



# Start-up Procedures

## 3M™ Liqui-Cel™ Membrane Contactors for TransMembrane ChemiSorption Operation

**For the following products:**  
MM-0.5×1 Series for TMCS  
EXF-2.5×8 Series for TMCS  
EXF-8×20 Series for TMCS  
EXF-14×28 Series for TMCS



**Prior to any start-up procedure, proper installation is required.**

Please read and follow all safety information, warnings and instructions in this manual. Failure to follow all product warnings and instructions could cause serious injury and property damage. Retain these instructions for future reference.

**Intended Use and Product Selection:**

3M™ Liqui-Cel™ Membrane Contactors are intended to remove dissolved gasses and bubbles from compatible liquids or to add gasses to a liquid stream. Liqui-Cel products are for use in industrial separation applications of industrial fluids only, in accordance with the applicable product instructions and specifications. Certain limited Liqui-Cel products are also intended for use in specific Food and Beverage (F&B) applications when used in accordance with product use requirements and instructions. Refer to the specific Liqui-Cel product’s performance data sheet to determine whether it includes a F&B designation and can be used for such applications.

3M Liqui-Cel Membrane Contactors may further be used in the production of water for various pharmaceutical products upstream of the final water sterilization step.

Certain limited Liqui-Cel Membrane Contactors may further be used in Transmembrane Chemisorption (TMCS) processes where the removed gasses are absorbed into a liquid phase and converted by chemical reaction.

Since there are many factors that can affect a product’s use, the customer and user remains responsible for determining whether the 3M product is suitable and appropriate for the user’s specific application, including user conducting an appropriate risk assessment and evaluating the 3M product in user’s application.

**Restrictions on Use:**

3M advises against the use of these 3M products in any application other than the stated intended use(s), since other applications have not been evaluated by 3M and may result in an unsafe or unintended condition. Do not use in any manner whereby the 3M product, or any extractable or leachable from the 3M product, may become part of or remains in a medical device, drug, cosmetic, or supplement, infant formula; or in applications involving life-sustaining medical applications or prolonged contact with internal bodily fluids or tissues.

**SAFETY INFORMATION**

Explanation of Signal Word Consequences	
<b>⚠ WARNING</b>	Indicates a hazardous situation which, if not avoided, could result in serious injury or death.
<b>⚠ CAUTION</b>	Indicates a situation which, if not avoided, could result in product or system damage.
<b>NOTICE</b>	Indicates a situation which, if not avoided, could result in product or system damage.

**Read entire product manual. Failure to follow all product instructions and warnings could cause personal injury and/or property damage.**

**⚠ WARNING – To reduce the risks associated with liquid bursting or gas explosion and/or exposure to chemicals and membrane contactor damage:**

- Do not introduce gas alone into the membrane contactor without liquid in the shell side except when following 3M storage guidelines.
- Do not exceed maximum operating pressure or temperature limits.
- Implement workplace safety risk controls according to local applicable laws and regulations.
- Always use appropriate personal protective equipment (PPE) when installing, servicing, operating, cleaning or disposing of the membrane contactor.
- All plumbing should be done in accordance with local regulations and code.
- To prevent buildup of pressure inside the membrane contactor, do not block or valve off all gas/vacuum ports during operation or downtime.
- Ensure chemically compatible materials of construction are used within system.
- Always make sure to verify proper connections within the membrane contactor system.
- Never modify or alter the membrane contactor. Only 3M or parties authorized in writing may make changes/repairs to the equipment.
- Inspect membrane contactor prior to cleaning or installation. Only use replacement parts supplied by 3M for this product.
- Inspect the membrane contactor to ensure no leaking, cracking, or other signs of damage on membrane contactor, gaskets and tubing or piping.

**To reduce the risks associated with asphyxiation [or other health hazards], accidental gas explosion, or environmental contamination:**

- Ensure proper system ventilation and discharge of any gases being used in or generated during membrane contactor operation, cleaning and drying, (including sweep gas, vacuum pump or blower discharge,) according to all applicable building codes and regulations.

