Conserving Energy in Large-Scale SWRO Desalination Plants

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Abstract

Isobaric energy recovery devices (ERDs) save energy in seawater reverse osmosis (SWRO) processes by reducing the amount of water that must be pressurized by the high-pressure pump. In a SWRO system operating at a 40% membrane water recovery rate, the ERDs supply 60% of the membrane feed flow. Energy consumed by the ERD circulation pump is minimal, therefore, nearly 60% of the membrane feed flow is pressurized with almost no energy input. Compared to SWRO systems operating with older turbine technology, isobaric ERDs reduce energy consumption by 15 to 35%. Since energy consumption can comprise as much as 75% of the total operating costs of a SWRO plant and energy costs are rising, it has become almost inconceivable to build a SWRO process without using isobaric energy recovery technology.

Like vessels of membrane elements, multiple isobaric ERDs may be operated in parallel, deployed in arrays to serve the desired flow rate. The capacity of an array is potentially unlimited. Currently, there are trains with permeate production rates of up to 25,000 mega-liters per day (MLD). Larger trains utilize large high-pressure centrifugal pumps which can operate at much higher efficiency than smaller pumps.

The recognition of the advantages of scale in SWRO operation, together with increased demand for new fresh water supplies, is evidenced by the dramatic global increase in the number of “mega-plants” exceeding 100,000 MLD of permeate production capacity. These include the 144,000 MLD Kwinana plant just south of Perth, Australia, the 200,000 MLD Hamma plant now operating in Algeria, the 240,000 MLD Torrevieja plant in Spain which will be Europe’s largest desalination plant and the 320,000 MLD Hadera plant being constructed in Israel. In addition to energy efficiency, these plants are designed for maximum reliability, flexibility and uptime.

This paper provides an overview of energy recovery devices for RO applications and presents important design and operating information for large-scale SWRO. Process energy consumption and operational flexibility are discussed. Process dynamics and control through startup and shutdown scenarios are considered. “Lessons learned” from hundreds of successful plant commissions are shared with the goal of promoting SWRO as a reliable and affordable means of fresh water supply.