

Reverse Osmosis

Operation & Maintenance



Courtesy: RAWEC



Orange County Water District



Tampa Bay Water

WHERE & WHEN

IDA World Congress-Dubai, UAE

November 12, 2009

DAILY SCHEDULE

8:00 a.m. - 11:30 a.m.

Lunch Break

12:30 p.m. - 5:00 p.m.

WHO SHOULD ATTEND

Anyone desiring to know the latest, **UNBIASED** information on reverse osmosis (RO) and nanofiltration (NF) water treatment (DHP is a training company, NOT an equipment vendor).

WHY YOU SHOULD ATTEND

Much of the information presented in this seminar is typically not found in Operations & Maintenance (O & M) manuals and other vendor material. This course covers the fundamental information you need to know to most cost effectively operate and maintain the smallest to the largest brackish water and seawater RO/NF systems. The instructor, David Paul, has over 32 years of experience in the operation, maintenance, monitoring and troubleshooting of brackish water and seawater RO units. He has trained and consulted at hundreds of RO/NF plants, including many of the largest.



Courtesy: City of Chandler

WHAT YOU'LL RECEIVE

8 hours of practical, interesting, easy-to-understand reverse osmosis water treatment training

8 hours of the latest in multimedia training including video & 3-D animations

A highly illustrated workbook

Break refreshments (lunch included)

INSTRUCTOR



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Barring unforeseen circumstances, David Paul will instruct this training program. David was an operator for 2.5 years, first-level supervisor for 1 year and manager for 8 years of one of the most advanced water treatment systems in the world. He then began David H. Paul, Inc. (DHP) and has trained and consulted since 1988. David is the author of over 130 published articles on advanced water treatment, has developed and administers a 4,000 page correspondence training program on advanced water treatment, and has created and administers on-campus *Associate Degree in Advanced Water Treatment* programs at three different colleges in the United States. David is the President of DHP, an advanced water treatment training and consulting firm located in Farmington, New Mexico, USA. DHP has trained over 13,000 water treatment professionals worldwide since 1988.

OVERVIEW OF TOPICS

- Water Contaminants Overview
- Semipermeable RO/NF Membranes
- Osmosis & Reverse Osmosis
- Membranes
- Membrane Elements
- Pressure Vessels
- RO/NF Units
- RO Unit Operation
- Seawater RO Unit Operation
- Potential Problems
- Brackish water pretreatment to minimize problems
- Seawater pretreatment to minimize problems
- Chemical Cleaning of RO/NF units



Courtesy: City of Scottsdale

WHAT YOU'LL LEARN

You'll learn all of the practical information necessary to thoroughly understand the RO/NF water treatment technologies.



Courtesy: City of Robinson, TX



Siemens



US Army

DETAILED AGENDA

7:45 Refreshments (Provided)

8:00 Introductions

Water Contaminants Overview

- Ions
- Gases
- Organics
- Silica

Semipermeable RO/NF Membranes

- Structure
- Water Flux
- Salt Flux
- Rejection of contaminants

9:00 Break (Refreshments Provided)

9:15 Osmosis & Reverse Osmosis

- Osmotic pressure
- Applied pressure
- Net Driving Pressure
- Water flux
- Salt flux

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 1: Build a simulated element

10:15 Break (Refreshments Provided)

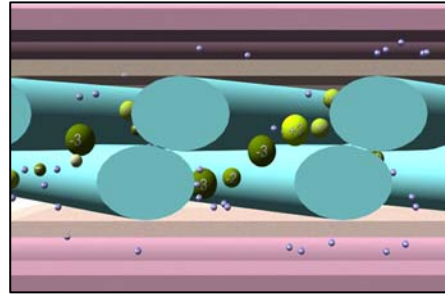
10:30 Pressure Vessels

- 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

11:30 Lunch (Not Provided)



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Courtesy: Dow FilmTec



Courtesy: RAWEC

12:30 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

Workshop 2: RO Unit Operation

1:45 Break (Refreshments Provided)

2:00 Potential Problems

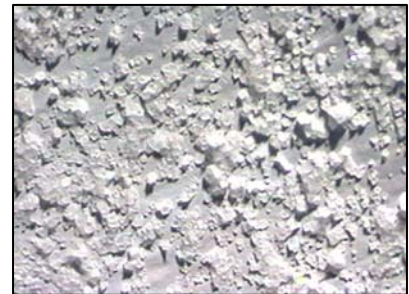
- Scaling
- Fouling
- Chemical Attack



Courtesy: Tampa Bay Water

Brackish water pretreatment to minimize scaling, fouling, chemical attack

- Minimize scaling
 - Softening
 - Acid injection
 - Scale inhibitor injection
- Minimize fouling
 - Clarification
 - Media filtration
 - Cartridge filtration
 - Microfiltration/ultrafiltration
- Minimize chemical attack
 - Activated carbon
 - Sulfite injection
 - Ultraviolet irradiation



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Seawater pretreatment

- Conventional
- Advanced

3:15 Break (Refreshments Provided)

3:30 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



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4:45 Summary & Conclusions

- Final Questions & Answers
- Seminar evaluation

5:00 End

CERTIFICATE OF COMPLETION

Each attendee will receive a DHP *Certificate of Completion* following the seminar.

WHAT ATTENDEES SAY ABOUT 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 is over 9 (on a scale of 1-10, with 1 being a terrible rating and 10 being an outstanding rating). The following are typical comments from attendees of DHP seminars:

“Learned so much my brain hurt.”

Harold (Budji) McDill, System Operator, Monterey Bay Aquarium

“Excellent course material/presentation-lays a solid foundation to build upon. Very high emphasis on students understanding the volume of information given.”

Robert Markle, Boiler Area Leader, Proctor& Gamble

“Course should be required prior to installing & operating RO systems.”

Kim Price, Sr. Plant Engineer, Lucent Technologies

“Excellent info and presentation.”

W.R. Schulz, Manager of Product Development, Isco Industries

“Very good course, even if you have some background in RO.”

Kevin Simmons, Mechanical Project Engineer, US Filter (Siemens)

“Excellent! Very helpful.”

Stan Brooks, President, MoBetta Water Inc.

“Great! Workshops really helped on my troubleshooting skills.”

Gerald Lands, Operator, Duke Energy

“Great seminar! Came in knowing very little about reverse osmosis, left with a good understanding of RO and RO units.”

Chris Greer, Technical Sales Rep., Ashland Specialty Chemical

“This class was extremely enlightening even for someone with RO experience.”

Lionel Fontes, Chemist, SRP

“Great course- I would recommend this course to everyone in this field of work.”

Mike Wilkey, UPW/IWS Tech., Intel-Colorado Springs

“The flow and concentration of information was excellent.”

Joe Turner, Plant Utility Operator, Amgen-Longmont

“Very informative, very in depth, and very helpful.”

Martin Wix, Instrument Tech., BOC Gases