



## Pre-treatment optimisation of SWRO membrane desalination under tropical conditions

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### ABSTRACT

Seawater quality and temperature under tropical conditions require particular attention to optimise the pre-treatment process and to minimise reverse osmosis (RO) membrane fouling in order to maximise plant performance. A skid-mounted pilot plant of 50 m<sup>3</sup>d<sup>-1</sup> was constructed to examine the impact of various pre-treatments on RO feed quality and to optimise the operation conditions for continuous seawater RO (SWRO) membrane desalination. The pilot plant consisted of five main subsystems: (1) open seawater intake, (2) conventional pre-treatment, (3) one-stage RO membrane, (4) effluent discharge and (5) supervised control and data acquisition (SCADA). Such set-up allows pre-treatments of varying coagulants and their doses, hydraulic retention time, with and without chlorination, different filtration schemes of the dual-media filter, several methods of clean-in-place of the RO membrane and its service and flushing arrangement. The sub-systems were tested and the operation conditions optimised. The optimal operation conditions include intermittent chlorination (6 mg L<sup>-1</sup> NaOCl) and dechlorination (6 mg L<sup>-1</sup> Na<sub>2</sub>S<sub>2</sub>O<sub>5</sub>), coagulant dose of 3 mg L<sup>-1</sup> poly-aluminium chloride, 30 min hydraulic retention time in the clarifier, dual-media filter (DMF) operation cycle of 5 h service, 3 min backwashing and 1 min rinsing. Under these operation conditions, the pretreatment continuously produced RO feed of high quality, with the silt density index always less than 5, most often around 3. The SWRO membrane performed as designed when being fed with the pre-treated high-quality water. The total salt rejection was greater than 99% with product water having total dissolved salt concentration less than 500 mg L<sup>-1</sup>. All of the product water parameters, except boron, meet the WHO drinking water standards. After nearly 1 year of operation, a water recovery 35% could still be achieved when the RO membrane operation pressure was 60.5 bars, compared to 54.5 bars at the early stage of plant operation for the same rate of water recovery. The 10% increase in the operation pressure at the later stage is likely due to irreversible loss of the desalination capability of the SWRO membrane.

**Keywords:** SDI; RO permeate flux; Specific permeate flux; Membrane scaling; Fouling; Water recovery; Salt rejection

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