

# **Operation Maintenance & Troubleshooting Of RO**

3-Day Seminar

## **Information Packet**

**Seminar Cost** - \$2,097 USD (Early Bird Discounts May Apply)

**Seminar Length** – 3 day (8 hours per day)

**Seminar Description**

Much of the information presented in this course is typically not found in O & M manuals and other vendor material. What you don't know CAN hurt the efficient, least-cost operation of your RO/NF water treatment system. This seminar teaches you the monitoring and troubleshooting activities you must perform to catch problems at an early stage when hopefully they're relatively easily reversible. Thorough understanding of required monitoring activities and thorough understanding of performance trends and interpretation of data are stressed.

This course covers the fundamental information you need to know for the smallest POU/POE systems to the largest brackish water and seawater RO/NF units, as well as provides the technical information that's typically missing from startup training and O & M manuals. All information is applicable to NF units as well.

**Who Should Attend**

Anyone desiring to know the latest, UNBIASED information on reverse osmosis (RO) and nanofiltration (NF) water treatment monitoring and troubleshooting.

**Why You Should Attend**

Even people with 10+ years of experience marvel at how much they learn in a DHP seminar. The reason for this is that DHP continually improves its step-by-step training methodology and seminar materials so that anyone with a typical high school education can thoroughly understand the information presented.

DHP's outstanding, proven training methodology is based upon:

- Practical information. We know what's important and know what's not. You WON'T be taught water flux and salt flux equations (typical in other RO training programs). Only researchers use these equations. You'll be taught what you need to excel in RO water treatment.
- Practical RO water treatment experience. DHP instructors have dozens of years of real-world experience.
- Extensive training experience. DHP has trained tens of thousands of RO water treatment professionals since 1988.
- Effective multimedia presentations. DHP has invested millions of dollars over the years in electronic teaching aids, including extensive photographs, video clips and animations. If a picture is worth a thousand words, DHP has a "bazillion" words worth of training aids.

**What You'll Receive**

- 24 hrs of enjoyable, interesting, easy-to-understand hands-on training
- A highly illustrated workbook
- Break refreshment
- Personal attention: Questions & comments are encouraged

### Instructor Biography

Your instructor will be one or more of the following



David Paul  
David H. Paul, Inc.  
Owner/Founder/Instructor

**David Paul** is the President of David H. Paul, Inc. (DHP), an advanced water treatment training and consulting firm. David has 36 years of operating, managing, training and consulting experience in membrane water treatment. He has published over 160 technical articles and papers, of which many have been for Water Technology, Water & Wastes Digest and Water Conditioning and Purification. He has trained many times at the WQA Annual Conference and has held seminars at the WQA Headquarters. He has created and administers many on-line, on-site, and on-campus training programs in advanced water treatment. He holds a B.S. degree in biology and an M.S. degree in microbiology



Bill Dees  
David H. Paul, Inc.  
Director of Training  
Services/Instructor

**Bill Dees** is Director of Training Services for David H. Paul, Inc. (DHP). He has 10 years of experience as a Service Technician/Installer/Service Manager and was part owner and General Manager of his own Residential/Commercial water conditioning business. In addition he has 15 years of design, operation, maintenance, troubleshooting, training and consulting experience of water treatment systems including membrane, ion exchange, pretreatment and post-treatment equipment. Bill holds an Associate of Applied Science Degree in Industrial Water Treatment from San Juan College, DHP's first on-campus, college degree program. Bill also performs system technical assessments, consulting, element autopsies and chemical cleaning evaluations.



Dick Youmans  
David H. Paul, Inc.  
Director of Certification/  
Instructor

**Richard (Dick) Youmans** has over 30 years of experience in the industrial water treatment industry with 16 of those specializing in reverse osmosis chemical applications, training and troubleshooting. Dick received an Associate of Applied Science Degree in Industrial Water Treatment from San Juan College and David H. Paul, Inc. in 2002. As a corporate trainer, he has trained over 1,400 students in reverse osmosis technology and chemistry.

## **Certificate of Completion**

Each attendee will receive a DHP certificate of completion following the course.

## **DHP Training Seminars**

DHP has trained over 16,000 water treatment professionals worldwide since 1988. Trainees include industrial, governmental and drinking water clients. The average rating given by attendees for all DHP seminars, including this one, is over 9 (on a scale of 1-10, with 1 being a terrible rating and 10 being an outstanding rating).

