

the ANALYST

THE VOICE OF THE WATER TREATMENT INDUSTRY

Condenser Tube Failure
Mechanisms

Maximizing the Life and
Performance of Reverse
Osmosis Membranes in
Industrial Water Purification
Systems

Water Treater Deposit
Control Polymer Evaluation
Criteria and Considerations

OSHA Hazard
Communication Update

PRESORT STANDARD
US POSTAGE
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WOODBRIIDGE, VA
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Published by
AWT
ASSOCIATION OF WATER TECHNOLOGIES

MicroVision and MicroTrac Controllers

Toroidal Conductivity Sensor
Flow Switch Input
3 Drum Level Inputs
Dry Contact/Hall Effect Water Meter Input
Bleed Output Supports Solenoid Or Motorized Valve
4-20mA Isolated Analog Output
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MicroTrac Cooling Tower Controller

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% Post Bleed Timer
Limit Timer
No Calibration Required



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Can Be Programmed In
Pulse Mode
Percent Mode
Cycle Mode Or
28 Day Biocide Timer Mode

Cooling Tower Controllers Boiler Controllers Programmable Timers

Simple Programming
Easy Installation
Reliable Conductivity Probe
5 Output Relays
Selectable Timers
5 Digital Inputs
4-20mA Output



MicroVision Boiler Controller



the ANALYST

THE VOICE OF THE WATER TREATMENT INDUSTRY

Summer 2013

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Cover

Condenser Tube Failure Mechanisms: Steam water droplet erosion of stainless steel tubing in a nuclear power plant, page 10. Image overlay: Crevice corrosion—(Courtesy of Mars G. Fontana and Norbert D. Greene, *Corrosion Engineering*, McGraw-Hill Book Company, New York City, 1967.)

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Daniel S. Janikowski, Plymouth Tube Co.

The operating environment within a condenser is extremely harsh, and in spite of the designer's best intentions, sometimes tubes made of the best materials fail. The most important tube failure mechanisms typically result from different forms of corrosion and erosion. When it's time to select new condenser tube material, you'll need to consider the projected operating environment and failure mechanisms that material will be subjected to.

23 Maximizing the Life and Performance of Reverse Osmosis Membranes in Industrial Water Purification Systems

Gregg Poppe, Dow Water & Process Solutions

In a challenging economic environment, even more attention than usual is placed on lowering operating costs. If utilities, such as the water treatment system, can deliver the required output for less cost, profits can improve. Fortunately, several proactive steps can be taken to lower the operating cost of a reverse osmosis (RO) plant. These steps include extending the life of the installed membranes by optimizing both the cleaning frequency and the cleaning method. Also, when the membranes operate in an environment with potential to foul, it is important to make wise and well-informed choices, regarding membrane selection, when it is finally time to replace them.

29 Water Treater Deposit Control Polymer Evaluation Criteria and Considerations

Zahid Amjad, Ph.D., and Robert W. Zuhl, P.E., Lubrizol Advanced Materials, Inc.

Industrial systems that use water are often faced with a variety of challenges including scaling, fouling, microbiological growth, and corrosion. To combat these operational problems, water treaters have developed and apply effective treatment programs. This article presents new information on the comparative performance of poly (acrylic acids) made in different polymerization solvents, acrylate terpolymer, and polymer blends.

37 OSHA Hazard Communication Update

Frederick C. Hopkins, CHMM, Consultant and Thomas C. Kuechler, Ph.D. and Kindra Levels, M.P.H., Occidental Chemical Corporation

The new OSHA Hazard Communication Standard was published in the Federal Register on March 26, 2012. All AWT members will be required to comply with this new standard. The fundamental change is the adoption of the international Globally Harmonized System for the Classification and Labeling of Chemicals (GHS). This will result in significant changes in Safety Data Sheets and product labeling for chemicals. Information provided will include some historical background, the hazard classification process, the new requirements for Safety Data Sheets and labels, and compliance deadlines.

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Calendar of Events Page

Association Events

2013 Annual Convention and Exposition

October 30–November 2, 2013
The Mohegan Sun Hotel
Uncasville, Connecticut

2014 AWT Training Seminar West

March 6 - 8, 2014
Green Valley Ranch Resort
Las Vegas (Henderson), Nevada

2014 AWT Training Seminar East

April 24 - 26, 2014
Omni Severin Hotel
Indianapolis, Indiana

2014 Annual Convention and Exposition

October 29–November 1, 2014
The Omni Fort Worth Hotel and Fort Worth Convention Center
Fort Worth, Texas

2015 Annual Convention and Exposition

September 9-12, 2015
Omni Nashville Hotel and Music Center
Nashville, Tennessee

2016 Annual Convention and Exposition

September 7-10, 2016
Omni San Diego Hotel and San Diego Convention Center
San Diego, California

Also, please note that the following AWT Committees meet on a monthly basis. To become active in one of these committees, please contact us at (301) 740-1421.

