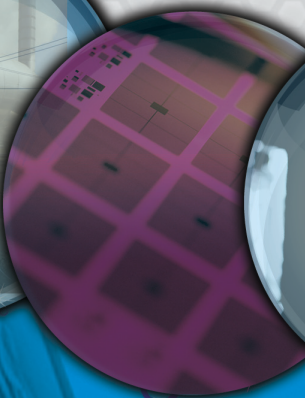


# Liqui-Cel<sup>®</sup>

MEMBRANE CONTACTORS

Liquid Degassing & Gasification Solutions



Deoxygenation  
Decarbonation  
Carbonation  
Nitrogenation  
Hydrogenation  
Debubbling  
Hydrogen Sulfide Removal

VOC Removal  
Osmotic Distillation  
Liquid/Liquid Extraction  
Humidification of Gases  
Dealcoholization  
Ammonia Removal  
Many More

# About Our Products

Liqui-Cel® Membrane Contactors are leading gas transfer devices that have been used in many industries around the world for over 20 years. Carbon dioxide removal, deoxygenation, nitrogenation and carbonation are all common applications. There are also many other applications where Liqui-Cel® Contactors can be applied, including ammonia, radon, H<sub>2</sub>S, THM and TOC/VOC removal.

Capable of achieving < 1ppm CO<sub>2</sub> and < 1ppb O<sub>2</sub>, Liqui-Cel® Membrane Contactors provide significant benefits to industrial processes by removing or adding gases to liquids. For example, carbon dioxide and oxygen removal can reduce the impact of corrosion on boilers and piping to protect capital investments and reduce operating costs. Removing these gases can also improve process efficiency and prevent negative impacts on production yields related to dissolved gases. Because of their cleanliness and predictability, Liqui-Cel® Membrane Contactors are the standard degassing technology installed in ultrapure water systems for the Semiconductor, Microelectronics and many other industries.

Liqui-Cel® Membrane Contactors are also found in many gasification applications. In the beverage industry these devices are often used for nitrogenation and carbonation because they provide precision in gas control. Membrane Contactors can also remove oxygen and add carbon dioxide in a single step.

Although other degassing technologies, such as vacuum towers and forced draft deaerators have existed for many years, these technologies may be displaced by Liqui-Cel® Membrane Contactors due to the smaller footprint, lower installation costs and the modular nature of membrane contactor systems. Contactors are easily piped together and can be readily expanded to meet growing capacity even after initial installation.



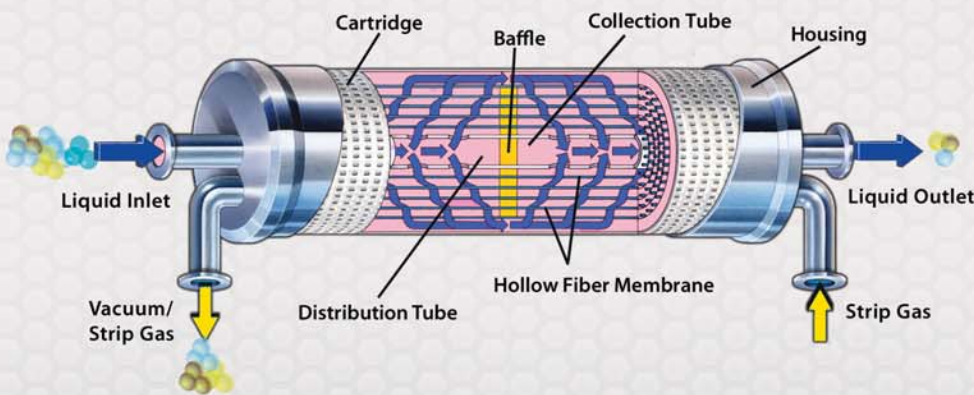
- Semiconductor/Microelectronics
- Boiler Feedwater
- Power Generation
- Flat Panel/TFT Displays
- Food & Beverage
- Pharmaceutical
- Ink Jet Inks
- Offshore Injection Water
- Medical/Analytical
- General Industrial
- Solar Panels
- Aquifer Storage
- Photographic
- Plating/Coatings
- Eye Care Products
- Many More

For more information about our products and applications visit [Liqui-Cel.com](http://Liqui-Cel.com)

