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Brine Concentration with Innovative RO Membranes and Processes

Menachem Elimelech

Menachem Elimelech is the Roberto Goizueta Professor at the Department of Chemical and Environmental Engineering at Yale University. His research focuses on membrane-based technologies at the water-energy nexus. Professor Elimelech was the recipient of numerous awards in recognition of his research contributions, including the 2005 Clarke Prize, election to the US National Academy of Engineering in 2006, the Eni Prize for 'Protection of the Environment' in 2015, and election to the Chinese Academy of Engineering in 2017.

Brine Management with Low-Salt-Rejection Reverse Osmosis (LSRRO)

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Minimal or zero liquid discharge (MLD/ZLD) are brine management strategies that are attracting heightened attention worldwide. The application of conventional reverse osmosis (RO) for brine management is limited by the maximum hydraulic pressures that current RO membranes and modules can withstand. This presentation will introduce low-salt-rejection RO (LSRRO), a novel staged RO process, that employs low-salt-rejection membranes to desalinate or concentrate highly saline feed streams, requiring only moderate hydraulic pressures. Based on process modeling, we demonstrate that LSRRO can overcome the hydraulic pressure limitations of conventional RO, achieving hypersaline brine salinities (> 240 g/L NaCl) that are required for MLD/ZLD applications, without using excessively high hydraulic pressures ($\leq$ 70 bar). In addition, we show that the energy efficiency of LSSRO is substantially higher than traditional thermally-driven phase-change-based technologies, such as mechanical vapor compressor (MVC). This presentation highlights LSRRO's potential for energy efficient brine concentration using moderate hydraulic pressures, which would drastically improve the energetic and economic performance of brine management.

Rick Stover

Dr. Richard Stover serves as Vice President of Technology for Gradiant's membrane business, focused on high recovery desalination and minimum liquid discharge solutions for industrial wastewater, seawater and brine treatment applications. He is recognized globally for expertise in reverse osmosis systems and components. His PhD is in Chemical Engineering.

Membrane Brine Concentration

Richard Stover
Gradiant Corporation

Increasing water scarcity is driving the development of alternative resources such as salt water and wastewater. For inland desalination processes, brine can be a major financial and environmental challenge. For seawater desalination plants, constrained or constrained intakes or pretreatment systems can limit the ability to increase freshwater production. Concentration or desalination of brine is desired in these applications but has been limited by the cost and technical limits of existing thermal and membrane desalination methods.
The CounterFlow Reverse Osmosis (CFRO) process is a membrane-based method for desalinating brines at a fraction of the cost and energy consumption of ultra-high-pressure or thermal brine concentrators. Streams of 65,000 mg/l total dissolved solids (TDS) salinity or more are desalinated at pressures of less than 80 bar (1,200 psi), producing drinking-quality permeate while minimizing brine flow by concentrating it up to 260,000 mg/l TDS. This presentation provides technical details of the membrane brine concentration processes and reports experiences from a number of installations as case studies. Its reliability and performance portend a broad shift away from thermal brine concentration, in the same way that seawater RO displaced thermal desalination, while opening new opportunities for brine treatment.