Second Tuesday each month, 10am—**Marketing/Communications Committee**
Second Tuesday each month, 11am—**Legislative/Regulatory Committee**
Second Wednesday each month, 9am—**Business Resources Committee**
Second Friday each month, 9am—**Pretreatment Subcommittee**
Second Friday each month, 10am—**Special Projects Subcommittee**
Second Friday each month, 11am—**Cooling Subcommittee**
Third Monday each month, 9am—**Certification Committee**
Third Monday each month, 11am—**Education Committee**
Third Friday each month, 9am—**Boiler Subcommittee**
Third Friday each month, 10am—**Technical Committee**
Fourth Tuesday each month, 9am—**Convention Committee**
Fourth Tuesday each month, 4pm—**Membership Committee**
Meets quarterly (call for meeting dates), 11am—**Wastewater Subcommittee**

Other Industry Events

ACS, Fall National Meeting & Expo, September 8-12, 2013, Indianapolis, IN
NACE, Corrosion Technology Week, September 22-26, 2013, Vancouver, Canada
RETA, Annual Convention, September 30-October 2, 2013, Bellevue, WA
WEFTEC, Annual Technical Exhibition and Conference, October 5-9, 2013, Chicago, IL
IWC, Annual Conference, November 17-21, 2013, Orlando, FL

DTEA II™

Biofilm Control from Every Angle!



DTEA II™ is an organic deposit cleaner, penetrant and dispersant used in industrial cooling water systems. It is also an effective corrosion inhibitor. Applied in a coordinated manner with biocides, DTEA II provides water treatment professionals with a highly effective Biofilm Control Program, yielding improvements in biofilm, corrosion and scale control.



DTEA II Biofilm Control Program
360° Protection
from Every Angle!

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- A fouled water system slows operations, increases costs and may result in a complete system failure.
- Failures cost money in replacement parts, wasted man-time and missed deadlines.
- DTEA II penetrates biofilm which allows biocides to work more effectively, from every angle, thus reducing the level of biocide needed.

Increase Efficiency

- Used regularly, DTEA II maintains maximum operating efficiency by keeping surfaces clean.
- A system free from deposits allows optimum heat transfer from vital components.
- Cleaner systems, like an engine, provide more power, smoother operations and increased efficiency.
- Maintaining a system with DTEA II allows peace of mind that the system is continually kept clean, with a proven chemistry, and increases customer satisfaction.

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- No special dosing equipment required.
- DTEA II and a small amount of biocide provide a complete Biofilm Control Program.

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Many of you know that one of my favorite videos and books is *The Last Lecture* by Randy Paus, a professor at Carnegie Mellon, who was giving his last lecture, not just because he was leaving his position, but because he had been given six months to live.

Pausch talked about achieving his dreams and some of the keys to success. Two of those keys to success are:

1. You've got to get the fundamentals down or all of the fancy stuff isn't going to work.
2. Be prepared. Luck is truly where preparation meets opportunity.

I believe that AWT can help you in these areas:

Webinars

AWT offers complimentary webinars to members on a monthly basis. These webinars are also recorded, so if you are unable to join us for the live offering, you can visit the Members Only section of the website and watch the presentation at your convenience. Our webinars cover a wide range of topics, from marketing and sales to insurance.

Benchmarking Survey Results

Another tool in your arsenal is the fiscal operations Benchmarking Study. Many of you participated in this survey that has provided us great financial and sales information about our industry. It can also tell you more about your own company—you can see where your company is doing well and areas where it needs improvement. This is critical to helping you make important business decision.

Even if you didn't participate in the survey, you can still order a copy of the results. You'll receive thorough information on performance statistics and other important data. More information can be found on the AWT website.

Certified Water Technologist (CWT) Program

The CWT program is a way to demonstrate that you have the fundamentals down. It tells your colleagues and customers that you have achieved a high level of experience, knowledge and education in the industry. The CWT program represents the highest professional credential in the industrial and commercial water treatment field. Start on the path to certification today!

AWT Annual Convention

The AWT Annual Convention offers you a chance to learn about new products and services in the industry and to make new contacts. The Convention gives you face time with your peers, and one of the best ways to succeed is to have a trusted friend in the industry that you can turn to for advice and counsel. At the AWT Convention, you can meet with people who are confronted with the same challenges as you. As small to medium size businesses, attendees at the Annual Convention can relate to the exact difficulties you face.

It's hard to believe that, at the end of the Board meeting after the Annual Convention, my presidential term is up. I would like to thank the amazing group of volunteers at the Board and Committee level within AWT. They have accomplished so much and added some great member benefits.

