STATE-OF-THE-ART OF DESALINATION AND WATER REUSE TECHNOLOGIES

This training program covers both theoretical and practical aspects of the use of reverse osmosis membrane technologies for seawater desalination and water reuse. The program focuses on selection, design and operational monitoring of RO desalination and water reuse plants. A great number of illustrations, e.g. pictures, videos, cases studies, feedbacks from operation, design tips and operational traps, will be provided in order to help the better design and operation of desalination and water reuse membrane facilities, with improved reliability, energy efficiency and economic benefits.

3-DAY COURSE

Leading Lecturers:

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PROGRAM OUTLINE

Day 1: Desalination and Water Reuse Fundamentals

09:00 – 10:30 Overview of Desalination and Water Reuse

- Sustainable Water Cycle: Why we Need Desalination and Water Reuse?
- Water Reuse
  - ✓ Status, Trends and Market Development
  - ✓ Benefits and Challenges
  - ✓ Alternative Water Reuse Technologies
- Desalination
  - ✓ Status, Trends and Market Development

- ✓ Benefits and Challenges
- ✓ Alternative Desalination Technologies

- Objective of the Training Course: How to Succeed Desalination and Water Reuse Projects?
- Questions and Discussion

10:30 – 10:45 Coffee Break

10:45 – 12:00 Reverse Osmosis Fundamentals

- RO Separation – Basic Principles
  - ✓ Principle of Operation & Basic Schemes and Calculations
  - ✓ Major Types of RO Membranes and Materials
- Key Performance and Design Parameters
  - ✓ RO System/Plant Recovery
  - ✓ Membrane Rejection and Salt Passage
  - ✓ Concentrate Salinity and Concentration Factor
  - ✓ Feed Pressure and Membrane Flux
- RO System Components
  - ✓ Intake Facilities
  - ✓ Pretreatment Alternatives
  - ✓ Key RO System Components
  - ✓ Post Treatment
  - ✓ Instrumentation and Control Systems
- Video on Reverse Osmosis Fundamentals
- Questions and Discussion

12:00 – 13:00 Lunch Break

13:00 – 14:00 Planning for RO Desalination and Reuse Plants

- Integrated Water Resource Planning
- Key Project Implementation Steps
- Water Reuse Projects
  - ✓ Key Issues When Implementing Water Reuse
  - ✓ Engineering Issues of Water Reuse Planning
  - ✓ Community and Political Engagement

- Desalination Projects
  - ✓ Key Plant Components
  - ✓ How to Determine Plant Site Size and Location?
  - ✓ Source Water Quality Characterization
  - ✓ Choosing Product Water Quality – Issues and Considerations
- Video on Planning of Barcelona SWRO Plant
- Questions and Discussion

14:00 – 14:15 Coffee Break

14:15 – 15:00 Seawater Intakes

- Source Water Quality Issues and Considerations
  - ✓ TDS, Mineral and Organic Content
  - ✓ Type of Membrane Foulants
- Subsurface Intakes
  - ✓ Site Consideration, Requirements and Costs
  - ✓ Design Considerations
  - ✓ Monitoring & Operation
- Open Ocean Intakes
  - ✓ Types of Open Intakes
  - ✓ Site Considerations and Recommendations
  - ✓ Case studies
  - ✓ Intake Screens
  - ✓ Monitoring & Operation: Minimizing Shellfish Growth
- Selection of Intake
- Power Plant Collocation: Capex Saving and Environmental Benefits
- General Design Guidelines
- Questions and Discussion

15:00 – 16:30 Pretreatment for Desalination and Water Reuse

- Membrane Fouling
  - ✓ Types of Foulants and Main Sources
  - ✓ Types of Fouling and Scaling
  - ✓ Effect of Fouling on Membranes Performance
- Pretreatment Technologies for Desalination and Water Reuse
  - ✓ Enhanced Sedimentation: Coagulation & Flocculation

- ✓ Filtration: Gravity & Pressurized
- ✓ Low Pressure Membrane Filtration: Microfiltration & Ultrafiltration
- ✓ Micro-Screens
- ✓ Cartridge Filters