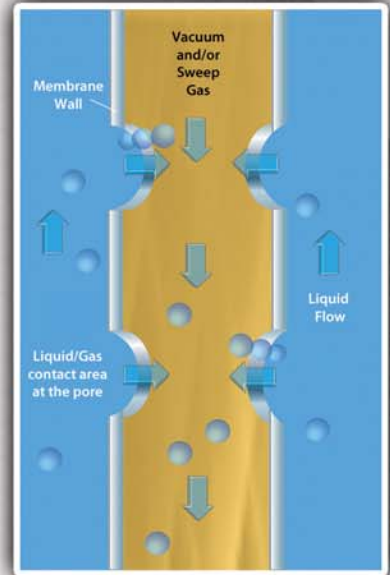
# How It Works

Liqui-Cel® Membrane Contactors use a microporous hollow fiber membrane to add gases to and remove gases from liquids. The hollow fiber is knitted into an array and wrapped around a center tube inside of the contactor housing.

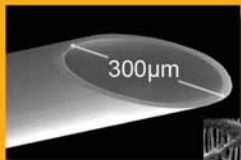
During typical operation, liquid flows over the shellside (outside) of the hollow fibers while a vacuum, strip gas, or both in combination, is applied to the lumen-side (inside) of the fibers. Because the membrane is hydrophobic it acts as an inert support that allows direct contact between a gas and liquid phase without dispersion. Applying a higher pressure to the liquid stream relative to the gas stream creates the driving force for dissolved gas in the liquid to pass through the membrane pores. The gas is carried away by the vacuum pump or sweep gas.



Inside of the Hollow Fiber

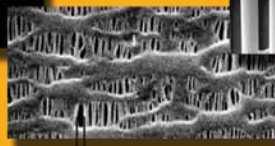


An animated product tour is available at [www.Liqui-Cel.com](http://www.Liqui-Cel.com)



Microporous Hydrophobic Hollow Fiber Membrane

Hollow Fiber Membrane Array



0.03µm Pore

Several fiber types have been developed for specific gas transfer applications.

- X40 - Oxygen removal from liquids
- X50 - Carbon dioxide removal from liquids
- XIND - Industrial liquid degassing
- Polyolefin - Low surface tension fluid (20-40 dynes/cm)

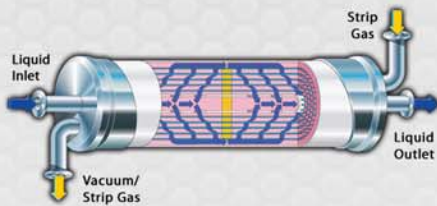
## Benefits:

- Modular design offers flexibility for meeting future capacity or tighter specification requirements
- High inlet pressure and low pressure drop reduces the need for repressurization pumps
- Maximized surface area/volume results in high performance and space efficiency
- No chemicals required to operate the membrane contactor
- Fast equilibrium means quick start-ups
- Different contactor sizes and material options provide tremendous flexibility
- Non-dispersive characteristics allow the contactor to be operated over a wide range of flow rates
- Simple operation could reduce instrumentation and maintenance requirements

# Product Variants

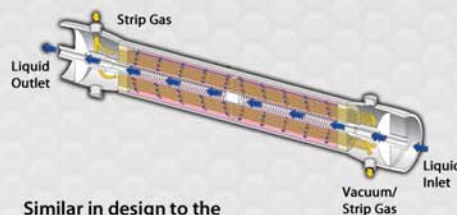
Liqui-Cel® Membrane Contactors come in multiple variants that maximize efficiency and performance while taking into account the flow rate and footprint requirements associated with the many applications.

## Extra-Flow



Liquid flows around the outside (shellside) of the hollow fibers. This design incorporates a baffle in the middle of the contactor, which directs liquid radially across the membrane array. A strip gas or vacuum is applied, separately or in combination, on the lumenside (inside) of the hollow fibers.

## High Pressure



Similar in design to the Extra-Flow with a baffle, the liquid is directed radially across the membrane array. However, this product group uses an RO style vessel that has a much higher maximum pressure than other Extra-Flow products.

