



European  
Desalination  
Society

## A 4-day intensive course MEMBRANE DESALINATION AND MEMBRANE WATER FILTRATION

Reverse Osmosis, Nanofiltration and  
MF/UF Systems  
Process, Design, Applications and Economics

Lecturer Mark Wilf, Ph.D.

February 20–23, 2006, L'Aquila, Italy



The Membrane Desalination and Membrane Water Filtration Technology Course encompasses the latest state-of-the-art commercial membrane desalination technology. It provides a thorough overview and understanding of the RO, NF, and MF/UF processes, all with a detailed discussion on how to apply, design and operate potable systems using innovative membrane technologies, and how to evaluate project economics. The seminar contents is directed toward project engineers, plant designers, planners, utility directors, and operation managers, involved in municipal and industrial membrane projects. Also scientists and academics interested in membrane desalination will find in this course an insight into latest trends in commercial membrane desalination technologies for potable water applications. A step-by-step approach to designing, operating and cost evaluation of membrane system is explained in simple practical terms, all backed up by sample process calculations and case studies. The information included in this seminar represents the current state of development of commercial membrane desalination technology and applications for potable water production.

The course provides information, education and real life examples of the following major subjects:

- **Principles of membrane separation** — presents explanation of membrane technology and factors that affect membrane element performance in field operation.
- **RO/NF system configurations and system design parameters** — presents information on major components, process steps and configuration of desalination plants and modern approach to membrane plant design process including optimization of power consumption and water cost.



University of L'Aquila

- **RO/NF system design, construction and operation** — presents information on the design process, steps of projects execution, commissioning and approach to assure successful plant operation.
- **Application of RO and nanofiltration technology in wastewater reclamation plants** — presents overview of suitable membrane technology for wastewater processing, practical range of design parameters and experience based performance projections.
- **Cost estimation and planning process of RO/NF desalination projects** — presents information on cost factors to be considered in preparation of desalination project budget. It also includes detailed discussion on their relative importance in different types of desalination project alternatives such as Turn-key, DBO, BOOT.
- **Microfiltration and ultrafiltration technology** — presents information on this new emerging technology, commercial membrane modules and process economics. It describes various alternatives of process and system configurations applied for treatment of potable water and as pretreatment technology in RO plants.

### Lecturer

Dr. Mark Wilf, Vice President Corporate Technology, for Hydranautics Corporation, San Diego, CA, has planned and will deliver the course. Dr. Wilf has a long career in the reverse osmosis membrane industry and has published and presented many papers in this field. He holds a number of patents in the field of membrane desalination.

### VENUE

#### L'Aquila

L'Aquila, the capital of the Abruzzo region, is dominated by the Gran Sasso mountain, highest point in the Appenines and enjoys a healthy alpine climate: cold but dry in winter, and hot without becoming unpleasant in summer.

The city was born in the Middle Ages, has a hundred splendid squares which are symbols and testimony of the small villages that cooperated in building it. The long cultural tradition is preserved in the beautiful medieval monuments and buildings in Baroque and Renaissance style, in paintings and in its museums, as well as maintaining an active and musical and theatrical life, local cuisine, handicrafts and folklore.

In the surroundings there is a unique natural environment at a height of 3,000 m where there are protected woods with chamoix, bears and wolves. In the winter there are attractive ski areas.



#### Canadian Hotel

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## PROGRAM

### Day 1 Basics of Reverse Osmosis Technology

**09.00 Basic parameters of the RO process**

Development of membrane technology  
Terms and parameters of membrane separation process.  
Effect of feed salinity on osmotic pressure, net driving pressure, feed pressure and permeate salinity.  
Effect of recovery rate on average feed salinity and concentrate salinity.  
Effect of temperature on water transport and salt transport.

**09:45 Coffee break**

**10.00 Commercial RO membranes and membrane module configuration**

Concept of semipermeable membrane for water treatment  
Configuration of asymmetric cellulose acetate and composite aromatic polyamide membranes. Hollow fiber and capillary membranes.  
Membrane manufacturing process: flat sheet asymmetric, composite and capillary membranes.  
Membrane types: microfiltration, ultrafiltration, softening, brackish, seawater.  
Special membrane materials: highly charged, low fouling, selective permeability.  
Membrane elements configuration: spiral wound, hollow fiber, plate and frame.  
Membrane elements manufacturing process.  
Nominal performance and nominal test conditions.

