Industrial filtration

Power plant uses Liqui-Cel membrane contactors to remove CO_2 from water

A major power plant in Thailand is using Thermo Scientific™ Liqui-Cel™ Membrane Contactors to remove carbon dioxide from a DI water system. The system is an expansion project and will be used to feed a high pressure boiler. Liqui-Cel membrane contactors are being used to lower the CO_2 inlet into an Ionpure Electrodeionization (EDI) system. Carbon dioxide adds an ionic load to the EDI system, which can reduce the performance of the system. Manufacturers of the EDI equipment suggest lowering the inlet CO_2 to reduce the load on the equipment and improve the water quality.

The system was designed, built and installed by Liquid Purification Engineering International Co., Ltd. in Bangkok Thailand. LPE designed the DI water system as an all-membrane-based system that does not require the use of ion exchange resin or chemicals. The system uses a double pass Reverse Osmosis (RO) membrane, a Liqui-Cel membrane contactor and Ionpure EDI technology. The system produces water with a resistivity >16.0 MΩ-cm (see Table 1 and Figure 2).

The Liqui-Cel membrane contactor system consists of one 14-inch (35.6 cm) membrane contactor that operates in combination mode using vacuum and air sweep.

Liqui-Cel membrane contactors utilize a hydrophobic polypropylene membrane to remove dissolved gasses from water. Water flows on one side of the membrane and a vacuum or strip gas is passed on the other side of the membrane. In this system air is drawn into the membrane under vacuum. The high flow rate of air sweep under vacuum creates a driving force to move the dissolved CO_2 from the water into the gas phase.

Historically, forced draft deaerators have been used to remove CO_2 from water. This type of deaerator uses ambient air that is fed into the tower with a blower, putting the air in direct contact with the water. This results in air-to-water contamination from any contaminants that are present in the air. For this reason, using a forced draft deaerator downstream of an RO membrane system is not recommended.



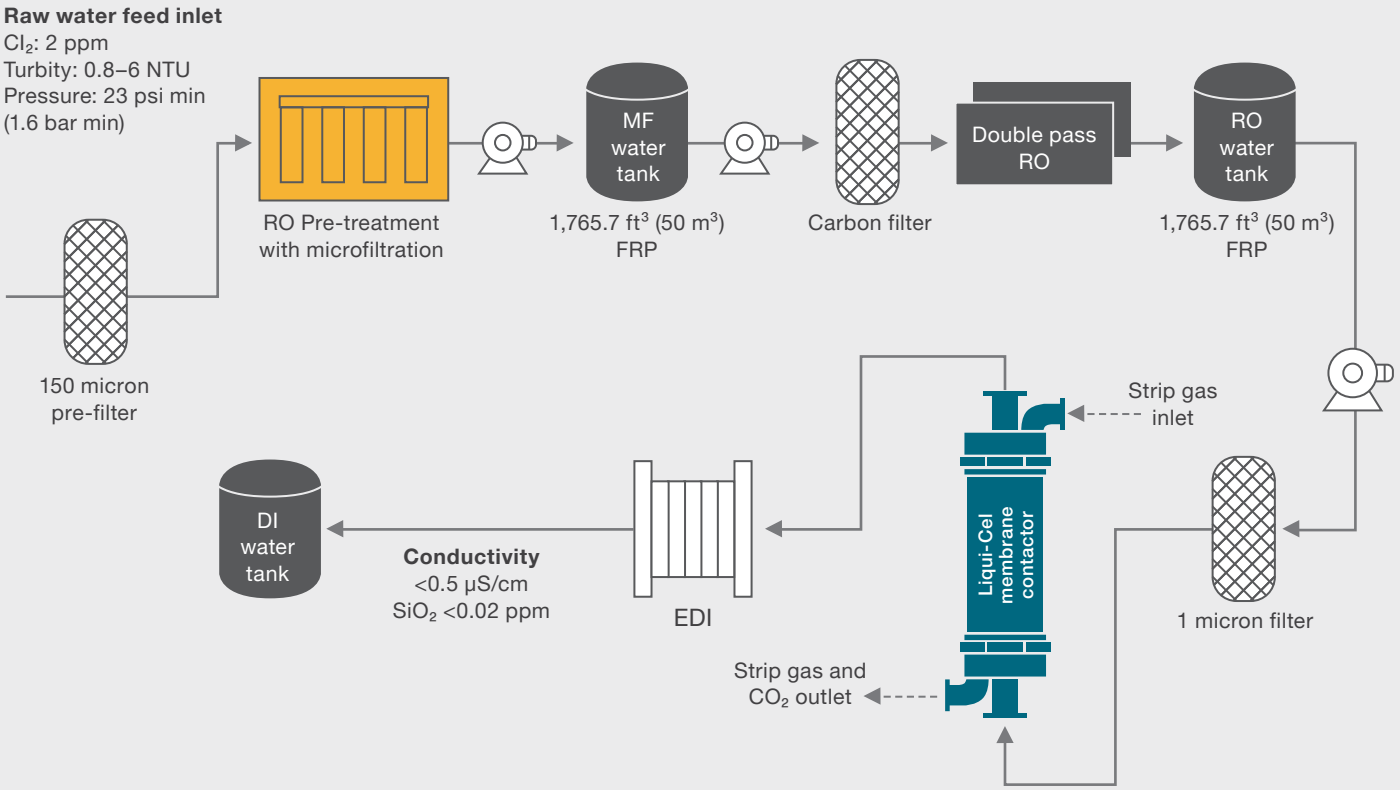
Figure 1. Thermo Scientific™ Liqui-Cel™ Membrane Contactor