As always, I welcome your feedback and can be reached at president@awt.org. It has been an honor to serve as President of AWT. I look forward to seeing you at the Annual Convention at the Mohegan Sun!

A handwritten signature in black ink, appearing to read 'Mark T. Lewis'.

Liability and Property Insurance Coverage For Water Treatment Businesses



Eligible Companies:

- **Industrial and Commercial **Water Treatment Companies****
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The AWT 2013 Annual Convention and Exposition is just around the corner. We have some really great things in store for you, so I hope you will join us.

If you are thinking about obtaining your LEED GA, you'll have your chance to get training at the Convention, where we will again offer a 4-hour course that will meet the requirements necessary to take the exam. There is a separate \$50 registration fee, but the same course is normally 8-hours and costs \$300. All study materials and practice tests are included in this registration.

We will also have several "lounges" set up at the Convention; these are new sessions we are unveiling this year and are designed to be an informal way for attendees to share their own experiences and ideas. Each session will be open for one hour on Thursday and one hour on Friday and will have room for about 20 people. We will have a Chat Lounge, where attendees are both the teacher and student, and can impart their experiences on various topics. The Expert Lounge will be a time when we have a few of our speakers available, for 30-minute intervals, so attendees to ask questions of them. Finally, we will have a Learning Lounge, which will be hands on learning, such as a session on apps. These really will be great ways to learn and interact in a more dynamic way.

When the Board meeting following the Convention ends, I assume my role as AWT President. I'm genuinely looking forward to it. There are a lot of things AWT is working on, and a few I hope to focus on.

AWT and CWT Promotion

We want AWT and CWT to be the preferred choice for our current and potential customers. AWT has made a commitment to this by focusing on marketing

to the end-user through advertising, writing articles, purchasing mailing lists, and exhibiting at shows. We are targeting the International Facility Management Association (IFMA), as well as the Association of Facilities Engineering (AFE), and cultivating relationships with them to build brand awareness. We're confident that these efforts will make end-users not only prefer, but demand AWT members and CWTs.

SEED Program

The Marketing/Communications Committee continues to do a great job with the SEED program. We now have over 40 students from 20 colleges and universities enrolled. The Committee is working to get students more involved through capstone projects in our industry. All of this will assist us in our effort to encourage students to enter the water treatment industry.

Service Technician Certificate Program

Throughout the course of this year, the AWT Education Committee has continued to refine the in-person Service Technician Training. This, coupled with the work done by the Certification Committee to develop an outline for the Service Technician Certificate program, means that we are close to having a path that will allow AWT member companies to quickly and properly train their service technicians. Since the service technician is often the person on-site at the client facility, it is important for the customer to have confidence in their ability. With all of this in mind, this program is being created for entry-level service technicians. This training will be done online and will be available in 2014.

I welcome your input on AWT in the coming year. I can be reached at cwalton@maine.rr.com. I look forward to serving you as President in 2014!



The AWT Annual Convention and Exposition is the perfect time to sit down with other professionals in a non-competitive atmosphere and learn, network, and share.

Whether success materializes through strategic partnerships, or simply new and innovative ways to manage your company, these opportunities result in growth and development for all AWT members.



AWT 2013 Annual Convention

2013 Annual Convention and Exposition

October 30–November 2, 2013 | Mohegan Sun | Uncasville, CT | awt-annual13.org

2013

Registration Form

AWT 2013 Annual Convention and Exposition
October 30 - November 2, 2013 • Mohegan Sun • Uncasville, Connecticut



1 Attendee Information

☐ Member ☐ Non-Member

First Name _____ Middle Initial _____

Last Name _____ Suffix _____

First Name on Badge _____

Company _____

Company Address _____

City _____ State _____ Zip _____ Country _____

Telephone _____ Fax _____

Email (Confirmations & meeting notices will be sent to this email address) _____

Emergency Contact Name and Telephone _____

Special Accommodations/Meals Requested

☐ Vegetarian ☐ Kosher ☐ Low sodium ☐ Low fat
☐ Other _____

2 Full Convention Registration

Full Convention Registration includes:

- Continental breakfast each day
- Access to papers and presentations
- Admittance to all educational sessions
- Admittance to the Exposition Hall
- One ticket to the Annual Reception and Awards Dinner

Early	Member 1 st attendee	☐ \$515
Registration by 9/20/13	Member additional attendee	☐ \$485
	Non-Member attendee	☐ \$725
Regular	Member 1 st attendee	☐ \$630
Registration after 9/20/13	Member additional attendee	☐ \$600
	Non-Member attendee	☐ \$880

☐ **Yes, I will attend the Annual Reception and Awards Dinner**
Friday, November 1, 6:30 pm–9:30 pm

3 Additional Tickets

Annual Reception and Awards Dinner

Full Convention and Spouse/Guest Registration already include one ticket to the Annual Reception and Awards Dinner
Friday, November 1, 2013, 6:30 pm–9:30 pm
_____ x \$80 /ticket = \$ _____

Name on badge for additional attendee(s) _____

4 One-Day Pass Registration

(A maximum of two, one-day passes may be purchased.)