**12.00 Parameters affecting membrane performance**

Effect of composition of feed water and operating parameters of RO system on membrane performance.  
Translation of nominal element data to performance in field conditions.  
Effect of feed water composition, pH, temperature, salinity and recovery rate on membrane performance.

**13.00 Lunch**

**14.00 Water chemistry of the RO process**

Feed water types.  
Typical water composition.  
Analytical data required for RO applications.  
The carbonate system.  
Calcium carbonate saturation indicators, methods of calculation.  
Saturation limits of other salts.  
Acidification, calculation of acid consumption using sulfuric and hydrochloric acid.  
Distribution of pH along RO system.  
Types of scale inhibitors.  
Conditioning of RO permeate: pH adjustment, CO<sub>2</sub> removal, caustic dosing, alkalinity adjustment, hardness adjustment, use of corrosion inhibitors.  
Chlorination and dechlorination process.

**16.00 Summary and discussion**

## Day 2 System Configuration and Performance Projections

### 09.00 RO system configuration: feed water supply and pumping unit

Feed water sources and characteristic feed quality.

Water quality indicators: TDS, Turbidity, SDI, suspended solids, TOC, BOD, bacterial count, sparingly soluble salts concentration.

Pretreatment processes: clarification, in line flocculation, media filtration, membrane filtration, pH adjustment, adding of scale inhibitors, softening, cartridge filtration, dechlorination.

Pumping system configuration

Performance parameters of pumping systems

Power recovery devices

Components of power consumption

Optimization of power consumption in RO unit

### 10.45 Coffee break

### 11.00 RO system configuration – cont.

RO system configuration: single element system, single stage system, multistage system, two pass system with single pump and two pumps system with permeate throttling.

Instrumentation and control system

Membrane cleaning unit

### 12.00 Computer projections of RO system performance.

Manual methods of RO membranes performance calculations.

Description of computer program algorithm.

Examples of performance calculations.

Additional features of computer programs.

### 13.00 Lunch

### 14.00 Introduction to membrane system design

Project specifications

Process development

Performance calculations

Bill of materials

Process and instrumentation diagram

Parameters of capital and operating cost

### 16:00 Summary and discussion

## Day 3 Membrane system design and operation

### 09.00 System design verification through operation of a pilot unit

Pilot testing objectives

Pilot unit configuration

Testing program

Evaluation of results

- 10.00 Membrane system startup procedure**  
Preparation for system startup  
Acceptance test procedure  
Performance follow up, recording of operating parameters
- 10.45 Coffee break**
- 11.00 Performance normalization of RO membranes**  
Recording of operational data.  
Examples of system performance normalization.  
Determination of performance trends and membrane cleaning schedule  
Pressure vessels probing and evaluation of probing results.
- 13.00 Lunch**
- 14.00 Membrane fouling and cleaning procedure**  
Type of membrane fouling processes.  
Indicators of fouling conditions.  
Identification of fouling constituents.  
Procedure and parameters of membrane cleaning process.  
Cleaning formulations.
- 16:00 Summary and discussion**

## **Day 4 Microfiltration and Ultrafiltration Technology**

- 9:00 Introduction to MF/UF technology**  
MF/UF membrane types  
Membranes and modules configuration  
Mode of operation  
Membrane and module performance criteria  
Parameters affecting performance  
Applications: potable, RO pretreatment ,wastewater reclamation, membrane bioreactors  
System performance requirements
- 10.45 Coffee break**
- 11:00 UF/MF system design**  
System sizing  
Components of UF/MF system  
System layout  
Economics of UF/MF systems: capital and operating cost  
UF/MF pilot unit configuration and operation
- 13:00 Lunch**
- 14:00 UF/MF system operation**  
Sequence of operation of MF/UF system  
Verification of UF/MF system integrity  
MF/UF system cleaning procedure
- 16:00 Summary and discussion**

## REGISTRATION FORM

Surname \_\_\_\_\_ Name \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

Country \_\_\_\_\_ Telephone \_\_\_\_\_

Fax \_\_\_\_\_ E-mail \_\_\_\_\_

*Registration fee:* Till December 15: **€ 1.900** After December 15: **€ 2.000**

*The fee includes 5 nights accomodation, transportation to/from airport, lunches, coffee, dinners, course Workbookand CD.*

*Payment can be made by:*

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