**To reduce the risks associated with fire and explosion:**

- Do not introduce explosive, flammable, toxic or oxidizing liquids or gases in dangerous concentrations into the membrane contactor or the system.
- Over-pressurization of liquid and gas should be prevented by the installation of proper pressure relief valves/safety systems.



**To reduce the risks associated with acid spraying or leakage and property damage:**

- Proper safety equipment, such as flange covers and/or skid enclosures or shielding, must be installed in the facility to protect against possible spraying from system components, bursting or release of acid under pressure.

**To reduce the risks associated with impact, lifting or moving:**

- Do not attempt to move the system while it contains liquid.
- Do not attempt to move system while in operation.
- Use appropriately rated lifting equipment for lifting or moving. Review the product datasheet or operating guide for weights.
- Always ensure the system is stable, level, and properly secured. Be sure the system cannot tip, roll, fall, slide or make any movement that may cause injury, damage to the unit, or damage to other system components.
- If needed, use shims to level the system.

**⚠ CAUTION**

**To reduce the risks associated with hot surfaces and hot exhaust gases:**

- Do not touch the membrane contactor or liquid lines during operation or cleaning and drying. Surfaces may be hot.
- Avoid close proximity to blower exhaust.

**To reduce the risks associated with environmental contamination:**

- Exhaust gas should be vented in a safe manner and according to local regulations.

**To reduce the risks associated with damaging the membrane contactor:**

- Ensure membrane contactor is properly aligned with piping, and flanges are adequately tightened during use and after cleaning. Always conduct system checks in accordance with installation instructions and facility policies prior to operation.
- Ensure proper draining and flushing of membrane contactor before maintenance, service, or shipping of membrane contactors.

**NOTICE – To reduce membrane contactor or system damage:**

- Care must be taken not to drop, hit or impact the membrane contactor.
- If the membrane contactor is used with air sweep, then the temperature should not exceed 35°C (95°F). For membrane contactors used with vacuum only this statement does not apply.
- For all membrane contactors, lumen side pressure should never exceed shell side pressure during cleaning and operation. Always refer to operating and cleaning guidelines for the use application.
- To avoid contamination of the process fluid, gloves are recommended when handling the membrane contactors.
- All plastic port extensions should be supported to prevent bending of extensions under excessive piping loads.
- 3M™ Liqui-Cel™ Membrane Contactors should be stored dry and in a sealed plastic bag or shrink wrap material to help prevent the introduction of contaminants into the membrane contactor.
- 3M Liqui-Cel Membrane Contactors should be stored in their original box, or other opaque box, and should not be installed where they are exposed to direct sunlight.
- Store 3M Liqui-Cel Membrane Contactors dry at temperatures < 50°C (122°F), but preferably at lower temperature such as <35°C (95°F), to not risk reduced lifetime. Membrane contactors should always be stored above freezing temperatures, and if stored at low temperature, they should be allowed to equilibrate to room temperature before use.
- Do not use thread sealant to connect fittings to membrane contactor.
- Use care if using a metal fitting to connect to a plastic connector on the membrane contactor.
- Do not allow membrane contactors containing microporous hollow fiber membranes to come into contact with surfactants, oil, or organic solvents, such as pure alcohols, glycol, acetone, etc., to reduce the risk of membrane wet out. SP-series membrane contactors containing polyolefin membrane are not subject to this restriction.
- To protect the membrane contactors, prefiltration equipment should be inspected and maintained in accordance to 3M Liqui-Cel Membrane Contactors Inlet Water & Sweep Gas Operating Guidelines, in the Technical Resources section at 3M.com/Liqui-Cel.
- Suspended solids, biological contaminants, or the precipitation of soluble or insoluble salts on the membrane surface may lead to membrane plugging.
- Filtered, de-chlorinated, and deionized water is recommended for mixing cleaning solutions. If a pH shift occurs water containing sparingly soluble compounds of Ca, Mg, Fe, Al, and silica (SiO<sub>2</sub>), etc. could precipitate from the solution and block or damage the membrane. Ensure that your water is free of these compounds.
- Cumulative exposure of the membrane to oxidants, such as ozone, chlorine, hydrogen peroxide, peracetic acid, etc., should be restricted to reduce the risk of membrane oxidation.
- Avoid water hammer (sudden pressure spikes) in system.