One-Day Pass Registration includes:

- Continental breakfast for that particular day
- Access to papers and presentations
- Admittance to all educational sessions for that particular day
- Admittance to the Exposition Hall for that particular day

Member	☐ \$200	Non-Member	☐ \$300
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Please indicate day choice:

☐ Wed., 10/30/13 ☐ Thurs., 10/31/13 ☐ Fri., 11/1/13 ☐ Sat., 11/2/13

5 Spouse/Guest Registration

Spouse/Guest Registration includes:

- Continental breakfast
- All organized guest events
- Admittance into the Exposition Hall
- Admittance to the Opening General Session
- One ticket to the Annual Reception and Awards Dinner

Early (by 9/20/13)	☐ \$270	Regular (after 9/20/13)	☐ \$295
---------------------------	--------------------------------	--------------------------------	--------------------------------

Spouse/Guest Name _____

Spouse/Guest First Name on Badge _____

Spouse/Guest Email _____

- ☐ Yes, I will attend the Mystic Seaport Tour
Thursday, October 31, 10:30 am–3:00 pm
- ☐ Yes, I will attend Water Treatment 101
Friday, November 1, 10:00 am–11:30 am
- ☐ Yes, I will attend the Wine Glass Painting/Wine Tasting
Friday, November 1, 11:30 am–2:00 pm
- ☐ Yes, I will attend the Annual Reception and Awards Dinner
Friday, November 1, 6:30 pm–9:30 pm

6 Golf Tournament Registration

Wednesday, October 30, 2013, 8:00 am – 4:00 pm
(Deadline to register is *Friday, October 18*)

Golf Registration includes:

Full Buffet Breakfast, Golf Cart, Lunch on the Course, and Eligibility for several prizes.

Member	☐ \$150/player	Non-Member	☐ \$180/player
--------	---------------------------------------	------------	---------------------------------------

Team: _____

Mulligan(s) \$20 each x _____ = \$ _____ (total)
Proceeds from the mulligans will go to *Camp Sunshine*.

Handicap or Average Score:

You must submit your handicap or an average score to participate.

☐ Yes, I anticipate using the bus for transportation to Mohegan Sun Country Club. The course is located approximately 30 minutes away from the hotel.

If you need to rent clubs, please contact the Mohegan Sun Country Club at (860) 862-9660. Club rentals are \$40 plus tax. In order to guarantee club rentals, be sure to contact the Club two weeks prior to the golf outing.

7 LEED GA Training Course

Optional 4-Hour LEED GA Training Course

Saturday, November 2, 2013, 1:00 pm – 5:00 pm

Registration Fee	☐ \$50
------------------	-------------------------------

This is a preparatory course for the LEED GA exam. Upon completion of the course, contact the USGBC (www.usgbc.org) to schedule the exam.

8 Total Payment: \$ _____

Check enclosed (made payable to "AWT") Check #:

Credit Card: ☐ Visa ☐ MasterCard ☐ American Express

Card Number _____

Expiration Date _____ Security Code _____

Signature _____

Questions?

Contact Susan Cairnes, CMP, Meetings Manager
scairnes@mgmtsol.com or (240) 404-6481
Fax (301) 990-9771

Mail Association of Water Technologies
9707 Key West Avenue, Suite 100
Rockville, MD 20850

Online registration is available at awt_annual13.org

Cancellation Policy

All cancellations must be in writing and are subject to a \$50 processing fee. No refunds will be made after Friday, September 20, 2013.

Keeping pace with change.

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Changing conditions needn't mean a drop in chemical dosing accuracy, thanks to EWN-Y series metering pumps with the NEW rapid response EFS sensor option.

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The background image shows a close-up of several condenser tubes. The tubes are yellowed with age and show significant corrosion, particularly pitting and scaling. Overlaid on the image are various chemical symbols and diagrams. A curved arrow points from the left towards the right, passing over the tubes. Chemical symbols include O_2 , Na^+ , Cl^- , OH^- , and H^+ . Some symbols are enclosed in circles. There are also arrows indicating the movement of these ions. A hatched area at the bottom right suggests a cross-section of a tube or a specific region of interest.

Condenser Tube Failure Mechanisms

By Daniel S. Janikowski, Plymouth Tube Co.



