3M | Liqui-Cel™ Membrane Contactors

Jotem Water Treatment Uses a 3M™ Liqui-Cel™ System for Oxygen Removal from the Feedwater of a Central District Heating System in a Dutch Power Station

Introduction

Central district heating systems have gained attention in recent years because they can be more efficient than localized boiler units. The efficiency of district heating is usually due to power generation plants being able to produce heat and electricity simultaneously. District heating also helps prevent pollution by using advanced flue gas cleaning techniques

Central district heating systems distribute heated water from power plants to densely populated residential and industrial areas through insulated piping networks. Large storage tanks are typically used to safely store heat for use during peak demand times. High water quality is required to prevent internal corrosion and to increase the lifetime of piping and storage tanks.

Inlet water is typically filtered, softened and deoxygenated during the initial filling of the system. But a water source is also needed to feed the recirculation system that compensates for any water loss during operational or seasonal fluctuations, and this water must also be deoxygenated to prevent corrosion. As part of this refilling system, Jotem Waterbehandling BV installed 3M™ Liqui-Cel™ Membrane Contactors for O_2 removal at a Netherlands power station.

3M™ Liqui-Cel™ Membrane Contactor Technology

The technology behind Liqui-Cel membrane contactors is based on Henry's Law, which states that gasses will dissolve in water relative to their partial pressure above the liquid. The solubility constant (Henry's Constant), which is different for each gas, also depends on temperature. Water below atmospheric standard conditions (20°C, 1bar) and in contact with ambient air contains up to 8-9 ppm (mg/L) of oxygen.

Water flows through the contactor on the outside (shellside or liquid side) of the hollow fiber membrane. Because the membrane is microporous and hydrophobic, only gas molecules are able to pass through the membrane. Applying a vacuum or using an inert sweep gas on the inside (lumenside) of the hollow fiber membrane lowers the partial pressure of the gas that needs to be removed, carrying excess gasses away into the vacuum.

System Design

Jotem's goals were to achieve an O_2 specification of <10 ppb for filling the storage water tanks and to maintain a constant fill level. For an inlet water flow of 30 m^3/h, Jotem installed

four 14-inch Liqui-Cel contactors connected in series. To achieve the low O_2 requirements, the system operates in N_2-vacuum (combo) operation. The vacuum pump pulls vacuum through a parallel connected manifold from the bottom gas ports, while the N_2 sweep gas enters the contactors through the top gas ports. The O_2 content is reduced through each membrane step.

The necessary 2.2 m^3/h of total nitrogen sweep gas (0.55 m^3/h for each module) is produced in a separate N_2 generator with a pressure swing absorption technique. This generator constantly creates N_2 gas with a purity of >99.99% (100 ppm of O_2) from ambient air. For each cubic meter of N_2, about 6 m^3 of compressed air (at 6 bar) is required. The nitrogen can be stored in pressurized tanks during system stand-by.

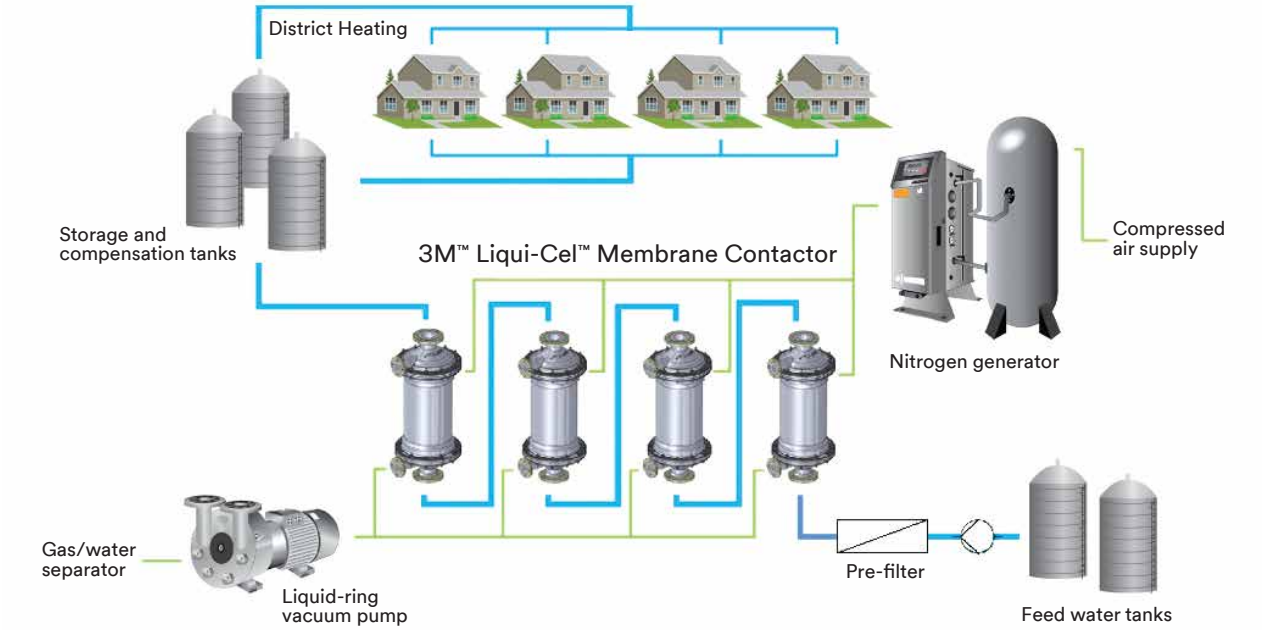
The vacuum level of 66 mbar absolute (50 torr) is created by a liquid ring vacuum pump with an external water cooling system. The service water is recycled to about 50% by a gas/water separator.

Results

The system exceeded expectations, achieving 5 ppb oxygen levels. The 3M™ Liqui-Cel™ Membrane Contactor system also has a much smaller footprint than a traditional degassification system. This smaller footprint allowed Jotem to install the O_2 removal system close to point-of-use at the treatment solution, lowering energy demand and operating costs.

To learn more about Liqui-Cel technology and how it can be integrated into existing or new platforms, please contact your 3M representative or visit 3M.com/Liqui-Cel.

Figure 1. Jotem's District Heating System with 3M™ Liqui-Cel™ Membrane Contactors



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