Table 1. Water quality analysis

Water quality influent analysis water source	Clarified surface water
Turbidity, NTU	0.8–5
pH	6.5–8
Conductivity, micro siemen-cm	400
TDS, mg/l	280
M- alkalinity, mg/l as $CaCO_3$	100
Total hardness, mg/l as $CaCO_3$	120
Calcium hardness, mg/l as $CaCO_3$	75
Chloride, mg/l as Cl-	45
Iron, mg/l as SO_4	0.01
Sulfate, mg/l as SO_4	26
Phosphate, mg/l as PO_4	0.03
Silica, mg/l as SiO_2	15
Effluent quality, RO feed	
Turbidity, NTU	<0.5
SDI	<3
Effluent quality, DI water	
Resistivity, MΩ-cm	>16.0
Silica, mg/l as SiO_2	<0.02

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Figure 2. Example process flow diagram of water treatment system (RO-LMC-EDI) using a Thermo Scientific™ Liqui-Cel™ Membrane Contactor



Liqui-Cel membrane contactors, however, are well suited to remove dissolved carbon dioxide and other dissolved gasses along side of an RO membrane system because the membrane has 0.03 µm pores that prevent air stream contamination from coming into contact with the RO water.

Liqui-Cel membrane contactors are mechanical devices that remove the dissolved CO_2 that will ionize in water and be present in both gaseous and ionic forms. The amount of CO_2 gas present in the water depends on the pH of the water. The lower the pH, the greater the amount of CO_2 present in the water. Due to the natural decrease of pH across the RO membrane system, the pH inlet to the membrane contactor is below 6. This favors the formation of CO_2 gas and allows the membrane contactor to efficiently remove CO_2 gas from the water.

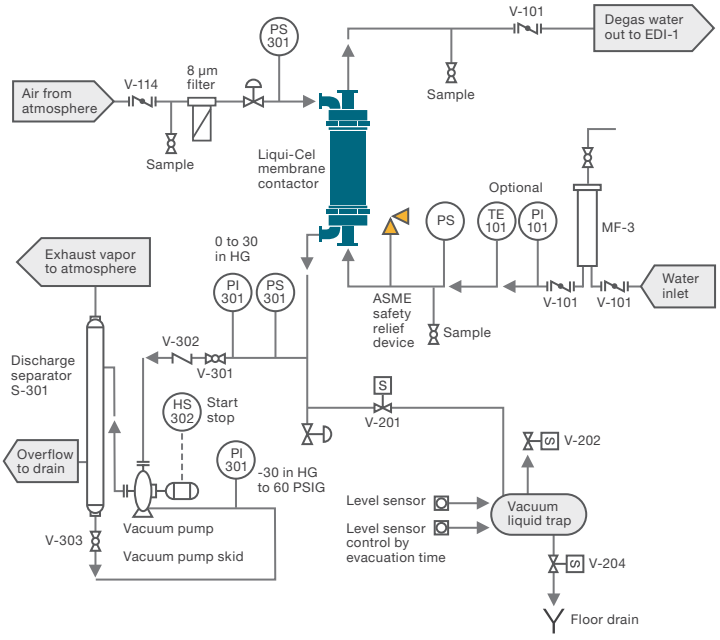


Figure 3. Example process and instrumentation diagram (P&ID) using Thermo Scientific™ Liqui-Cel™ Membrane Contactor

The power plant is very pleased with the membrane based DI water system. It requires little maintenance and exceeds the performance specifications for the system. In addition, by incorporating Liqui-Cel membrane contactors into the system to remove CO_2, the amount of chemicals used in the plant is reduced. By mechanically removing the CO_2, the end user did not need to adjust the pH up to facilitate removal by the RO membrane system or use ion exchange beds upstream of the EDI to lower the CO_2 ionic load on the EDI.

Liqui-Cel membrane contactors are used in thousands of systems throughout the world to remove dissolved gasses from water. This design is one example of how membrane contactors can be used in a water system.



Figure 4. Thermo Scientific™ Liqui-Cel™ Membrane Contactor installed as part of a membrane-based DI water system

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