The operating environment within a condenser is extremely harsh, and in spite of the designer's best intentions, sometimes tubes made of the best materials fail. The most important tube failure mechanisms typically result from different forms of corrosion and erosion. When it's time to select new condenser tube material, you'll need to consider the projected operating environment and failure mechanisms that material will be subjected to.

The steam surface condenser is the largest heat exchanger in a power plant, and the quality of the tubing within the condenser is critical for reliable plant operations. As discussed in "Optimizing Condenser Tube Selection", a plant engineer has several materials from which to choose when specifying a replacement set of condenser tubes.

Those specifications must go well beyond mere material selection, however. The environment in which the tubes will operate, now and in the future, also must be described in the specifications. Upset and unusual operating conditions are often the cause of premature failure for tubing and piping materials in the power plant. Other failure modes are caused by changes in water chemistry due to leaks in other parts of the system, corrosion from unexpected sources, the impact of improper lay-up practices, and the effect of corrosion products transported to other parts of the system. This article discusses those failure mechanisms, what causes them, and how these types of failure can be avoided in the future.

Steam-Side Failure Mechanisms

Because the total concentration of all contaminants in the steam cycle water chemistry is usually measured in parts per billion, steam cycle water chemistry is normally considered nonaggressive to most alloys. However, by actively condensing the steam, the condenser will concentrate gasses that don't condense at the same temperature as the steam. The most common contaminants include gases like oxygen, nitrogen, and ammonia (from decomposing oxygen scavengers). Stainless steels and titanium are resistant to these gases, but the copper-based alloys can be attacked by ammonia; admiralty brass and aluminum brass are the most susceptible. The ammonia can cause two types of failures: ammonia grooving and stress corrosion cracking (Figures 1 and 2).

Figure 1: Ammonia grooving of aluminum brass.

Courtesy: Plymouth Tube Co.



Figure 2: Intergranular stress corrosion cracking of admiralty brass.

Courtesy: Plymouth Tube Co.



Dissolved copper, originating in the copper-nickel alloy condenser tubes, is also transported in the condensate throughout the system. The solubility of the copper decreases dramatically when the pressure significantly increases. Plating of surfaces often occurs in the boiler

where it plates on the interior surfaces of tubes and on high-pressure turbine blades. Deposits on the boiler can depress the melting point of the boiler tube material, causing premature failure. This is called liquid metal embrittlement. When copper deposits in the turbine (Figure 3), it can cause as much as a 5% decrease in power generation, which is worth millions of dollars each year.

Figure 3: Copper deposits on the control stage of a high-pressure steam turbine.

Courtesy: Pacificorp



Cooling Water Attacks

In addition to general corrosion, many condenser tubes are susceptible to galvanic-driven mechanisms, such as pitting and crevice corrosion. These failure mechanisms usually have two stages: an incubation or initiation period and a propagation mode. The time of initiation is rarely determinable. It could be as short as in a few weeks or may take years. Once initiated, the propagation mode can proceed rapidly, driven by the electropotential between the depassivated location and the surrounding area. Other tubes can be biologically attacked. The following sections describe each of these different forms of corrosive attack.

Pitting

Pitting corrosion is a highly localized attack that can result in through-wall penetration in very short order. Failures may occur in less than four weeks. Once a pit is initiated, the environment in the pit is more aggressive than the bulk solution, because the material in the pit itself is stagnant. The pH in a pit can drop to below 2. When this occurs, the surface inside the pit activates. The potential difference between the pit and the more noble surrounding area, is the driver for a galvanic attack. As the surface area of the anode (pit) is small and

Water Treatment Solutions

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the cathode (the passive surface surrounding the pit) is large, current density can be quite high. For TP 316 in seawater, the voltage difference between the active site (a pit) and the passive region surrounding it can be 0.4 volts. These two factors will result in very high-localized corrosion rates. Through-wall pitting in condenser tubes has occurred in less than three weeks.

The most common initiator of stainless steel pitting is the presence of chlorides in the condensate. Several alloying elements, such as chromium, molybdenum, and nitrogen, promote chloride resistance in this group of alloys. Not all of the alloying elements have the same effect. By investigating the impact of each element, a formula was developed that will determine the resistance of stainless steel to chloride pitting:

$$\text{PREn} = \% \text{Cr} + 3.3 (\% \text{Mo}) + 16 (\text{N})$$

PREn represents the “pitting resistance equivalent” number. This formula can be used as a quick reference on chloride resistance based upon just the chemistry of the alloy. In this formula, nitrogen is 16 times more effective, and molybdenum is 3.3 times more effective, than chromium for chloride pitting resistance. The higher the

PREn, the more chloride resistance an alloy will have. It is interesting to note that nickel, a very common stainless steel alloying element, has little or no effect on chloride pitting resistance. However, it does have a profound impact on stress corrosion cracking.