**ATTENTION**

**Disposal**

At end of life, dispose of the membrane contactor or cartridges in accordance with all applicable local and government regulations

**Hazards from Chemicals**

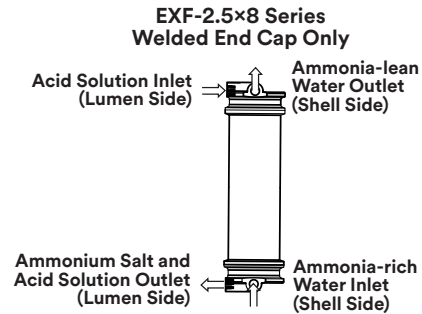
The chemicals that User selects to use in connection with the membrane can present their own hazards. User should follow all safety information and related requirements provided by the chemical supplier and applicable regulations, as well as conduct User's own workplace safety, hazard and application assessment. This document cannot and does not address all safety and/or safe handling requirements that different chemicals could present. User is responsible for ensuring that chemicals are only used by persons familiar with their use and hazards (for example, personnel who have received hazardous material training), and who have the appropriate protective equipment as specified in their organization's safety program and the chemical's safety datasheet (SDS). User assumes all responsibility for the suitability and fitness for use as well as for the protection of the environment and for health and safety involving such chemicals.

## Start-up Procedures | 3M™ Liqui-Cel™ Membrane Contactors for TMCS

Transmembrane Chemisorption (TMCS) is a specific operating mode for membrane contactors and can be used for various gas transfer applications. In this mode, using ammonia as an example, ammonia is physically removed (desorbed or stripped) from a feed water, diffuses across the membrane wall (trans-membrane), and is then absorbed into and chemically reacts with (chemical-sorption) a liquid acid stream. The process is also known as ammonia abatement.

The two aqueous liquid phases are separated by the wall of the hydrophobic microporous membrane. The feed water containing ammonia flows on the outside of the hollow fibers. An acid solution (pH<1-2) flows in counter-current direction inside (lumen side) the hollow fibers. Ammonia gas passes through the air-filled pores and chemically reacts with an acid (sulfuric acid shown as example) to form ammonium sulfate salt. The driving force for ammonia transfer is the ammonia concentration differential between the feed water phase and acid phase.

### Correct Mounting Position and Port Identification



### Liquid-Stream Configuration

The following are guidelines for designing a TMCS process with 3M Liqui-Cel Membrane Contactors.

- Vertical mounting of contactor is recommended since only vertical orientation allows for self-draining of each stream.
- It is recommended that feed water should flow from the bottom to the top of the contactor.
- The flow direction of the feed water and acid must be counter-current to each other.
- If the feed water pressure coming into the membrane contactor system is greater than the maximum operating pressure, a pressure regulator is strongly recommended. For maximum pressure ratings and maximum operating temperature refer to the table 8.
- To avoid damage from water hammer always use slow closing valves on the downstream side of the membrane contactor system.
- Include feed water low-point drains, pressure and temperature indicators in the system design.

The typical recommended liquid flow rates for TMCS of ammonia listed in following table are guidelines. The ratio of acid to feed water flow rates is generally in the range of 0.5 to 2 depending upon the acid concentration and pH value. The acid concentration/pH should be monitored since water vapor transfer into the acid side dilutes the acid stream.

Product	Feed Water Stream (Shell Side)	Acid Stream (Lumen Side)
0.5 × 1	5 - 30 ml/min	5 - 30 ml/min
2.5×8	20 - 100 L/hr	20 - 100 L/hr
8 × 20	0.25 - 2.0 m <sup>3</sup> /hr (1 - 9 gpm)	0.25 - 2.0 m <sup>3</sup> /hr (1 - 9 gpm)
14 × 28	5 - 20.4 m <sup>3</sup> /hr (22 - 90 gpm)	2 - 10 m <sup>3</sup> /hr (9 - 40 gpm)

## Start-up Procedures | 3M™ Liqui-Cel™ Membrane Contactors for TMCS

### Notes:

- Water entering the shell side of the membrane contactor should be pre-filtered at 5 micron absolute at 99.9% removal (beta 1000).
- Acid entering the lumen side of the membrane contactor should be pre-filtered at 1 micron absolute at 99.9% removal (beta 1000).
- Prior to start-up, flush all pipes to drain prior to introducing liquids into the membrane contactors.



