



Stabilization of Desalinated Water

Course Number: CH-02-213

PDH: 10

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Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the primary chemical and physical characteristics of desalination permeate that necessitate post-treatment.
- **Evaluate** the growth trends and regulatory drivers of synthetic membrane processes in the global and domestic water industry.
- **Outline** the core research objectives and questions addressed for stabilizing desalinated water within existing distribution infrastructure.

Executive Summary: Desalination processes like RO, NF, and EDR produce water with low dissolved solids that is inherently aggressive toward metallic and concrete infrastructure. Effective post-treatment—including stabilization, pH adjustment, and disinfection—is critical to prevent corrosion, ensure regulatory compliance, and maintain customer acceptance when integrating desalinated water into distribution systems.

Design Fundamentals

Motivation for the Project

Desalination is primarily intended to remove **Total Dissolved Solids (TDS)** that conventional treatment cannot address. However, synthetic membrane processes—specifically **Reverse Osmosis (RO)**, **Nanofiltration (NF)**, and **Electrodialysis Reversal (EDR)**—produce water that is chemically unstable.


Key technical challenges include:

- **Mineral Depletion:** RO and NF membranes remove the majority of ions, resulting in "hungry" water that seeks to achieve chemical equilibrium by dissolving materials it contacts.
- **Infrastructure Aggression:** This mineral-depleted water is highly corrosive to metallic pipes and can cause the dissociation of concrete appurtenances.
- **Variable Characteristics:** * **RO/NF:** Mass transfer characteristics and molecular weight cutoffs dictate permeate concentration.
 - **EDR:** The electrical current imparted to the stack determines the level of salt depletion.



Common post-treatment unit operations required to mitigate these issues include:

- **pH Adjustment**
- **Disinfection**
- **Degasification** (specifically for hydrogen sulfide removal)
- **Stabilization and Corrosion Control**

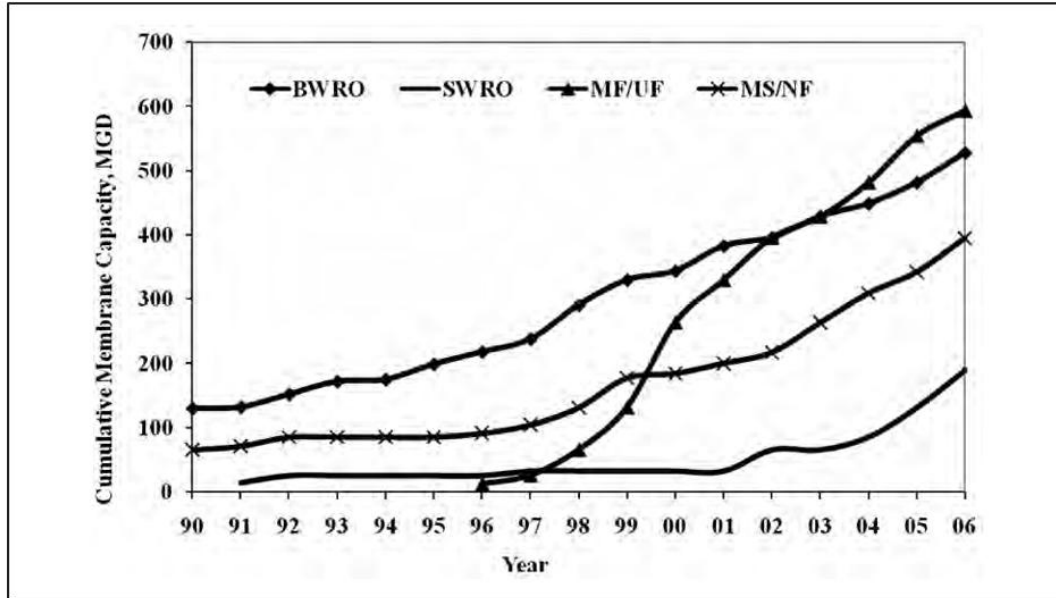
 **Design Tip:** While pretreatment and membrane optimization are well-documented, the secondary impacts of desalinated water on internal corrosion control, hydraulics, and disinfection by-products in existing distribution systems require careful engineering judgment and site-specific pilot testing.

Growth Of Synthetic Membrane Processes

The use of synthetic membranes has seen a compounded growth rate of approximately **17 percent since 1990**. This expansion is driven by the need to exploit poorer quality source waters and the increasing cost-effectiveness of membrane technologies.

Current Industry Capabilities

- **Global Capacity:** Increased from 17.3 to 35.6 million m³/day between 1994 and 2004.
- **Domestic Presence:** Approximately **1,200 desalting plants** operate in the United States, primarily for brackish groundwater treatment and softening.
- **Performance Standards:** * **RO:** Removes >99% of dissolved minerals and >95% of organic compounds.
 - **NF:** Often called "membrane softening," it removes up to 95% of TDS and significant DBP precursors.
 - **EDR:** Ideal for lower salinity waters with high fouling or silica content, though it does not remove microorganisms.



Source: Pankratz; Global Water Intelligence

Figure 1.1: Cumulative contracted desalination capacity

Drivers for Membrane Adoption

1. **Regulatory Pressure:** Stringent standards for both potable water and wastewater treatment.
2. **Water Scarcity:** Increased demand during droughts requiring the use of impaired sources.
3. **Technological Maturity:** Improved manufacturing and lower operational costs.

Research Approach

Project Objectives

The Water Research Foundation initiated this study to bridge the gap between membrane production and distribution system integration. The primary goals are to:

- Survey industry practices and conduct expert workshops.
- Develop guidelines linking water quality targets to **distribution system operational goals**.
- Identify research gaps in post-treatment stabilization.

Critical Research Questions for Engineers

- **Corrosion Indices:** Are traditional indices (e.g., LSI) sufficient for permeate, or are new measures required to estimate the useful life of pipe materials?
- **Blending Ratios:** What criteria determine the best blend ratios? Can blending occur within the distribution system, or is dedicated storage and mixing required?
- **Inhibitors:** What are the secondary impacts of adding corrosion inhibitors to permeate streams?
- **Disinfection Dynamics:** How does bromide concentration in permeate impact **Disinfection By-Product (DBP)** formation when blended with other sources?

⚠ **Safety Constraint:** Engineers must ensure that permeate pH adjustment for alkalinity recovery does not inadvertently increase DBP formation potential or negatively impact residual disinfectant stability.

📊 **Calculation Note:** When evaluating stabilization, consider the mass balance of blending scenarios. The resulting water quality must satisfy both aesthetic standards and Lead and Copper Rule (LCR) compliance.

Checkpoint Quiz

1. **Which desalination process is most likely to require the addition of disinfection because it does not inherently remove microorganisms?**
 - a) Reverse Osmosis (RO)
 - b) Nanofiltration (NF)
 - c) Electrodialysis Reversal (EDR)
 - d) All of the above

Answer: (c). EDR is effective for ion removal but does not remove microorganisms or small suspended materials.

2. **What is the primary reason permeate from RO and NF is considered "aggressive" toward distribution systems?**
 - a) High concentration of chlorides
 - b) Depletion of minerals and ions
 - c) Excessive dissolved oxygen
 - d) High pH levels

Answer: (b). The lack of dissolved solids makes the water chemically unstable and prone to leaching minerals from pipe walls.



3. According to industry trends, what has been the compounded growth rate of installed desalination capacity since 1990?

- a) 5%
- b) 12%
- c) 17%
- d) 25%

Answer: (c). This rate reflects the rapid global adoption of membrane technologies for water augmentation.



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