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Crystallization of salts from super-concentrate produced by tandem RO process

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ABSTRACT

We continue to address the challenge of improving concentrate disposal for the large 15 mgd (2370 m^3/h) inland reverse osmosis (RO) plant in El Paso, Texas. For the first time on a pilot scale, the feasibility of using two RO systems in tandem and using appropriate antiscalants and pH control, continuous production of permeate to limiting osmotic pressure of about 1000psi (69 bar) is possible. Recovery is simply limited by the highest pump pressure available to overcome the resulting osmotic pressure. Tandem RO without interstage treatment is being demonstrated. We envision that such a continuously operated tandem RO process can recover all the water possible to be produced from brackish ground waters at the highest possible pump pressures. At the maximum system pressure of 1000 psi, the highest total dissolved solids attainable in the concentrate are about 8–9% by weight. Anticipating the universal application of the continuous tandem RO process to generate super RO concentrates, an alternate path is now open for fractional crystallization of salts before thermal evaporation of water. Pursuing the development of an economical zero-liquid-discharge process applicable to inland municipal water treatment plants, we wish to explore the feasibility of fractionating the less soluble divalent calcium and magnesium salts from the monovalent sodium and potassium salts. In relatively large amounts, even in mixtures, these fractionated salts may have economic values such as in soil and dust control and for softening and deicing applications. Furthermore, 8–9% brine softened by the removal of multivalent salts and silica may have utility in cooling towers while being thermally concentrated for the ultimate recovery of the soluble sodium and potassium salts. In this paper, we present our initial investigation into a super-concentrate depleted of bicarbonates due to acidification needed for silica control. The concentrate at maximum recovery with a secondary RO in tandem in the demonstration plant was treated for calcium sulfate, magnesium, iron and silica precipitation. This paper describes the laboratory conditions used and observations made on the use of lime in preparation for scale-up.

Keywords: Tandem RO; Super-concentrate; Crystallization; Calcium sulfate; Silica precipitation; Zero-liquid-discharge; Salt fractionation; Divalent salts; Monovalent salts

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