Reverse Osmosis Desalination: Principles, Design Concepts & System Understanding

Madrid -

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Reverse Osmosis Desalination: Principles, Design Concepts & System Understanding

Course code: PQ409 From: 14-09-2026 Venue: Madrid - Course Fees: 5000 £

Introduction

Reverse Osmosis (RO) desalination is one of the most widely used technologies for producing fresh water from seawater and brackish water. It plays a critical role in addressing global water scarcity, particularly in arid and coastal regions. This course provides a comprehensive theoretical understanding of RO desalination, focusing on the physical principles, system design concepts, membrane behavior, and performance factors that govern modern desalination plants. The training is designed to build strong conceptual knowledge without requiring hands-on or field-based activities.

Course Objectives

By the end of this course, participants will be able to:

- Understand the fundamental principles of reverse osmosis and desalination processes
- Explain the role and behavior of membranes in water separation
- Describe key process parameters such as pressure, flux, recovery, and salt rejection
- Understand system design concepts including staging and configuration
- Identify major performance limitations such as fouling, scaling, and energy constraints
- Gain awareness of sustainability and environmental considerations in desalination systems

Target Audience

This course is designed for:

- Engineers and technical staff in water, oil & gas, and utilities sectors
- Environmental and water resource professionals
- Project managers involved in desalination or water treatment projects
- Technical consultants and analysts
- University graduates and trainees in chemical, mechanical, or environmental engineering
- Non-technical professionals seeking conceptual understanding of desalination systems

Course Outline

Day 1

Introduction to Desalination and Water Scarcity Context

- Global water challenges and demand trends
- Overview of desalination technologies (thermal vs membrane)
- Introduction to Reverse Osmosis (RO) technology
- Basic process flow of a desalination plant
- Key terminology (TDS, salinity, brackish water, seawater)
- Role of RO in modern water infrastructure

Day 2

Fundamentals of Reverse Osmosis Principles

- Osmosis vs reverse osmosis
- Osmotic pressure and driving force concept
- Semi-permeable membrane function
- Basic physics of water transport through membranes
- Salt rejection mechanisms
- Limitations of natural and applied pressure systems

Day 3

Membrane Science and Water Chemistry Concepts

- Types of RO membranes (thin-film composite overview)
- Structure and selective permeability of membranes
- Solution-diffusion transport model (theoretical)
- Water chemistry basics (ions, salinity, scaling species)
- Concentration polarization concept
- Introduction to fouling mechanisms (theoretical overview)

Day 4

System Design Concepts and Process Configuration

- RO system layout and process flow understanding
- Single-pass vs multi-pass systems
- Staging and array design concepts
- Recovery ratio and system efficiency logic
- Brine concentration and disposal pathways (conceptual)
- Basic system performance indicators

Day 5

Performance, Energy, Sustainability and Future Trends

- Energy requirements and thermodynamic limits
- Energy recovery concepts (theoretical overview)
- Membrane fouling, scaling, and system limitations
- Environmental impacts (brine discharge considerations)
- Sustainability in desalination systems
- Emerging technologies and future developments (advanced membranes, hybrid systems, digital optimization)