## **Testimonials**

The following are typical comments from attendees of DHP Seminars:

“Great Course! Well worth the time.”

**Bob Castle - Water Quality Manager, Marin Municipal Water District**

“Excellent training materials and presentation.”

**Gary Trent - Abbott Laboratories**

“Excellent... got what I was interested in and more, especially in the inner workings of UF.”

**Eric Lozano - Austin Energy**

“Well presented and well worth the investment.”

**John Countz - Operations Manager, Consolidated Water Co.**

“Excellent! More than I expected.”

**Mark Hall - Texas Water Development Board**

“It was great!”

**Trent Hughes - Civil Engineer, Black & Veatch**

“Great Course.”

**Joe Gonzales - Xcel Energy**

“Most Excellent!”

**Mike Milner - Alternative H2O Solution**

## Reverse Osmosis Operation, Maintenance & Troubleshooting Day 1

08:30 Introductions

09:00 Water Contaminant Overview

- Contaminants (Dissolved & Suspended)
- The characteristics of contaminants that allow their removal by membrane technologies



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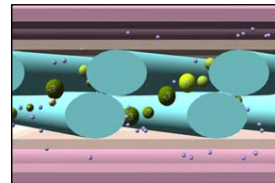
09:30 Break

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

Workshop 2: Membrane Water Treatment



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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



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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



Courtesy: Dow FilmTec

Workshop 3: 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



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Workshop 4: 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



Courtesy: U.S. Bureau of Reclamation

Seawater RO Unit Operation

- Single stage, double stage
- Single pass, double pass

14:50 Final Questions & Answers

17:00 End



Courtesy: Tampa Bay Water

## Reverse Osmosis Operation, Maintenance & Troubleshooting Day 2

08:30 Workshop 5: 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 6: 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

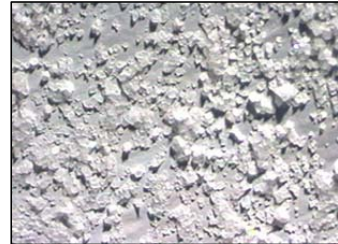
15:45 Break

16:00 Workshop 7: RO Unit Operation & Maintenance

Workshop 8: Attendees' PFDs

16:50 Final Questions & Answers

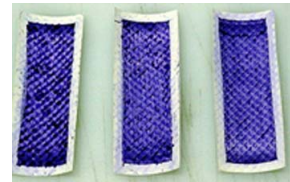
17:00 End



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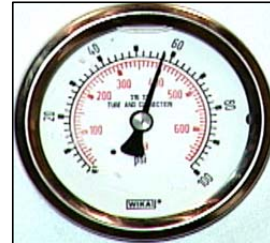


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## Reverse Osmosis Operation, Maintenance & Troubleshooting Day 3

### 08:30 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)



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### Hand-held/bench instruments needed for proper monitoring

- pH
- Conductivity
- Chlorine
- Sulfite
- SDI
- Silica (for some)
- ORP (for some)



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### 09:30 Break

### 09:45 Daily Monitoring

- Pressures
- Flows
- Conductivities
- pH
- Temperature
- Silt Density Index (SDI)
- Free & 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



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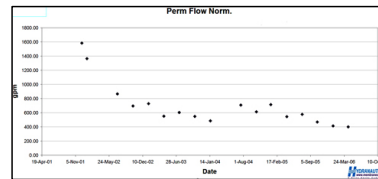
### 10:45 Break



11:00 How to Use Free Monitoring Software for weekly trending

- Startup data
- Daily data
- Performance trends

Workshop 9: Monitoring & Performance Trends



Source: Hydranautics RO Data Program

12:00 Lunch

13:00 Monthly Monitoring

- Profiling
  - 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

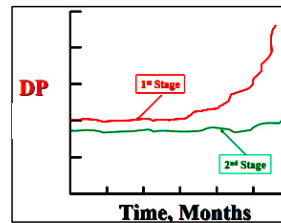
16:00 Workshop 10: Evaluating Performance Data

16:45 Summary & Conclusions

Final Questions & Answers

Seminar Evaluation

17:00 End



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