- Conclusions: Selection of Pretreatment
- Video on Orange County Advanced Water Recycling Facility
- Questions and Discussion

16:30 – 17:00 Questions and Discussions

Day 2: Desalination and Water Reuse Systems – Design & Costs

09:00 – 10:30 Reverse Osmosis System Configurations

- RO System Components
  - ✓ Key Components
  - ✓ Type of Pumps
  - ✓ Membrane Elements and Vessels
  - ✓ RO Membrane Cleaning
- Reverse Osmosis Trains – Alternative Configurations for Desalination
  - ✓ Pumping Alternatives
  - ✓ Configuration Alternatives
- Reverse Osmosis Trains – Alternative Configurations for Reuse
  - ✓ Typical RO Membrane Configuration and Design Parameters
  - ✓ Critical Factors for Selection of RO Membranes for Water Reuse
  - ✓ Optimization of Membrane Performances: Examples and Recommendations
- Energy Recovery Systems – Types and Applications
- Design and Sizing of Key Components of RO Systems
- Video of Melbourne Desalination Plant
- Questions and Discussion

10:30 – 10:45 Coffee Break

10:45 – 12:00 Energy Use in Desalination and Water Reuse

- Energy Footprint of Water Reuse and Desalination
- Key Energy Use Components & Factors
  - ✓ Example of Typical Desalination Plant Energy Use Breakdown

- ✓ Example of Typical Water Reuse Plant Energy Use Breakdown
- Desalination
  - ✓ Energy Use Trends and Examples
  - ✓ Methods to Minimize Desalination Plant Energy Use
  - ✓ Potential Energy Benefits of Collocation
  - ✓ Pumps & Motors Efficiency Constraints
  - ✓ Reducing Energy Losses Through Innovation: Nanotechnologies and Forward Osmosis
- Water Reuse
  - ✓ Energy Use Trends and Examples
  - ✓ Methods to Minimize Energy Use of Water Reuse Plants
- Use of Renewable Energy In Water Reuse and Desalination: Solar and Wind Energy
- Video of Pembroke Desalination Plant, Malta
- Questions and Discussion

12:00 – 13:00 Lunch Break

13:00 – 14:00 Seawater Desalination Costs

- Construction Costs (Capex)
  - ✓ Indirect Capex/ Example and Comparison
  - ✓ Capex of Intake and Pretreatment
  - ✓ Capex of SWRO Systems and Key Components
  - ✓ Capex of Post-Treatment and Brine Disposal
  - ✓ Influence of Plant Size
- O&M Costs (Opex)
  - ✓ Typical Opex Breakdown
  - ✓ Variable, Fixed and Indirect Opex
  - ✓ Opex Comparison for Different Pretreatment Schemes
- Total Cost of Water Production (Total Annualized Costs)
  - ✓ Typical Breakdown and Total Annualized Costs
  - ✓ Examples and Common Features of Low-Cost Desalination Plants
  - ✓ Key Factors Affecting Costs
- Key Project Risks and Costs: The Role of Public-Private Partnership
- Example of Large Desalination Plant Costs
- Where Future Cost Savings Will Come From?
- Questions and Discussion

14:00 – 15:00 Water Reclamation and Reuse Costs

- Purpose of the Cost Analysis and Key Components of Water Reuse Costs
- Construction Costs (Capex)
  - ✓ Influence of Plant Size
  - ✓ Influence of Treatment Technologies
  - ✓ Influence of Recycled Water Distribution Systems
  - ✓ Typical Capex Breakdown and Examples
  - ✓ Evolution of Capex of Membranes for Water Reuse
- O&M Costs (Opex)
  - ✓ Components of Opex
  - ✓ Influence of Plant Size
  - ✓ Examples of Opex Breakdowns for various reclamation facilities, MF/RO systems versus Conventional Advanced Treatment, Pressure vs. Vacuum Driven Membranes
  - ✓ Fixed and Variable Opex
- Total Costs and Environmental Benefits of Water Reuse
  - ✓ Comparison of Total Cost of Water Reuse and Desalination
  - ✓ Examples of Total Costs and Influence of Plant Size
  - ✓ Challenges for Calculation and Example of Benefits of Water Reuse
- Funding and Pricing of Water Reuse
  - ✓ Key Principles for Water Reuse Funding Strategy
  - ✓ Mechanisms for Funding Water Reuse Systems & Examples
  - ✓ Importance of Project Phasing
  - ✓ Pricing of Recycled Water: Who should pay for recycled water system costs?
  - ✓ Cost Recovery Concerns and Lessons Learned from Leading Water Reuse Projects
  - ✓ Cost Efficiency: Multi-barriers Approach and Custom-Made recycled Water
  - ✓ Example of Water Reuse Prices Worldwide
- Video of West Basin Recycling Plant, California
- Questions and Discussion

