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Rokeby Generating Station Saves 50% in Capital Expense by Using 3M™ Liqui-Cel™ EXF-14×28 Series Membrane Contactors to Remove CO_2 to Extend Mixed Bed Resin Life

Lincoln Electric Systems (LES) recently commissioned a membrane decarbonation system using 3M™ Liqui-Cel™ EXF-14×28 Series Membrane Contactors to remove CO2 prior to their mixed bed deionizers. The system was installed at the Rokeby Generating Station (RGS) in Lincoln, Nebraska.

Background

The Rokeby Generating Station is LES' primary peaking power station, totaling 255 MW and consisting of 3 duel fuel combustion turbines. The existing DI water system consisted of two single-pass, two-stage RO skids followed by a 31 ft³ (0.87 m³) mixed bed deionizer and two 250,000-gallon (943 m³) storage tanks.

LES determined that the mixed bed unit was producing only 30% of its expected capacity (90,000 gallons actual vs. 300,000 gallons expected or 341 m³ actual vs. 1136 m³ expected). It was determined that the cause of the decreased capacity was due to dissolved CO_2 in the water, which was overloading the anion resin. As the power capacity demand increased, LES had to act quickly to update their winter contingency plans.

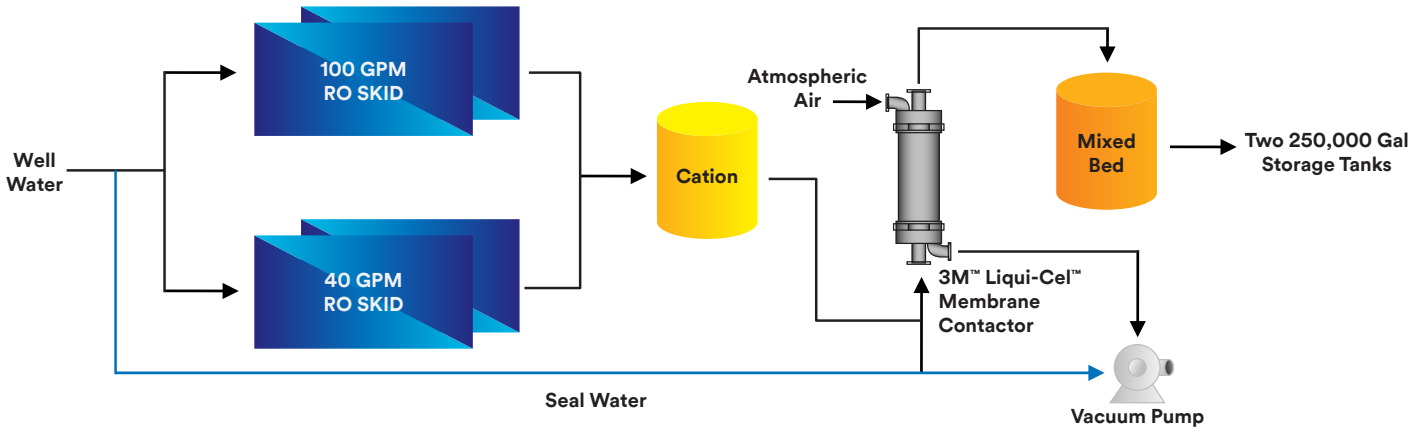
Treatment Options

Multiple treatment options including chemical treatment and the installation of a forced draft degasifier were considered. Ultimately, chemical treatment was considered too risky because of its negative impact on increasing scale on the RO membranes. A forced draft deaerator was also considered impractical due to the large capital expense and size constraints at LES.

System Design

In 2005, LES began engineering a membrane decarbonation system using Liqui-Cel EXF-14×28 series membrane contactors. The system was designed to treat the combined water flow from both RO skids, approximately 150 GPM (0.6 m³). The goal was to achieve approximately 90% reduction of dissolved CO_2.

Figure 1. Decarbonation system incorporating a 3M™ Liqui-Cel™ 14x28 Membrane Contactor



Additionally, the system was designed to operate with vacuum assisted air sweep, using a liquid ring vacuum pump to draw atmospheric air through the 3M™ Liqui-Cel™ Membrane Contactors.

Since the LES staff was able to design, fabricate, and install the Liqui-Cel membrane contactor degassing system, the total capital cost was approximately 50% less than the cost of a forced draft degasifier. The compact design also allowed LES to build the system inside of an existing building with minimal modification. The low system pressure drop through a Liqui-Cel membrane contactor system also eliminated the need for a re-pressurization pump, further lowering operating costs for LES.

The degas skid was installed downstream of the RO skids and before the mixed bed. In order to maximize efficiency, a cation bottle was installed between the RO skids and the degas skid to reduce the pH and convert the HCO_3 to free CO_2 gas. (See Figure 1 on the previous page.)

Test Set Up

LES temporarily installed three 3.3 ft³ (0.09 m³) mixed bed bottles downstream of the degas skid. The bottles were installed in parallel for a total capacity of 9.9 ft³ (0.28 m_3). During the test, only one of the RO units was operated, resulting in water flow of 40 GPM.

LES expected to achieve 138,000 to 168,000 gallons (522 m³ – 636 m³) throughput with this design. They actually achieved 191,000 gallons (725 m³). Specific conductivity was 0.5 µS/cm and silica was 7.5 ppb. LES estimates the full-scale capacity will be approximately 617,000 gallons [(32 ft³ / 9.9 ft³) x 191,000 = 617,374 gallons (2337 m³)]. This represents an increase in the total capacity of the system by a factor of 5.9.

Summary

Liqui-Cel membrane contactors offer a cost-effective, efficient option for removal of CO_2 from process water. Removal of CO_2 prior to the mixed bed resins significantly improves regeneration times, thereby reducing operating costs and improving overall efficiency by minimizing downtime.

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

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LC-1070
70-2016-0234-2
Rev. 02/2021
3M.com/Liqui-Cel