolved gases enables beverage producers and bottlers to conveniently help protect product quality and process with a compact device.

Liqui-Cel membrane contactors diffuse gases into water at the microscopic level, giving industries precise control of nitrogen and CO<sub>2</sub> levels while limiting gas waste. Liqui-Cel membrane contactors can also remove oxygen while adding nitrogen and CO<sub>2</sub>, eliminating a big step – along with time and expenses – from large-scale beverage production.

There are also many other applications where Liqui-Cel membrane contactor technology could be applied, such as ammonia removal, alcohol adjustment, VOC reduction and H<sub>2</sub>S removal. To learn more about these applications, contact your 3M representative.

## A leader in membrane technology

3M is dedicated to the continued development and advancement of membrane technology. We also offer our technical expertise to support our customers from initial system design through module start-up and optimization.

## Applications

- Deoxygenation
- Decarbonation
- Carbonation
- Nitrogenation
- Hydrogenation
- Alcohol adjustment

# Gas transfer technology that puts you in control.

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



### Beverage industry

3M™ Liqui-Cel™ Membrane Contactors provide in-line carbonation, nitrogenation and removal of O<sub>2</sub>. This membrane-based technology improves efficiency over conventional deoxygenation technologies while extending the shelf life of beer, wine, juice, and many other beverages. When adding gases, Liqui-Cel membrane contactors use carbon dioxide or nitrogen gases more efficiently compared to traditional systems. They enable rapid diffusion of gases into liquids to precise levels, saving time and simplifying the production process.



### Laboratory water & analytical instrumentation

Dissolved gases can interfere with instrument readings and could alter the composition of solutions for analysis. With 3M™ Liqui-Cel™ MM Series Membrane Contactors, laboratory water can be effectively degassed, improving measurement reliability and overall lab efficiency. The ultra-small footprint also makes Liqui-Cel MM Series membrane contactors easy to integrate into analytical devices or into laboratory water supply systems.



### Oil & gas production

3M™ Liqui-Cel™ Membrane Contactors are ideal water management tools for the oil and gas industry. They degas water to protect boilers and eliminate environmental contaminants like ammonia. They also precisely calibrate dissolved gases in water for efficient water-pumping at onshore and offshore extraction sites. As a small-footprint, modular technology, Liqui-Cel membrane contactors are also easy to install and integrate into existing systems. They can also be easily expanded as system needs grow.



### Pharmaceutical manufacturing

The pharmaceutical industry relies on low CO<sub>2</sub> levels in process water to control water conductivity and pH. 3M™ Liqui-Cel™ Membrane Contactors reduce CO<sub>2</sub> to maximize the efficiency of the electrodeionization process. They also remove dissolved O<sub>2</sub> to reduce the risk of oxidation and spoilage in final products without using chemicals while saving space, time, and money as they produce the pure water they need. Liqui-Cel membrane contactors can also remove non-condensable gases without applying heat to help pharmaceutical plants meet standards for pure steam generation.



### Power & steam generation

3M™ Liqui-Cel™ Membrane Contactors remove dissolved  $O_2$  and  $CO_2$  from make-up water without using chemicals. This reduces risk of corrosion and pitting caused by oxidation and carbonic acid. By decreasing long-term damage to pipes, fittings, and boiler surfaces, Liqui-Cel technology helps power plants reduce the high costs of capital equipment maintenance and replacement. Reduced chemical use may also decrease the boiler blowdown frequency, saving on water and energy loss.

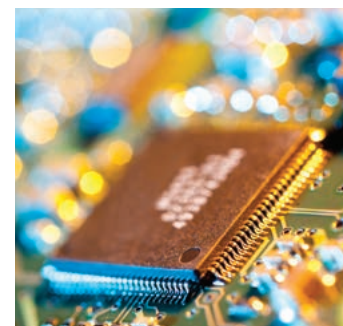
Lowering dissolved  $CO_2$  levels with Liqui-Cel membrane contactors reduces the total ionic load in water, enhancing the effectiveness of ion exchange purification technologies. With more efficient deionization, power plants can reduce costly bed regeneration cycles and increase the service life of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

The small physical and energy footprint of Liqui-Cel membrane contactors, along with savings from reduced chemical use and longer capital equipment lifespans, help make them a highly valuable solution for removing dissolved gases.



### Printing, inks & coatings

3M™ Liqui-Cel™ SP Series Membrane Contactors are widely used to remove dissolved gases from inks and coatings so that production lines operate efficiently and printheads eject ink smoothly and precisely. They offer a simple, in-line solution to keep printers and lines running at optimal quality and speeds. We offer a wide variety of sizes suitable for many different ink and coating applications. Liqui-Cel membrane contactors can also degassify a wide range of low surface tension fluids that are used in the electronics, medical, and quality testing industries.



