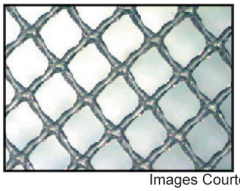
European Desalination Society

COURSES IN DESALINATION

Lecturer David H. Paul

RO Week in L'Aquila

November 5–7, 2012	**Operation, Maintenance and Troubleshooting of NF/RO Systems**
November 8–9	**Optimal Design & Operation of RO Systems**

Images Courtesy: Sumitomo, David H. Paul, Inc., Bureau of Reclamation, City of Scottsdale

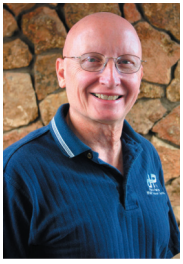
Who Should Attend

These courses are designed to provide valuable, practical knowledge to anyone wanting to understand the most important features of a well designed and operated RO system including.

Why you should attend

To understand the difference between low-bid, high-fouling, pain-in-the pocket-book (and other places) RO systems and ones that can operate with the lowest life cycle-costs and fewest problems.

Lecturer



David Paul is the President of David H. Paul, Inc. (DHP), a high-tech water treatment training and consulting firm. David has been working high-tech water treatment since 1977. He has published over 160 technical articles and papers. DHP has created and administers a 4,000 page, college-accredited correspondence training program, 4-semester on-campus programs, extensive on-line training programs and has trained over 17,000 professionals in high-tech water treatment. He holds a B.S. degree in biology and an M.S. degree in microbiology. His experience includes 2.5 years as an operator, 1 year as a first level supervisor and 8.5 years as the manager of a $500 million USD (today's value) membrane and distillation industrial water treatment plant followed by over 24 years of training and consulting at hundreds of high-tech water treatment systems including brackish water and seawater municipal drinking water RO plants and industrial high-purity systems..

VENUE
L'Aquila, Canadian Hotel

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.

Canadian Hotel

S.S. 17 Localta Casermette
67100 L'Aquila, Italy
Tel. +39 0862 317402
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Email: canadian@canadianhotel.it

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.

Operation, Maintenance and Troubleshooting of NF/RO System

A 3-day intensive course

Lecturer David H. Paul

November 5–7, 2012

Day 1

08:30 **Introductions**

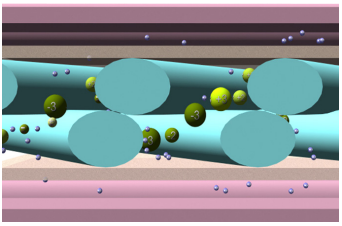
09:00 **Water Contaminant Overview**
Contaminants (Dissolved & Suspended)
The characteristics of contaminants that allow their removal by membrane technologies

09:30 **Break**

09:45 **Membrane Water Treatment Overview**
Pressure driven membrane technologies
Membrane configurations (flat sheet & hollow fiber)
Membrane filtration technologies
Reverse osmosis technologies

Workshop 1: Attendees Process Flow Diagrams

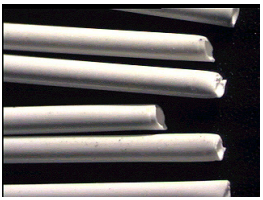
10:45 **Break**



11:00 **Semipermeable RO/NF Membranes**
Structure
Water flux
Salt flux
Rejection of contaminants

Osmosis & Reverse Osmosis
Osmotic pressure
Applied pressure
Net driving pressure
Water flux
Salt flux

12:00 **Lunch**



13:00 **Membranes**
Flat sheet, hollow fiber
Brackish, seawater
Low pressure, low fouling, high rejection

Membrane Elements
2” (5 cm), 2.5” (6 cm), 4” (10 cm), 8” (20 cm), 8.5” (22 cm) elements
12.75” (32 cm), New 16” (41 cm) and new 18.25” (46 cm) elements
Envelopes
Feed water spacer
Permeate spacer
Flow path
Low pressure, low fouling, high area & high rejection

Workshop 2: Build a simulated element

14:15 **Break**

14:30 **Pressure Vessels**
2”, 2.5”, 4”, 8”, 16”, 18.25”
End port, side port, multi-port
Stainless steel, fiberglass

Shimming elements
RO/NF Units
POU, POE, industrial, municipal
Single stage, multi-stage
Single pass, double pass
Brackish water RO, seawater RO

