

## Antiscalants for near complete recovery of water with tandem RO process

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### ABSTRACT

Near complete recovery of water from desalination of brackish and wastewater on land using a reverse osmosis (RO) system followed in tandem by a seawater RO system is highly desirable. Such a tandem RO process is being demonstrated for overall recovery of water in the range of 96%–98%, and fractionation of dissolved salts aimed at zero liquid discharge for municipal water plants. Serious issues of RO concentrate disposal, scaling of waste disposal lines, and salinity contamination of aquifers and soils are being addressed with such an approach. A wide range of differentiated antiscalant formulations is applied towards the task of maximizing water recovery of current municipal RO plants for maximized productivity and minimized concentrate disposal costs. Primary RO concentrates resulting from maximized recoveries are realized in the 70%–90% range. The concentrates from the primary ROs are being tested at pilot demonstration scales with seawater ROs for the highest possible recoveries of water limited by the high-pressure pumps to drive against the osmotic pressures of the resultant brine. We are providing a summary report on the limits of controls of our antiscalants for brackish water, the overall tandem RO recoveries attained in the initial pilot demonstration plants, and laboratory data pointing to our expectation that the tandem RO process is a universally usable process to generate super-concentrates from which the principal dissolved divalent salts of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  can be separated from the mono-valent  $\text{Na}^+$  and  $\text{K}^+$  salts with commercial utility. Such zero liquid discharge processes will represent the ultimate environmentally friendly water treatment for large municipal plants.

**Keywords:** Reverse osmosis; Tandem RO process; Zero liquid discharge; Concentrate minimization; Recovery maximization; Antiscalants; Antifoulants; Control limits; Salt fractionation; Brackish water RO; Seawater RO; Inland desalters

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