Crevice Corrosion

Crevice corrosion is caused by the same galvanic driving force as pitting corrosion. However, because the crevice allows higher concentrations than a pit (there is less opportunity to flush with freshwater), it is more insidious than pitting. The result is a lower-pH fluid in the crevice, resulting in attack at temperatures 30°C to 50°C lower than pitting in the same environment. Clean tubing may perform flawlessly for years, but unexpectedly start to show problems once a deposit forms. The critical pitting temperature (CPT, above which pitting starts to occur) may be above the operating temperature, while the critical crevice temperature (CCT) could be below, initiating an attack.

The potential for crevice corrosion in chlorides is commonly measured by the ASTM G 48 Method B test. Researchers evaluated a large database of existing crevice

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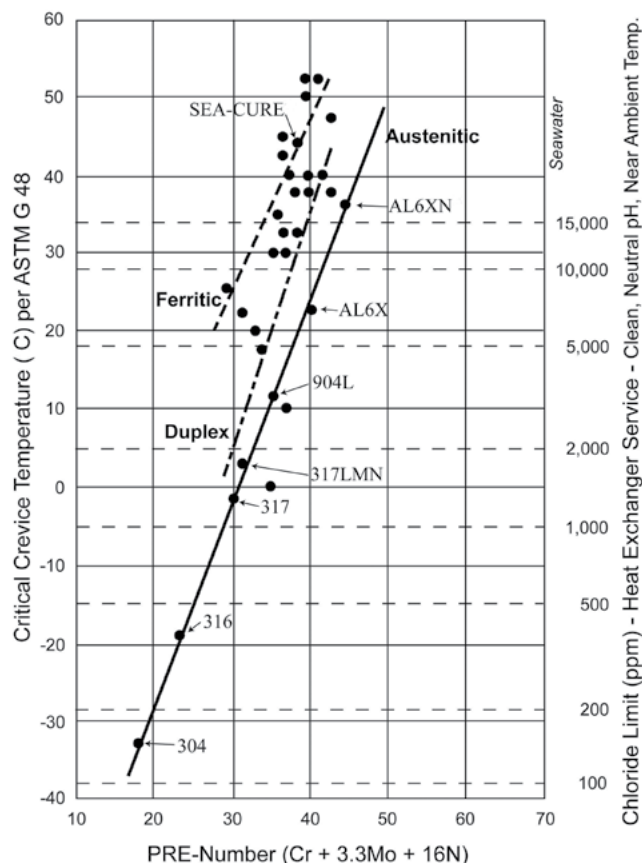
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corrosion data and compared it with the PREn number described earlier. The results were a series of graphical relationships between PREn and the G 48 CCT. Figure 4 is the result of that work, with the additional modification on the right axis that allows it to be used as a tool for determining maximum chloride levels for an alloy of a particular chemistry, particularly at lower PREn.

Figure 4: Critical crevice temperature and maximum chloride levels versus PREn of various stainless steels.

Source: C.W. Kovach and J.D. Redmond, "Correlation Between the Critical Crevice Temperature 'Pre-Number' and Long-Term Crevice Corrosion Data for Stainless Steels," presented at the NACE Annual Conference Corrosion 93, New Orleans, LA. (April 1993).



Ferritic stainless steels were found to have the highest CCT for a particular PREn, above the duplex grade of the same PREn, followed by the austenitics. Each specific stainless structure provides a separate parallel linear correlation. After a typical or minimum chemistry is determined, the PREn can be calculated.

To compare the corrosion resistance of two or more alloys, a line is drawn vertically from the calculated PREn for each alloy to the appropriate sloped line for the structure. The vertical line should stop at the bottom line for austenitics, such as TP 304, TP 316, TP 317,

904L, S31254, and N08367. Duplex grades, such as S32304, S32003, S33205, and S32750, fall on the center line. The G48 crevice corrosion results of the ferritics, such as S44660 and S44735, follow the top sloped line. From this intersection, a horizontal line can be drawn to the left axis to determine an estimated CCT. A higher CCT indicates more corrosion resistance.

Maximum Chloride Levels

Although the level of chlorides in the condensate is the primary driver for pitting and crevice corrosion of stainless steel, other important factors which have a significant impact include pH, temperature, presence and type of crevices, and potential for active biological species. On the right axis of Figure 4, the chlorine limit for a particular material is included to aid in the material selection decision. The scale is based upon having a neutral pH, 35°C flowing water (to prevent deposits from building and forming crevices), which is common in many balance-of-plant and condensing applications.

Once an alloy with a particular chemistry is selected, the PREn can be determined and then intersected with the appropriate sloped line. The suggested maximum chloride level can then be determined by drawing a horizontal line to the right axis. In general, if an alloy is being considered for brackish or seawater applications, it needs to have a CCT above 25°C measured by the G 48 test.