Workshop 3: RO membrane performance

15:45 **Break**

16:00 **RO Unit Operation**
POU
Single pass
Double pass
Recovery rate
Concentration
Water flux per element
Net driving pressure (NDP) per element
Salt passage per element
NDP and SP versus temperature

Seawater RO Unit Operation
Single stage, double stage
Single pass, double pass

14:50 **Final Questions & Answers**

17:00 **End**

Day 2

08:30 **Workshop 4: Review of Day 1**

09:00 **Potential Problems**
Scaling
Fouling
Chemical Attack

09:30 **Break**

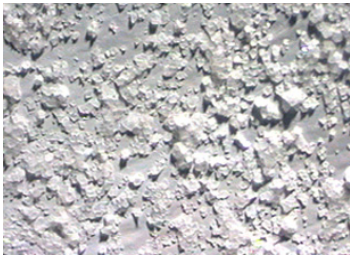
09:45 **Pretreatment to minimize problems**
Minimize scaling
- Softening
- Acid injection
- Scale inhibitor injection

10:45 **Break**

11:00 **Pretreatment (continued)**
Minimize fouling
- Clarification
- Media filtration
- Cartridge filtration
- Microfiltration/ultrafiltration

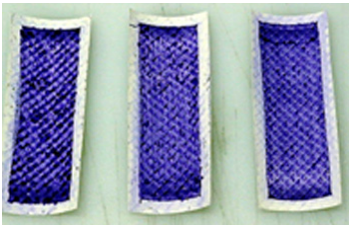
12:00 **Lunch**

13:00 **Pretreatment (continued)**
Minimize chemical attack
- Activated carbon
- Sulfite injection
- Ultraviolet irradiation



Seawater pretreatment
Conventional
Advanced

Workshop 5: Pretreatment



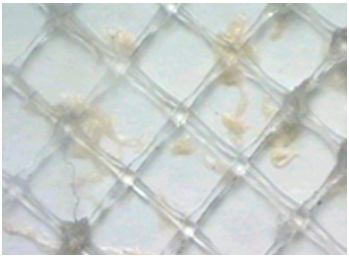
14:15 **Break**

14:30 **Chemical Cleaning**
Removing scalants
Removing foulants
A good cleaning procedure
How to determine when to stop cleaning
How to determine the effectiveness of a cleaning

15:45 **Break**

16:00 **Workshop 6: RO Unit Operation & Maintenance**

16:50 **Final Questions and Answers**



17:00 **End**

Day 3

08:30 **Workshop 7: Review of Day 1**

09:00 **On-stream instruments needed for proper monitoring**
Single stage RO units
Multi-stage RO units
Double pass RO units
Conductivity
pH
Pressure
Flow

Temperature
ORP (for some)
SDI (for some)

Hand-held/bench instruments needed for proper monitoring
pH
Conductivity
Chlorine
Sulfite
SDI
Silica (for some)
ORP (for some)

09:30 **Break**

09:45 **Daily Monitoring**
Pressures
Flows
Conductivities
pH
Temperature
Silt Density Index (SDI)
Free and Total Chlorine
Sulfite
Pressure drops
Recovery rate

Weekly Trending
Normalized Permeate Flow (NPF)

Normalized Salt Passage (NSP)
Normalized Pressure Drop
(Normalized Differential Pressure)
Changes seen with scaling, fouling & chemical attack

10:45 **Break**

11:00 **How to Use Free Monitoring Software for weekly trending**
Startup data
Daily data
Performance trends

Workshop 8: Monitoring & Performance Trends

12:00 **Lunch**

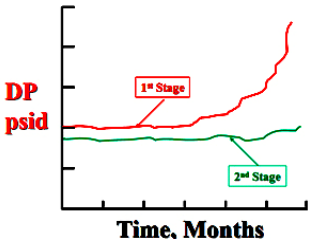
13:00 **Monthly Monitoring**
Profiling Source: Hydranautics RO Data Program
Performance changes with scaling, fouling & chemical attack

Startup & Intermittent Monitoring
Probing
Problems causing probing changes

Workshop 9: Evaluating Profiling & Probing Data

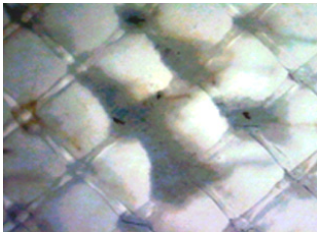
14:15 **Break**

14:30 **Performance Changes with Scaling, Fouling & Chemical attack**
NPF
NSP
NPD
Gauge changes
Profiling
Probing



