3M | Liqui-Cel™ Membrane Contactors

China Power Plant Installs Advanced Integrated Membrane System (IMS) to Reduce Capital Costs and Decrease Energy Use

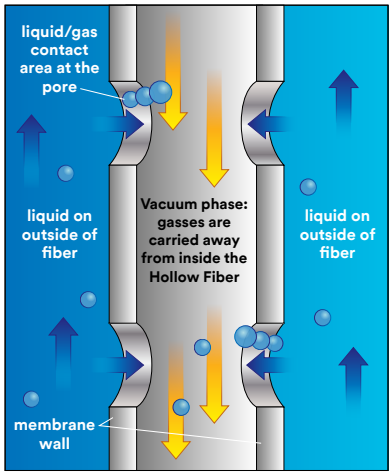
Double-pass RO + EDI systems have been widely used to produce ultra-pure water. As engineers come under increasing pressure to reduce maintenance and operating costs, Integrated Membrane Systems (IMS) have come to the forefront of the industrial water treatment industry. IMS is an industrial water treatment system that combines multiple membrane-based water treatment processes into a single system.

A heat and power plant in northeast China selected an IMS design over a conventional system for its water treatment process. The conventional design option incorporated both membrane and non-membrane technologies into the system and used a double-pass RO design before Electrodeionization (EDI). (See Figure 1)

Conventional Double-Pass RO System Design

The IMS design for this plant incorporated membrane-based technologies for all four major system components: Ultrafiltration (UF), single-pass RO, 3M™ Liqui-Cel™ Membrane Contactors for CO_2 removal, and Electropure™ Electrodeionization (EDI).

Figure 2 . 3M™ Liqui-Cel™ Membrane Contactor



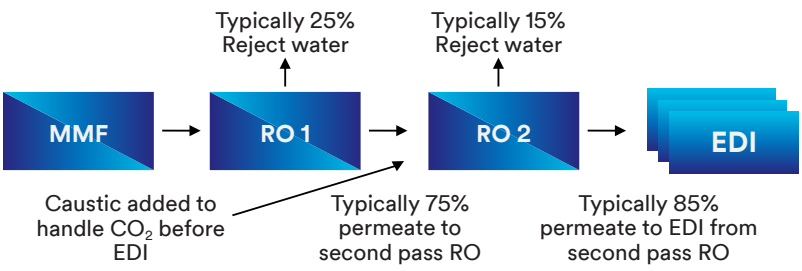
The Liqui-Cel membrane contactors used in this system are microporous hollow fiber membrane devices that remove dissolved gases from liquids. Gas flows across one side of the membrane with liquid on the other side. Because the membrane is hydrophobic, only gases can pass through the pores.

Lowering the partial pressure of the gas allows the dissolved gases in the liquid to easily transfer through pores in the membrane wall of the hollow fiber.

System Configuration

1. IMS Flow rate: 2 × 80 m³/h
2. UF flow rate: 120 m³/h
3. RO system flow rate: 90 m³/h
4. Liqui-Cel CO_2 removal technology flow rate: 90 m³/h
5. EDI flow rate: 80 m³/h

Figure 1 . Double-pass RO with EDI system design



Water Quality Summary

Raw Water Quality Analysis	
TDS	406 - 600 mg/l
pH	7.5 - 7.7
Total Alkalinity	280 mg/l (as $CACO_3$)
SiO_2	5.5 ppm

RO Permeate Analysis	
Conductivity	6.8 µs/cm
CO_2 Concentration	10 - 12 ppm

Liqui-Cel Membrane Permeate Water Quality	
Outlet CO_2 Concentration	1 - 2 ppm (actual result)

EDI Permeate Water Quality	
Conductivity	0.071 - 0.06 µs/cm (14 - 16.7 MΩ)
SiO_2	5 ppb

3M™ Liqui-Cel™ Membrane Contactor Operating Conditions

- 90 m³/h water flow
- Two 14-inch contactors in parallel
- X-50 membrane
- Combined with air sweep and vacuum
- Vacuum pump: 360 m³/h at vacuum level -0.094 Mpa (55 mmHg)

The IMS design (see Figure 3) was selected over the conventional system because it lowered capital and operating costs. Additionally, the water reclaimation rate was greatly improved compared with the traditional process.

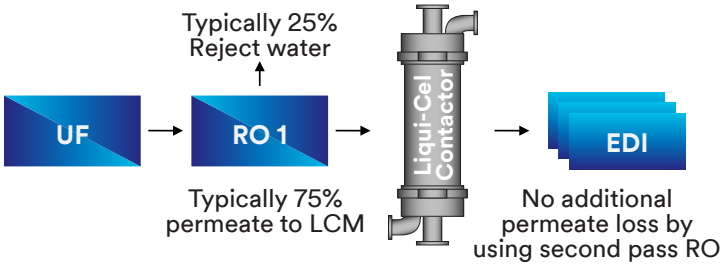
Benefits of IMS Compared with Conventional Processes

- The RO + Liqui-Cel contactor system eliminates the need for a second pass RO and an RO pump. This reduces capital costs and lowers the power required to operate the system because there is no longer a need for a second RO pump.
- The reject water from the conventional double-pass RO system is no longer lost. (See Figure 3.)
- Since Liqui-Cel membrane contactors remove CO_2, there is no need to add caustic to increase pH before the second pass RO. (Compare Figure 1 to Figure 3.)
- The Liqui-Cel membrane contactor system also has a smaller footprint compared to the system utilizing a double-pass RO system.
- By removing free CO_2 from the EDI feedwater, silica removal efficiency is improved.

The Liqui-Cel Contactor system offers other unique benefits. It can remove both carbon dioxide and oxygen at the same time. If the water is used for other applications, such as boiler feed water, the system can deliver water with a high resistivity and low levels of dissolved oxygen.

For more information and system sizing, please contact your 3M representative or visit 3M.com/Liqui-Cel.

Figure 3. IMS Design with Single-Pass RO and Membrane Degassing



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