There are several important caveats you should be aware of when using this guide:

- If the temperature is higher than 35°C, the maximum chloride level should be lowered.
- If the pH is lower than 7, the maximum chloride level should be lowered.
- This guide assumes a clean surface. If deposits form, the pH can be significantly lower under the deposits, and the chloride levels may be much higher than the bulk water.

MIC

Microbiologically influenced corrosion (MIC) is often confused with pitting corrosion and typically occurs in water normally considered benign. The term "influenced" is used because the bacteria do not actively cause the corrosion. The bacteria form a film, or slime, that creates a crevice. This isolates the water chemistry on the metal surface from the bulk water chemistry. The

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bacteria may also metabolate a product that can be very aggressive. Table 1 lists common bacteria types known to influence corrosion.

Table 1: Bacteria commonly associated with MIC.

Source: Plymouth Tube Co.

Organism	Action	Problem
Thiobacillus	Sulfate reducer	Produces H_2SO_4
Desulfovibrio	Sulfate reducer	Produces H_2SO_4
Gallionella	Mn/Fe fixer	Precipitates MnO_2 , Fe_2O_3
Crenothrix	Mn/Fe fixer	Precipitates MnO_2 , Fe_2O_3
Spaerotilus	Mn/Fe fixer	Precipitates MnO_2 , Fe_2O_3
Nitrobacter	Nitrate reducer	Produces HNO_3

The most common MIC attack in North America is a result of the influence of manganese-fixing bacteria (Figure 5). Although the mechanism is complicated, it's also the most likely type of attack. The bacteria assist in oxidation of the soluble manganese to form an insoluble manganese oxide (MnO_2) layer on the metal surface. This creates a crevice. When the operator detects an increase in condenser backpressure, sliming is suspected, and chlorination is initiated. The chlorination, intended to kill the bacteria and assist in slime removal, further oxidizes the MnO_2 layer to permanganate. Under that layer, the combination of the generated hydrogen and chloride ions react to form hydrochloric acid. The acid attacks the passive layer of the stainless steel, which initiates the attack.

Figure 5: Manganese MIC-related pitting on TP 439 tubing after eight months of baseload service.

Courtesy: Plymouth Tube Co.



Studies have found that manganese concentrations as low as 20 ppb can initiate MIC. This mechanism most commonly occurs with TP 304 and TP 316, but higher

molybdenum-containing grades and some duplexes have also been attacked. In general, an alloy needs a minimum CCT of 25°C in the G 48 crevice corrosion test to be considered resistant to MIC.

The Effect of Material Properties

The mechanical and physical properties for common copper base, titanium, and stainless steel tubing are available from a number of handbooks and online from tubing suppliers. These properties, such as ultimate strength, yield strength, and hardness, are important to consider when selecting a new condenser tube.

One important concern is the tube's erosion resistance. Erosion resistance is a function of the ability of the protective layer to remain attached to the substrate and the strength (hardness) of the substrate directly below the protective layer. Two types of erosion commonly cause problems in the power industry: flow-accelerated erosion-corrosion and water droplet/steam impingement erosion.

Flow-Accelerated Erosion-Corrosion

When the fluid velocity is so high that it will actually "scrub" the protective film from the metal surface, then flow-accelerated erosion-corrosion is possible. Conversely, higher velocities are desirable, because they increase the heat transfer rate and keep the tube surfaces clean, reducing the surface resistance to flow. In general, a minimum velocity of 6 feet per second (fps) is considered the minimum for keeping the tube surface clean. Biofilms have been known to develop at lower flow rates. Table 2 summarizes the maximum safe fluid flow velocities inside of condenser tubes of different materials.

Table 2: Commonly accepted maximum water flow rates for erosion-corrosion.

Source: Plymouth Tube Co.

Alloy	Maximum velocity (fps)
Admiralty	6
90/10 copper-nickel	8
70/10 copper-nickel	10
304/316 stainless steel	30+
Titanium Grade 2	100
Super-ferritic stainless steel	100+

Older traditional condenser designs restricted flow rates to the 6 to 7 fps range to protect the copper alloy-based tubing. With the elimination of copper in modern

condensers, modern flow rates are in the 9 to 10 fps range. If your existing condenser has marginal thermal performance and can handle a higher cooling water flow rate (velocity), then significant performance improvements can be made, assuming pump modifications to increase flow rate are possible. At the higher flow rates, stainless steels and titanium are immune to erosion and corrosion. In many systems, the payback on investment may be less than one year. Additionally, the higher flow rates will result in cleaner tubes.