Pretreatment Monitoring
Free & total chlorine
SDI
pH
Total Hardness (softener)
Scale inhibitor injection

Chemical Cleaning Monitoring



15:45 **Break**

16:00 **Workshop 10: Evaluating Performance Data**

Workshop 11: Attendees PFDs

16:45 **Summary & Conclusions**

Final Questions & Answers

Seminar Evaluation

17:00 **End**

Optimal Design & Operation of RO Systems

A 2-day intensive course

Lecturer David H. Paul

November 8–9, 2012

Day 1

8:00 **Introductions**

Membrane Water Treatment

Reverse Osmosis Overview

Water contaminants
Membranes
Osmosis and reverse osmosis
Net Driving Pressure
Water flux; RO unit operation
Scaling, fouling and chemical attack

9:00 **Break**

9:15 **Source Waters**

Fresh; Brackish; Seawater; Well water, surface water

A Complete RO Feed Water Analysis

Cations & anions; Other

How to Read a Complete Water Analysis Report

Solution neutrality
Cations, anions
Charge balance (ppm as $CaCO_3$ or meq/L)

10:15 **Break**

10:30 **Using free software programs to evaluate feed waters**

Workshop: Determining if a feed water analysis is complete and can be relied on

11:30 **Lunch**

12:30 **Analysis that must be performed on-site**

pH
Temperature
Silt Density Index (SDI)
Biological Activity Reaction Tests (BARTs)
Hydrogen sulfide

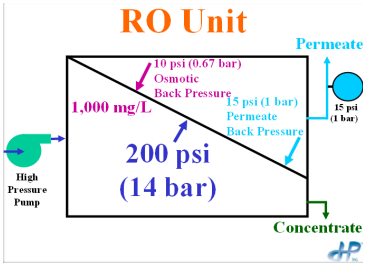
Evaluating Scaling Potentials

Scaling
Carbonate scaling potential
  Langelier Saturation Index (LSI), Stiff & Davis Saturation Index
Non-carbonate scaling potential
  % Saturation
Silica scaling potential: Temperature, pH, Using free software programs to calculate scaling potential

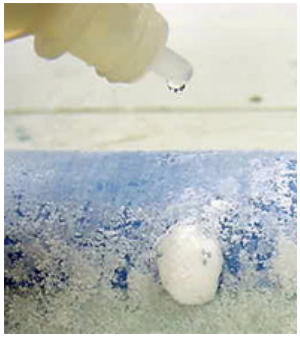
13:45 **Break**

14:00 **Evaluating Non-Living Fouling Potentials**

Fouling overview
Turbidity; TSS
Silt Density Index (SDI)

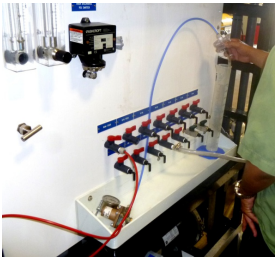


Ions	mg/l	ppm CaCO3	meq/l
Ammonium (NH4)	0	0.000	0.000
Potassium (K)	8.368	10.700	0.214
Sodium (Na)	49.658	108.000	2.160
Magnesium (Mg)	14.903	61.300	1.226
Calcium (Ca)	101.523	253.300	5.066
Strontium (Sr)	0.783	0.894	0.018
Barium (Ba)	0.018	0.013	0.000
Carbonate (CO3)	0.344	0.573	0.011
Bicarbonate (HCO3)	433.745	355.500	7.110
Nitrate (NO3)	0.489	0.394	0.008
Chloride (Cl)	52.045	73.400	1.468
Fluoride (F)	0.301	0.791	0.016
Sulfate (SO4)	16.704	17.400	0.348
Silica (SiO2)	68.8	n.a.	n.a.
Boron (B)	0	n.a.	n.a.



