

## Ultrafiltration pretreatment to reverse osmosis for seawater desalination — three years field experience in the Wangtan Datang power plant

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### ABSTRACT

Systems composed of ultrafiltration (UF) pretreatment for seawater reverse osmosis (SWRO) desalination are often termed “integrated membrane system” or “dual membrane system”. These systems promise to offer reliable handling of very difficult waters, also in regions which have traditionally experienced feed water and pretreatment problems such as Middle East and United States. Nevertheless, data sets presenting long-term integrated operation from a UF and SWRO point of view at a larger scale level, and hence validating the potential cost benefit of UF pretreatment, are very scarce. The dual membrane seawater desalination system at the Wang Tan Power Plant has been operating for three years and is an ideal case to present learnings. Despite some gaps in the data set, some operational problems, and an unconventional low flux and low chemicals operation approach, the authors believe that transparent sharing of this data set can significantly contribute to a better industry understanding of integrated operation. The data shows that UF system operation is possible using a low flux (25 L/m<sup>2</sup>/h), low chemical approach. This approach totally eliminates the need for coagulation or chemical enhanced backwash, and uses only yearly clean in place operations. This requires higher upfront capital investment, but results in lower chemicals cost, lower sludge and chemical brine disposal, better ease of operation and higher safety level. This approach has allowed reliable water production in the DOW™ UF and FILMTEC™ SWRO unit for 3 years and should be interesting for very environmentally aware regions with difficult waters, such as Australia or United States. Based on limited data, turbidity removal rate was 98–99.5% and outlet SDI typically <2.5. On a water with very high temperature fluctuation, this enabled SWRO operation with slow pressure drop increase and normalized flux loss, hence resulting in low cleaning frequency of around yearly clean in place operation, and low replacement rate of 1%/a. The data also shows that care should be taken that chlorine employed in ultrafiltration backwash operations does not attack SWRO membranes — improved modes eliminating these problems are available and discussed within the paper. Ultimately, a one-year pilot trial in the SWRO plant shows that the combination of ultrafiltration and internally staged design, employing high productivity elements such as FILMTEC™ SW30ULE-400i is synergistic and can enable unprecedented SWRO vessel productivity of 5 m<sup>3</sup>/h and flux rate in the range of 25 L/m<sup>2</sup>/h, while achieving excellent water quality in the range of below 500 µS/cm.

**Keywords:** Ultrafiltration; Reverse osmosis; Seawater; Desalination; Integrated membrane system; Dual membrane system

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