### Semiconductor & microelectronics

Because of their precision, efficiency, and simplicity, 3M™ Liqui-Cel™ Membrane Contactors are the standard water degassing technology for semiconductor processing, flat panel display manufacturing and other high-technology industries. The contactors remove  $CO_2$  and  $O_2$  in water to the extremely low levels required in today's plants. Low  $O_2$  levels protect product, and low  $CO_2$  levels help maximize the efficiency of water electroionization and ion exchange processes. Liqui-Cel membrane contactors also allows for precision control of the dissolved gases in cleaning water and wafer processing chemicals.



# Inside the Technology

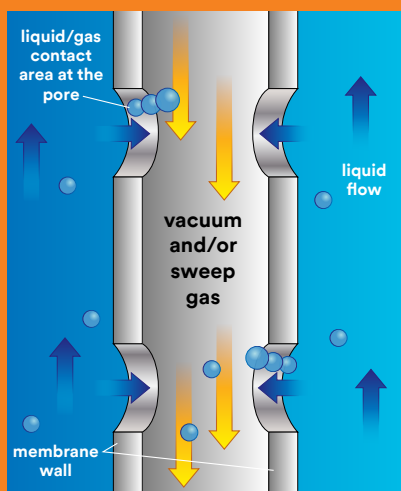
3M™ Liqui-Cel™ Membrane Contactors are microporous hollow fiber membranes that are knitted into an array and wrapped around a center tube inside a contactor housing.

During operation, liquid flows around the outside of the hollow fiber membrane while a vacuum or sweep gas is applied to the inside of the fiber.

Applying a vacuum or sweep gas creates a difference in the gas concentration levels between the inside (lumenside) and outside (shellside) of the hydrophobic membrane. This concentration difference drives rapid and efficient dissolved gas transfer to and from liquid streams.

## Features and Benefits

- Modular design offers flexibility for meeting future increase in capacity or tighter specification requirements
- High inlet pressure and low pressure drop reduces the need for repressurization pumps
- Large membrane surface area delivers high gas transfer performance and efficiency
- Membrane-based technology reduces or eliminates chemical use
- Fast equilibrium allows for quick start-up
- Different contactor sizes and material options provide tremendous flexibility with installation and capacity
- Operation over a wide range of flow rates
- Low operating costs
- Simple operation reduces instrumentation and maintenance requirements



## Fiber types

We offer two primary fiber types for specific gas transfer applications:

- **Polypropylene:** Primarily used for gas transfer to and from water streams
- **Polyolefin:** Used to remove gases from low surface tension liquids (>40 dynes/cm)



Microporous hydrophobic hollow fiber membrane



Hollow fiber membrane array

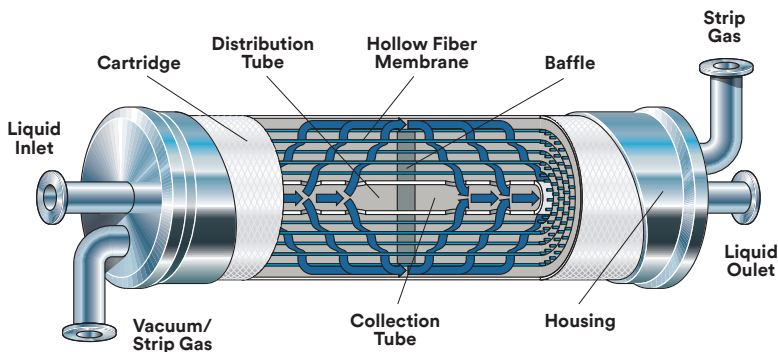
## Contactor configurations

3M™ Liqui-Cel™ Membrane Contactors come in different configurations, each of which helps maximize efficiency and performance in compact designs.

An animated product tour is available on our website: [3M.com/Liqui-Cel](http://3M.com/Liqui-Cel)

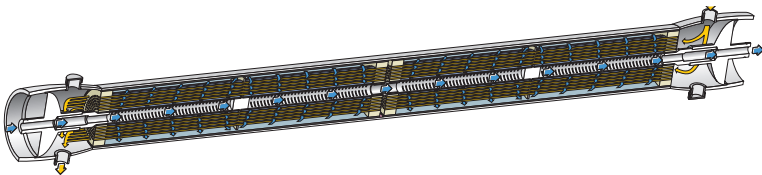
### EXF Series

Includes contactor designs with a center baffle to improve contactor degassing efficiency by maximizing contact with the membrane surface area.