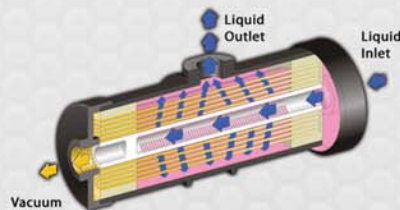


## Available Products

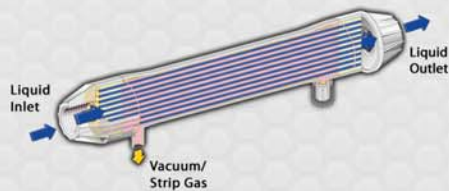
Contactor	Capacity	Fiber Type			
		X40	X50	XIND	P
MicroModule™	Up to 200 ml/min		✓		✓
MiniModule™	Up to 3000 ml/min		✓		
1 x 3 Radial Flow	15 - 60 ml/min				✓
2 x 6 Radial Flow	0.03 - 0.26 gpm 100 ml/min - 1 L/min				✓
2.5 x 8 Extra-Flow	0.5 - 3 gpm (0.1 - 0.7 m³/hr)	✓	✓		✓
4 x 13 Extra-Flow	3 - 15 gpm (0.7 - 3.4 m³/hr)	✓	✓		✓
4 x 28 Extra-Flow	5 - 30 gpm (1.1 - 6.8 m³/hr)	✓	✓		✓
6 x 28 Extra-Flow	5 - 50 gpm (1.1 - 11.4 m³/hr)	✓	✓		
8 x 20 Extra-Flow	5 - 50 gpm (1.1 - 11.4 m³/hr)			✓	
8 x 40 High Pressure	25 - 125 gpm (5.7 - 28.4 m³/hr)	✓	✓		
8 x 80 High Pressure	50 - 150 gpm (11.4 - 34.1 m³/hr)	✓	✓		
10 x 28 Extra-Flow High Purity	44 - 250 gpm (10 - 57 m³/hr)	✓	✓		
10 x 28 Extra-Flow Industrial	44 - 210 gpm (10 - 48 m³/hr)			✓	
14 x 28 Extra-Flow	70 - 400 gpm (16 - 90.8 m³/hr)	✓	✓		
14 x 40 Extra-Flow	70 - 550 gpm (16 - 125 m³/hr)	✓			

P = Polyolefin

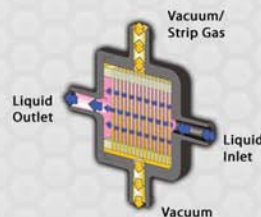
## Radial Flow



This variant utilizes a plugged center tube on one side of the device to force liquid radially over the hollow fibers. The 1 x 3 and 2 x 6 SuperPhobic® Membrane Contactors, which are primarily used for degassing low surface tension fluids, use the radial flow design.



The MiniModule™ Membrane Contactor does not utilize a baffle and the liquid and gas sides are reversed. Liquid flows through the inside of the hollow fiber (lumenside) while a vacuum is applied or a strip gas is used on the outside (shellside) of the hollow fibers.



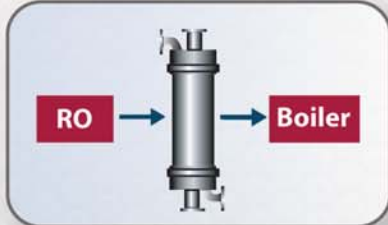
In MicroModule™ Membrane Contactors liquid flows into the liquid inlet, crosses the hollow fibers and then exits through the opposite port. No baffle is used. A vacuum or a strip gas can be applied to either gas port.



# Common Installation Scenarios

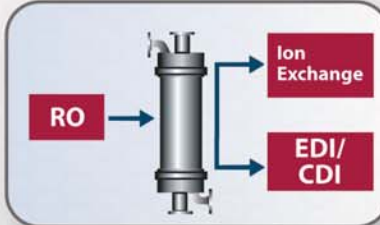
In many high purity and industrial applications, Liqui-Cel® Membrane Contactors have become the standard product for gas transfer to improve yields, reduce corrosion and increase efficiency.

## Chemical Free Boiler Feedwater Degassing



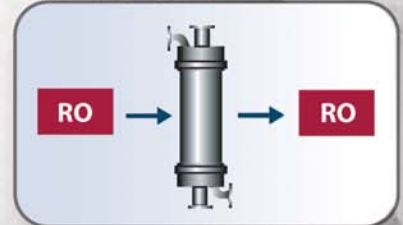
Removing CO<sub>2</sub> and O<sub>2</sub> from boiler feedwater protects the boiler and piping from corrosion while lowering operating costs with little or no chemical consumption.

## High Purity



Removing CO<sub>2</sub> after the RO and before Ion Exchange or EDI/CDI reduces chemical usage and allows optimization of the EDI/CDI units. Less CO<sub>2</sub> loading improves silica and boron removal as well.

## Double Pass RO



Removing CO<sub>2</sub> between a double pass RO system reduces chemical usage and minimizes scaling of the RO membranes.



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