Executive Summary

Understanding pretreatment selection for seawater reverse osmosis

Pretreatment for Seawater Reverse Osmosis:
Existing Plant Performance and Selection Guidance (Desal-14-07/4763)

The Central Issue

Selection of pretreatment technology is not always straightforward due to several factors that require consideration including raw feed water quality, pretreatment system filtered water quality, ease of operation, facility footprint, construction costs, operating costs, economy of scale, design specifications, contractual agreements, and the regulatory environment. Pretreatment varies from simple cartridge filtration to conventional granular media filtration, microfiltration or ultrafiltration or a combination of these and other pretreatment processes. Therefore, a critical understanding of the selection criteria for both conventional and membrane-based pretreatment is of paramount importance. The overall goal of this project was to develop key criteria and guidelines for selection of pretreatment processes for seawater reverse osmosis (SWRO) desalination.

Context and Background

The operational data from 10 existing SWRO plants were collected and reviewed to understand impact of feed water quality and non-water quality related factors (e.g., regulatory requirements, contractual processes, costs, etc.) on the performance of pretreatment technologies and the downstream RO process. The study included a comprehensive literature review, a questionnaire that was distributed to SWRO plants worldwide, and a detailed data analysis of the information and data collected from full-scale operating SWRO plants. An Excel™-based Pretreatment Selection tool was developed to assist water utilities in the selection of various seawater pretreatment systems, based on the water quality of the seawater and on the type of intake.

Findings and Conclusions

It was determined that subsurface intakes can produce raw seawater turbidity lower than 0.1 NTU and an SDI15 of less than 2, which may be suitable for direct feed to the SWRO system without further pretreatment if there is no iron and/or manganese present in the feed water.
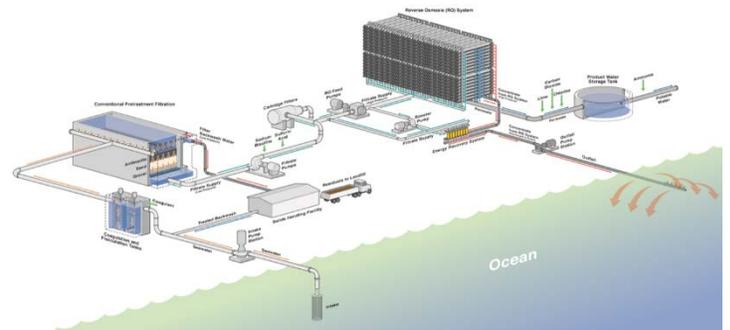
An example of a typical desalination plant installation.

In desalination plants with intake wells, cartridge filters are used to capture small amounts of silt and sand particles, which are released for a short period of time after one or more standby intake wells are brought back into service.

Additionally, successful operation of conventional pretreatment depends on an understanding of the dose, application location, and application duration of the chemicals applied. Well-designed and operated conventional gravity granular media filters could produce filtrate with turbidity and SDI15 values comparable to those produced by membrane pretreatment systems. Membrane filtration may be competitive to granular media filtration based on costs and performance when designed appropriately and operated by well-trained staff. Such pretreatment is advantageous for source waters with high solids and silt content, but with low concentrations of algae and a low biofouling propensity.

Lastly, plants with poor water quality in terms of elevated total dissolved solids (salinity), organic matter (natural or anthropogenic), biological activity and algae occurrence, and other adverse issues require more aggressive pretreatment configurations. These site-specific issues require a thorough understanding of fluctuations and changes in the intake water quality before a system is designed and built.

Management and Policy Implications

Organic and biological fouling remain the major impediments to efficient SWRO pretreatment because typical fouling indices focus on macro-level constituents such as turbidity. This research provides utilities with information on key criteria that can assist membrane desalination plants evaluate different pretreatment processes during the planning phase. It summarizes the operational data of existing plant design and performance including the factors that the study sites used in the pretreatment decision-making process, and provides guidance and an interactive decision tool that may aid in appropriate pretreatment selection based on water quality and non-water quality based criteria.

Related WRF Research	
Project Title	**Research Focus**
Protocol for Evaluating Chemical Pretreatment for High Pressure Membranes (4249)	Evaluates the current methods of determining chemical pretreatment needs for high-pressure membrane systems (nanofiltration and reverse osmosis). The research also developed and validated a practical protocol for evaluating the short- and long-term effectiveness of chemical pretreatment options, particularly antiscalants and scale inhibitors, for different NF and RO membrane materials and feed waters.
Database of Permitting Practices for Seawater Desalination Concentrate (Desal-13-07)	Documents SWRO discharge regulatory issues and provides a critical overview of facility discharge-related information required for permitting desalination projects in the U.S. and selected countries with advanced environmental regulations and experience in implementing seawater desalination projects. Includes case studies of SWRO plants.
Use of Heated Metal Oxide Particles as Adsorbents for Membrane Fouling Reduction in Water Reuse and Desalination Applications (Reuse-14-09)	Examines HMOPs, which include heated aluminum oxide particles and heated iron oxide particles, both of which part of this relatively new class of adsorbents. HMOPs have been shown to reduce membrane fouling, a major obstacle to efficient membrane treatment.
Carlsbad Desalinated Seawater Integration Study (Desal-15-06/4773)	Examines the impact of integrating seawater desalinated via SWRO water into existing regional supplies of disparate quality. The results of this study will serve as a resource for the water treatment industry to better anticipate the potential water quality blending impacts that may occur in similar seawater or other desalination applications.

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