#### Extra-flow

Liquid flows around the outside (shellside) of the hollow fibers. A baffle in the middle of the contactor directs liquid radially across the membrane array. A strip gas and/or vacuum is applied on the inside (lumenside) of the hollow fibers.

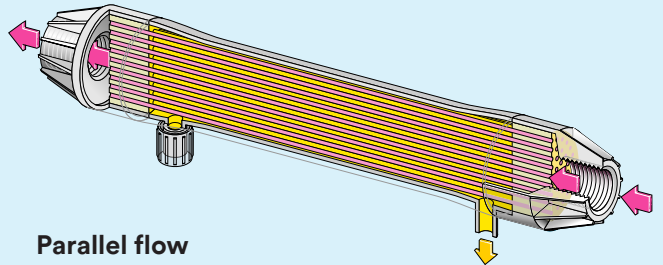


#### Extra-flow in high pressure vessel

An RO-style vessel generates a much higher maximum pressure. Liquid is directed radially across the membrane array by a baffle.

### MM Series

Includes transverse flow and parallel flow designs. No baffle is used.

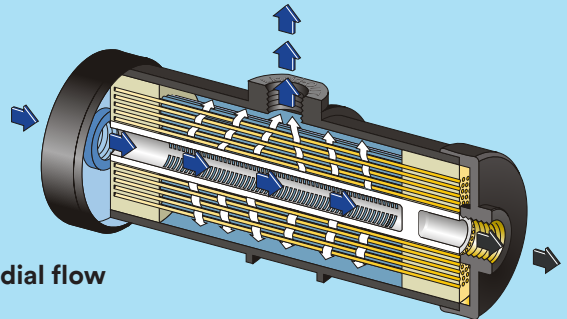


#### Parallel flow

The liquid and gas sides of the membrane are reversed: liquid flows through the inside (lumenside) of the hollow fiber while a vacuum or a strip gas is applied on the outside (shellside) of the fibers.

### SP Series

Includes extra flow, radial and traverse flow contactor designs with only polyolefin fiber.

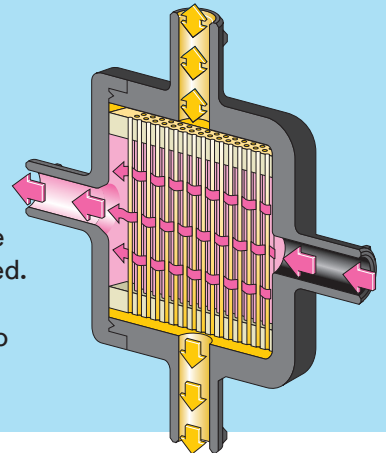


#### Radial flow

A plugged center tube on one side of the device forces liquid radially over the hollow fibers. Primarily used for degassing low surface tension fluids.

#### Transverse flow

Liquid flows into the liquid inlet, crosses the hollow fibers and then exits through the opposite port. No baffle is used. A vacuum or a strip gas can be applied to either gas port.

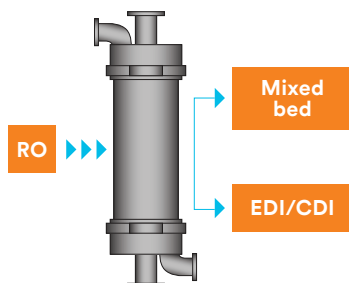


## Common installation scenarios

In many industrial applications, 3M™ Liqui-Cel™ Membrane Contactors have become the standard product for gas transfer to improve yields, reduce corrosion and increase water treatment process efficiency.

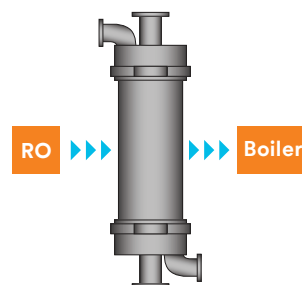
### High Purity

Removing CO<sub>2</sub> after the RO and before mixed bed or EDI/CDI reduces chemical usage and allows optimization of the EDI/CDI units. Lower CO<sub>2</sub> levels before EDI may also improve EDI outlet water quality and the efficiency of silica and boron removal.



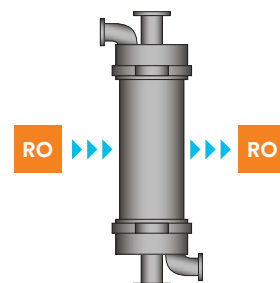
### Chemical-Free Boiler Feedwater Degassing

Removing CO<sub>2</sub> and O<sub>2</sub> from boiler feedwater helps protect boilers and piping from corrosion with little or no chemical use.



### Double Pass RO

Removing CO<sub>2</sub> between a double pass RO system helps reduce or eliminates chemical usage and associated dosing equipment and minimizes scaling of the RO membranes.



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