### Initial Start-up

- Make sure that all connections are tight.
- Open all water valves except the inlet valve to contactors.
- Fill acid circulating tank with sufficient volume of water for filling the piping and membrane contactors and open all valves to the acid circulation pump and each module.
- Turn on circulation pump for complete filling and venting of the acid circulation system.
- Slowly open water inlet valve to the system to introduce feed water to the system. Making sure that water inlet pressure and water flow rate through the membrane contactor never exceed the maximum operating limits.
- Adjust feed water flow rate to the desired levels by adjusting the appropriate system valves.
- Make sure there are no leaks.

### System Start-up

- Ensure acid circulation and wastewater flow pumps are operating properly. Then start acid dosing pump.
- Wait for pH to reach 1-2 before turning on the caustic dosing pump.
- Monitor process conditions (flow, pressure, pH, temperature).

### Shutdown Procedure

1. Stop caustic dosage and wastewater flow.
2. Stop acid circulation and acid addition.
3. Leave the lumen side (acid) valves open. Do not close these valves during shutdown. This avoids pressure build-up in the lumen side of the membrane contactor.

### Downtime Guidelines

- Composition of the feedwater will determine how one should handle the membrane contactors for downtime longer than 3 days. During downtime the wastewater side should be flushed with demineralized water. We recommend that the wastewater side remains filled with clean high-pH water (pH > 11). The acid pumps should be stopped and the acid outlet valve should be open to the tank to prevent pressure buildup on acid side because of osmosis (water from feed water side drawn into the acid side).

**Product Selection and Use:** Many factors beyond 3M's control and uniquely within user's knowledge and control can affect the use and performance of a 3M product in a particular application. As a result, customer is solely responsible for evaluating the product and determining whether it is appropriate and suitable for customer's application, including conducting a workplace hazard assessment and reviewing all applicable regulations and standards (e.g., OSHA, ANSI, etc.). Failure to properly evaluate, select, and use a 3M product and appropriate safety products, or to meet all applicable safety regulations, may result in injury, sickness, death, and/or harm to property.

**Warranty, Limited Remedy, and Disclaimer:** Unless a different warranty is expressly identified on the applicable 3M product literature or packaging (in which case such express warranty governs), 3M warrants that each 3M product meets the applicable 3M product specification at the time 3M ships the product. 3M MAKES NO OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR ARISING OUT OF A COURSE OF DEALING, CUSTOM, OR USAGE OF TRADE. If a 3M product does not conform to this warranty, then the sole and exclusive remedy is, at 3M's option, replacement of the 3M product or refund of the purchase price.

**Limitation of Liability:** Except for the limited remedy stated above, and except to the extent prohibited by law, 3M will not be liable for any loss or damage arising from or related to the 3M product, whether direct, indirect, special, incidental, or consequential (including, but not limited to, lost profits or business opportunity), regardless of the legal or equitable theory asserted, including, but not limited to, warranty, contract, negligence, or strict liability.

3M and Liqui-Cel are trademarks of 3M Company. All other trademarks are the property of their respective owners.  
© 2021 3M Company. All rights reserved.



**3M Company**  
**3M Separation and Purification**  
**Sciences Division**  
13840 South Lakes Drive  
Charlotte, North Carolina 28273 USA  
Phone: +1 980 859 5400

**3M Deutschland GmbH**  
**3M Separation and Purification**  
**Sciences Division**  
Öhder Straße 28  
42289 Wuppertal Germany  
Phone: +49 202 6099 - 0

LC-2104  
REV 09/2021  
34-8727-6152-2  
[3M.com/Liqui-Cel](https://www.3M.com/Liqui-Cel)