Water Solutions

DUPONT

Textile Wastewater Pilot Trial

Industrial Water Treatment

Ultra-High Pressure Reverse Osmosis Reduces Overall Treatment Cost for ZLD Wastewater Treatment

Background

Industrial water users in Tamil Nadu, India are finding it more challenging to manage their water utility because of reduced access to reliable, low-cost water sources, as well as the higher costs associated with water discharge. As a result, investing in wastewater reuse systems to recover and recycle 70 percent or more of the water in textile plants has become a common practice. The region's textile industry has been employing Minimal Liquid Discharge (MLD) using reverse osmosis (RO), followed by evaporation for nearly 10 years to meet local zero liquid discharge (ZLD) requirements. In this review, water recovery using MLD is maximized using spiral wound ultra-high pressure reverse osmosis elements (UHP RO) (i.e., elements designed to operate at feed pressures up to 120 bar) to efficiently desalinate hypersaline brines.

The Challenge

An aggressive wastewater management approach is critical to minimalize freshwater withdrawals and eliminate wastewater discharge, both of which can be achieved via ZLD. Unfortunately, in some of India's textile plants, brine management practices in place are either expensive or environmentally unsustainable. Typically, when ZLD is mandated, inefficient and costly thermal evaporation processes are used. Advanced RO elements designed to treat challenging brine waters are needed to achieve more reliable, higher-recovery MLD processes to lower the cost of ZLD systems.

The System

Currently, the process for the tertiary treatment of wastewater using MLD and ZLD applications for Common Effluent Treatment Plants (CETP) starts with a three-stage RO system, followed by mechanical vapor recompression (MVR), and then multi-effect evaporation. The total dissolved solids (TDS) concentration after RO is approximately 50 g/L, and would, theoretically, be around 100 g/L at the MVR stage. After the MVR stage, wastewater passes to the multi effect evaporator, which raises TDS up to 250-300 g/L. There are disc-type RO systems competing with MVR systems to increase the salinity to 100-120 g/L, but both alternatives have technical and commercial challenges in terms of installation and operation.

Fast Facts

Project:	Textile Wastewater Treatment
Location:	Tirupur, India – State of Tamil Nadu
End user:	Common Effluent Treatment Plant (CETP)
Source:	RO Reject
Application:	Zero Liquid Discharge
Market:	Textiles
Key Solution:	Ultra-High Pressure RO Membranes
Year of Operation:	2017 – Trial Period of 80 Days

Key benefits

- UHP RO membranes are a cost-effective alternative in textile MLD/ZLD wastewater applications compared to costly all-thermal evaporation processes.
- UHP RO membranes can potentially eliminate the MVR phase.
- UHP RO membranes can achieve reject concentrations of 105 g/L.

The Solution

A CETP textile wastewater treatment plant in Tirupur, a city in Tamil Nadu, carried out an 80-day field trial in cooperation with the end user, a system integrator and a consultant, to better understand the flow, recovery and salt rejection performance of UHP RO membranes. These advanced RO elements are designed to treat high concentration brine waters that have previously been concentrated by RO elements operated at conventional pressures. The elements help operators squeeze out even more water for reuse and further reduce the amount of water sent to the ZLD system. The UHP RO element used has a spiral wound design with a pressure rating of up to 120 bar.

The field trial was conducted with a single 4-inch diameter UHP RO element in a single-element RO system, which is shown in the image below.

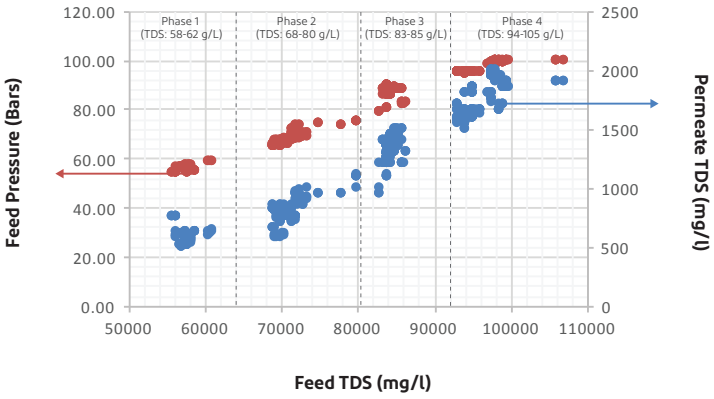
The membrane was subjected to four phases of operation. The first phase was simply treating the water from the RO reject of a textile wastewater treatment plant, which had high TDS (58.6 g/L, comprising a 0.68:1 mixture of sodium chloride and sodium sulfate) along with the severe fouling conditions – including high chemical oxygen demand (COD = 1024 mg/L) and high color (1,400 Pt/Co) – that are common in textile wastewaters. Because only a single element was used in this pilot, in order to evaluate the element performance at higher TDS levels additional sodium chloride and sodium sulfate were added to the feed in increments. This achieved a phase II TDS level of 68-80 g/L, a phase III TDS level of 83-85 g/L, and a phase IV TDS level of 94-105 g/L while maintaining the 0.68:1 sodium chloride to sodium sulfate composition. During each phase the rejection and the required feed pressure to achieve an operating flux of 10 lmh liters per meter squared of membrane was monitored.

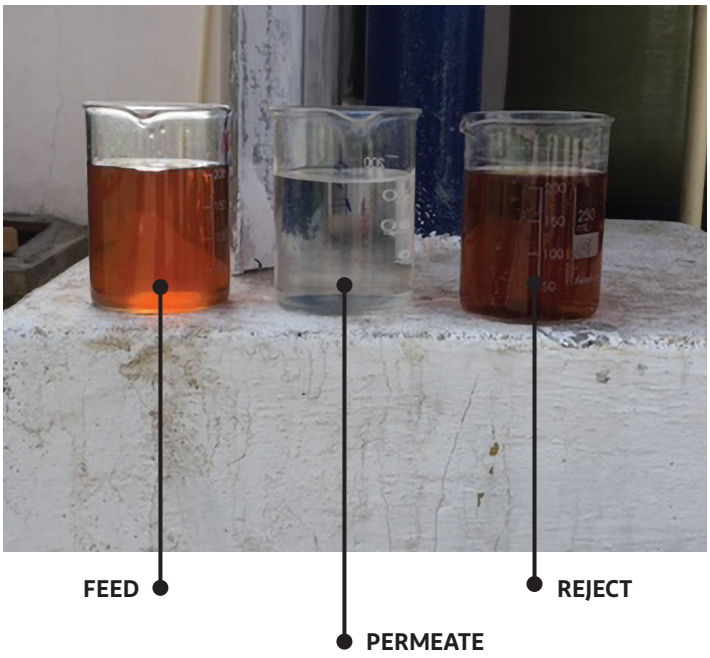
The Results

The field trial demonstrated the efficacy of UHP RO elements in challenging, high pressure MLD and ZLD applications at operating pressures up to 100 bar and feed TDS levels as high as 105 g/L.

- Color removal and >98% TDS rejection was achieved when treating water TDS levels as high as 105 g/L.
- Despite high fouling feed conditions of high salinity, COD and color, the normalized differential pressure observed throughout each phase of the test was maintained at about 0.2 bar.

Permeate Quality as Recovery Increases





The Benefits

The potential of Spiral Wound UHP RO membranes lowers the overall system cost by more than 50 percent in comparison with the MVC and drastically reduces the economic burden in MLD/ZLD treatment applications. This trial also highlighted the high energy efficiency of UHP RO compared with thermal processes, such as MVC, in an aggressive waste management approach of ZLD. In general, MVC would need two to three times more energy than UHP RO.

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