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Seawater RO treatment of RO concentrate to extreme silica concentrations

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ABSTRACT

Severe restrictions exist in the disposal of the concentrate from the 15 mgd (2370 m^3/h) reverse osmosis (RO) plant in El Paso, Texas (i.e., 15 mgd blended to 27.5 mgd). The current permit for the disposal by deep well injection limits the total dissolved solids in the brine to 10,000 mg/l. This limits water recovery in the plant and drives up the cost of sending a large volume of the concentrate a long distance for discharge. We have continued to work on developing a concentrate treatment process aimed at zero liquid discharge or a greatly reduced concentrate volume suitable for evaporation ponds. This is an interim report documenting an exciting demonstration of the feasibility of using a seawater RO system and synergistic antiscalant and low pH inhibition of reactive silica polymerization to concentrate the primary brackish water RO concentrate to total silica concentrations exceeding 1000 mg/l. This approach makes possible the use of tandem brackish RO followed immediately by a seawater RO (SWRO) to achieve an overall water recovery of greater than 96%, limited only by the highest pump pressures to overcome the resulting osmotic pressures. Pilot plant data using a single SWRO membrane and 700–740 psi feed pressure concentrating the brackish RO concentrate in a batch recirculation mode is presented. Recoveries of water in the 84–96% range were performed repeatedly with no apparent fouling of the membrane and no precipitation in the super-concentrate. The flux reduction curves in each case are consistent with gradual reduction of net driving pump pressure due to the rise in osmotic pressure that needs to be overcome. The reactive and total silica concentration profiles provide insight on the effects on membrane operation during buildup of reactive silica concentration with or without the increasing amounts of colloidal polymeric hydrated silica expected from the spontaneous polymerization of the reactive silicic acid monomer.

Keywords: RO concentrate; High silica; Seawater RO; Tandem RO; Zero liquid discharge; Concentrate disposal; Evaporation pond; Deep-well injection

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