Industrial filtration

Rokeby Generating Station saves 50% in capital expense by using Liqui-Cel membrane contactors to remove CO_2 to extend mixed bed resin life

Lincoln Electric Systems (LES) recently commissioned a membrane decarbonation system using Thermo Scientific™ Liqui-Cel™ EXF-14x28 Membrane Contactors to remove CO_2 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 three dual fuel combustion turbines. The existing DI water system consisted of two single-pass, two-stage Reverse Osmosis (RO) skids followed by a 31 ft^3 (0.87 m^3) mixed bed deionizer and two 250,000-gallon (943 m^3) 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 m^3 actual vs. 1136 m^3 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-14x28 membrane contactors. The system was designed to treat the combined water flow from both



Figure 1: Thermo Scientific™ Liqui-Cel™ Membrane Contactors

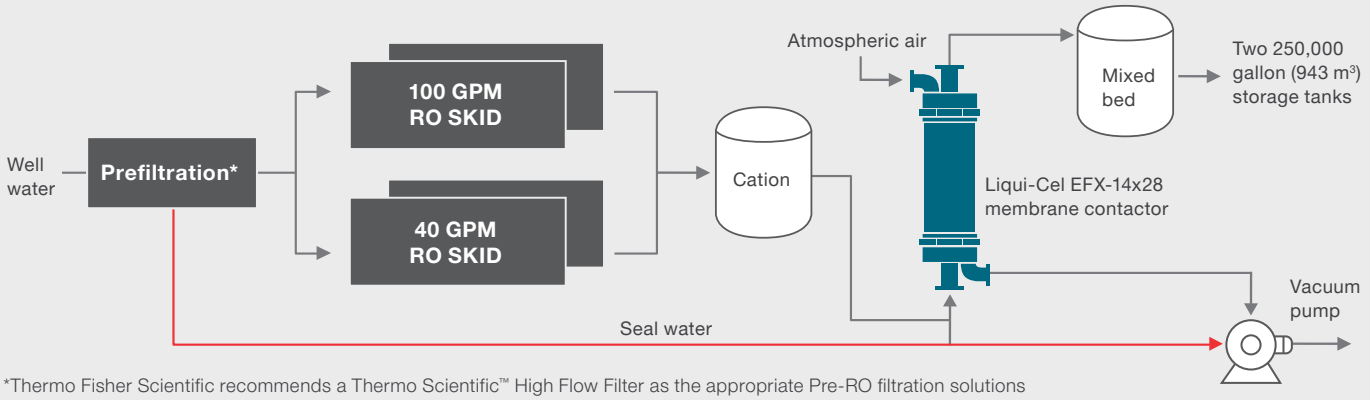
RO skids, approximately 150 gpm (34.1 m^3/hr). The goal was to achieve approximately 90% reduction of dissolved CO_2.

Additionally, the system was designed to operate with vacuum assisted air sweep, using a liquid ring vacuum pump to draw atmospheric air through the 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 2).

Figure 2. Decarbonation system incorporating a Liqui-Cel EXF-14x28 membrane contactor



*Thermo Fisher Scientific recommends a Thermo Scientific™ High Flow Filter as the appropriate Pre-RO filtration solutions

Test set up

LES temporarily installed three 3.3 ft^3 (0.09 m^3) mixed bed bottles downstream of the degas skid. The bottles were installed in parallel for a total capacity of 9.9 ft^3 (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 (522–636 m^3) throughput with this design. They actually achieved 191,000 gallons (723 m^3). 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 ft^3/9.9 ft^3) x 191,000 = 617,374 gallons (2337 m^3)]. 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.

Application engineering

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