Pre-treatment optimisation of SWRO membrane desalination under tropical conditions


*Centre for Advanced Water Technology, 80/82 Toh Guan Road East, #C4-03, Singapore 608575
Tel. +65 6326 2919; Fax: +65 6326 2929; email: rjxie@cawt.sui.com.sg
bBlock 62, New Upper Changi Road, #09-1192, Singapore 461062
cThe Public Utilities Board, 40 Scotts Road, Environment Building, Singapore 228231

Received 24 September 2008; Accepted 25 January 2009

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 m³d⁻¹ 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 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⁻¹. 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

* Corresponding author.