Industrial and brackish water treatment with closed circuit reverse osmosis

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ABSTRACT

Closed Circuit Desalination (CCD™) technology is an emerging platform for reverse osmosis (RO) water treatment and desalination. It lowers the feed pressure requirement, improves the membrane performance, increases the operational flexibility, and eliminates the need for energy recovery devices using only standard RO equipment. For industrial water treatment and brackish water desalination applications, CCD technology achieves maximum recovery in single-stage units while saving energy. Alternately, a CCD unit can be added to a conventional RO process to concentrate brine and raise recovery. Over 97% recovery has been demonstrated in a single-stage operation. The recovery rate of a CCD unit can be adjusted at the control panel without modification of system hardware, limited only by the scaling characteristics of the feedwater. Maximum recovery operation and high flexibility have significant cost-cutting implications for industrial water treatment and inland brackish desalination, where both feedwater supply costs and brine disposal fees can be significant. CCD systems also demonstrate excellent resistance to fouling and scaling. Cross-flow supplied by a circulation pump washes the membranes, and salinity cycling disrupts and greatly reduces the scaling and fouling. Short membrane arrays and high cross-flow allow the CCD process to operate at higher average fluxes than conventional RO processes, without exceeding the membrane manufacturer’s flow or recovery specifications. This paper describes the design and modeling of high-recovery CCD processes and compares the measured and calculated specific energy consumption levels to validate modeling methods and tools. Two brackish water RO cases are considered: one using Desalitech’s seawater reverse osmosis–CCD (SWRO-CCD) process and the other using its hybrid plug flow desalination–SWRO–CCD (PFD-SWRO-CCD) process. CCD systems are compared favorably to conventional RO trains modeled with the same feedwater, high-pressure pumps, and membranes operating at the same average flux and overall recovery percentage.

Keywords: Industrial; Brackish; Closed circuit; Reverse osmosis