15:00 – 15:45 Coffee Break

15:45 – 16:30 Concentrate Disposal

- Concentrate Disposal Alternatives
- On-shore and Offshore Discharges
- Technologies for Reduction of Concentrate Volume and Beneficial Reuse
- Environmental Discharge Considerations
  - ✓ Key Issues and Concerns
  - ✓ How to Assess Discharge Dispersion?
  - ✓ New Method for Salinity Tolerance Evaluation
  - ✓ Concentrate & Effluent Toxicity
  - ✓ Beneficial Uses of Concentrate
- Guidelines for Selecting and Designing Concentrate Disposal System
- Examples of Concentrate Treatment and Disposal in Water Reuse and Desalination Projects
- Questions and Discussion

16:30 – 17:00 Questions and Discussions

Day 3 – Plant Performance Optimization and Troubleshooting

09:00 – 10:30 Plant Performance Analysis and Optimization

- Key Plant Performance Parameters for Desalination and Water Reuse Systems
- Diagnostics of Membrane Fouling
- Key Steps of Plant Performance Analysis
  - ✓ Normalized Permeate Flow
  - ✓ Plant Control with Changing Water Quality
  - ✓ Optimization of Plant Design and Operations
- Optimizing Plant Design & Operation
  - ✓ Improving Performance by Redistributing Flux/Energy
  - ✓ Reducing Feed Pressure and Plant Recovery
  - ✓ Use of Larger Pumps/RO Trains
  - ✓ Optimizing Boron Rejection
- Optimizing Energy Efficiency
- Membrane Integrity Testing
- Membrane Cleaning
- Questions and Discussion

10:30 – 10:45 Coffee Break

10:45– 12:00 Desalination and Water Reuse – Plant Monitoring and Troubleshooting

- Operating Practices In Water Reuse and Desalination
  - ✓ What Do We Monitor in RO Systems?
  - ✓ Operations Monitoring Methods and Equipment
- RO Systems Monitoring
- RO Membrane Fouling: Potential Impacts, Causes & Remedies
  - ✓ Decrease In Permeate Flow
  - ✓ Increase in Pressure Drop
  - ✓ Increase of CIP Frequency
  - ✓ Investigation and Definition of Type of Fouling
- Failure Modes and Membrane Fouling in Water Reuse Systems
- Failure Modes and Membrane Fouling in Desalination Systems
- Questions and Discussion

12:00 – 13:00 Lunch Break

13:00 – 14:00 Desalination Plant Case Studies

- Tampa Bay Seawater Desalination Plant, USA – Challenges and Solutions
- Fujairah SWRO Plant, UAE – Solutions for Source Seawater with High Fouling Potential
- Questions and Discussion

14:00 – 14:15 Coffee Break

14:15 – 15:30 Water Reuse Plant Case Studies

- Milestones in Membrane Applications for Water Reuse
- The First Direct Potable Reuse Facility in Namibia – Challenges and Solutions
- Lessons Learned from the Largest and Most Efficient Water Reuse Operations in the World (Engineering Design, Operation, Costs and Benefits)
  - ✓ Groundwater Replenishment System, Orange County California
  - ✓ Designer Water Production in Edward C. Little Water Recycling Facilities, West Basin, California
  - ✓ Singapore Experience in Water Reuse: the NEWater Factories
- Key Advantages and Main Constraints for RO Application for Industrial Water Reuse: Refinery of Panipat, India
- Questions and Discussion

15:30 – 16:00 Questions and Discussions

16:00 – 17:00 Multiple Choice Test and Adjourn