Oxidation, reduction
Iron (Fe); Manganese (Mn);
Hydrogen sulfide (H_2S); Aluminum (Al)

Evaluating Living Fouling Potentials
Temperature
Chlorination/dechlorination
TOC
Biocounts
Nitrate; Phosphate; SDI



15:15 **Break**

15:30 **Workshop: Evaluation of Fouling Potentials**

16:00 **Summary & Conclusions**

Final Questions & Answers

Day 1 Evaluation

16:15 **Tour (at some locations)**

17:00 **End**

Day 2

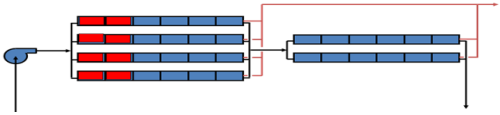
8:00 **Workshop: Day 1 Review (Optional)**

Good Design Means Low Fouling
Water Flux
Crossflow
Chlorination/Dechlorination

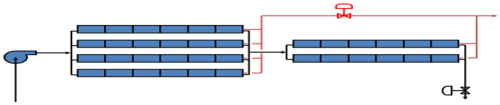
Standard NF/RO Unit Designs

9:00 **Break**

9:15 **Lower Fouling RO/NF Unit Designs**
Hybrid element loading



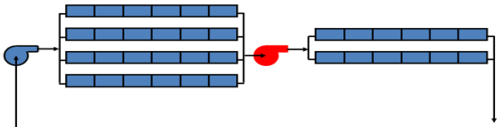
Workshop: Hybrid element loading
First stage permeate backpressure



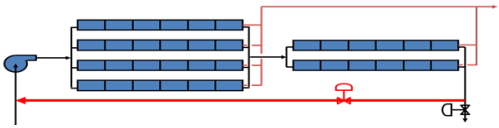
Workshop: First stage permeate backpressure

10:15 **Break**

10:30 **Lower Fouling RO/NF Unit Designs**
Interstage booster pumps



Workshop: Interstage booster pump
Concentrate recycle



Workshop: Concentrate Recycle

11:30 **Lunch break**

12:30 **Pretreatment**

Scaling control

Recovery rate

- Acid
- Scale inhibitor
- Softening
- Post-shutdown flushes
- Chemical cleaning

Fouling control

- Water flux
- Crossflow
- Media filtration
- Microfiltration/ultrafiltration
- Bag/cartridge filtration
- Chemical cleaning
- Pilot study

13:45 **Break**

14:00 **Pretreatment**

Biofouling control

- Operation
- Post-shutdown flushes
- Biocides
  - Hydrogen peroxide/peracetic acid
  - Chloramines
  - DBNPA
- Chemical cleaning
- Pilot study

Workshop: Quantify feed waters' scaling and fouling potentials

15:15 **Break**

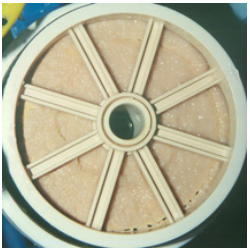
15:30 **Workshop: Attendees' plants/issues**

16:30 **Summary and Conclusions**

Final Questions and Answers

Day 2 Evaluation

17:00 **End**



David H. Paul, Inc.
1911 Rustic Place
Farmington, NM 87401
United States of America

RO Week in L'Aquilia Italy

REGISTRATION FORM

Surname _____ First name _____

Address _____

_____

Country _____ Telephone _____

Fax _____ E-mail _____

The classes are separated in to two parts:
Day 1–3: Operation, Maintenance & Troubleshooting of NF/RO Systems November 5–7, 2012
Day 4–5: Optimal Design and Operation of RO Systems November 8–9, 2012

Registration fee:	☐ Day 1–3 (includes 4 nights at hotel)	☐ Day 4–5 (includes 3 nights at hotel)	☐ All days (includes 6 nights at hotel)
☐ EDS members	**€2,600**	**€1,800**	**€3,900**
☐ Non-members	**€2,800**	**€2,000**	**€4,100**

The fee includes accommodation, lunches, coffee, dinners, course material.

You are responsible for your own transportation. Buses are now available from the airport to L'Aquila at a cost of €15 one way. There are 4 buses a day that leave the airport at 11, 14, 16 and 21.30. Bus stops by hotel.

Payment can be made by:

Bank Transfer to be sent to the address below and a copy emailed to us

Please take care of your own bank charges

Account Name European Desalination Society
Account No. 11863.19
Banca Monte dei Paschi di Siena
67100 L'Aquila, Italy
ABI: 01030 *CAB:* 03600
Swift code: PASCITMMAQU
IBAN code: IT 92 I 01030 03600 000001186319

Credit card

☐ Visa ☐ Mastercard
For other cards please contact us

Card N° _____

Exp. date _____

Cardholder name _____

Signature _____

Please fill in the form and fax to: Fax +1 928 543 3066
or send as an attachment to: miriambalaban@yahoo.com