Water Droplet/Steam Impingement Erosion

Under certain unique conditions, it is possible to experience erosion of the tube outside surface caused by the localized impact of high-velocity water droplets (Figure 6). This can occur near diverter plates that may focus the high-speed wet steam onto the tube or during other upset conditions. It often occurs in steam dump areas when the outlets are not properly designed.

Figure 6: Steam water droplet erosion of stainless steel tubing in a nuclear power plant.

Courtesy: Plymouth Tube Co.



The resistance of the tubes to this form of erosion is a direct function of the hardness of the metal substrate below the protective oxide. In general, higher hardness provides higher erosion resistance. Using a water droplet impingement device developed by Avesta Sheffield, alloys can be ranked by time to failure. The process is to graphically plot material hardness versus time to failure if a relationship can be determined. Other material grades can then be added by comparing the hardness. Using titanium grade 2 as the reference, with a value of 1, the relative resistance of other grades can be ranked, as presented in Table 3.

Table 3: Relative erosion resistance based on water droplet impingement tests.

Source: Jüri O. Tavast, "Steam Side Droplet Erosion in Titanium Tubed Condensers - Experiences and Remedies", ACOM 3-96, April 1996.

Alloy	Hardness (HV)	Relative erosion resistance
Admiralty	60	0.4
70-30 copper-nickel	135	0.8
Titanium Grade 2	145	1.0
TP 304/TPp 316 stainless steel	165	2.0
Titanium Grade 12	190	3.6
S31254/N08367 superaustenitic stainless steel	200	7.0
Titanium Grade 9	215	6.2
S44660 superferritic stainless steel	240	7.2
S32750 super-duplex stainless steel	290	9.4



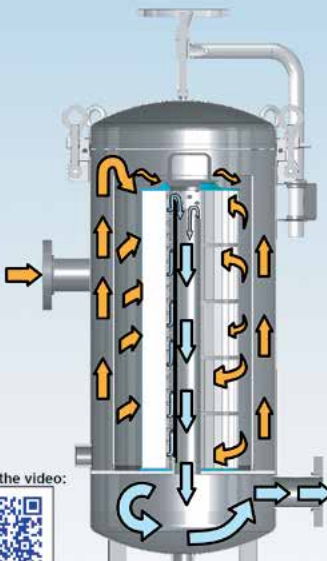
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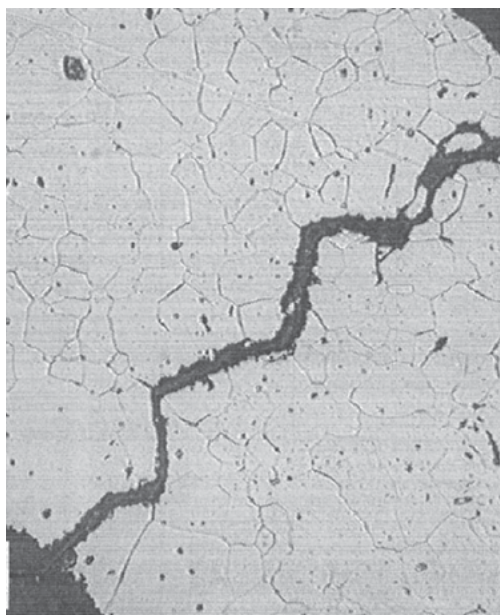
Hydrogen Embrittlement

Titanium and superferritic stainless steels, such as S44660 and S44735, can embrittle with exposure to monotonic hydrogen. This commonly occurs in water systems that have poorly controlled cathodic protection. The problem is prevented when the system is controlled so that the voltage is maintained at a potential more positive than 750 millivolt. When the voltage is more negative, hydrogen bubbles develop on the surface. During the development stage, monotonic hydrogen develops, which easily diffuses into the material.

Embrittlement of titanium occurs as an intermetallic phase develops on the surface in contact with hydrogen. This layer grows with exposure and eventually progresses through the entire wall. These embrittled tubes have little mechanical strength. Tubes can be broken simply by leaning on them. This process is not reversible.

Figure 7: Intergranular hydrogen embrittlement cracking of S44735 superferritic stainless steel.

Courtesy: Plymouth Tube Co.



Fortunately, unlike titanium, the hydrogen in superferritic stainless steels resides in interstitial sites in the lattice structure and does not form a compound. This allows the embrittlement in the stainless to be easily reversed. Once the source of the hydrogen

is eliminated, the atoms in the stainless diffuse out of the structure, and the ductility returns. This normally occurs within 24 to 48 hours at 80°F, and the ductility can return in as quickly as within one hour at 200°F. One caution is that multiple hydrogen charging and discharging may create microcracking that can then propagate (Figure 7).

Daniel S. Janikowski is the Technical Manager of Plymouth Tube Co. He can be reached at djanikowski@plymouth.com.

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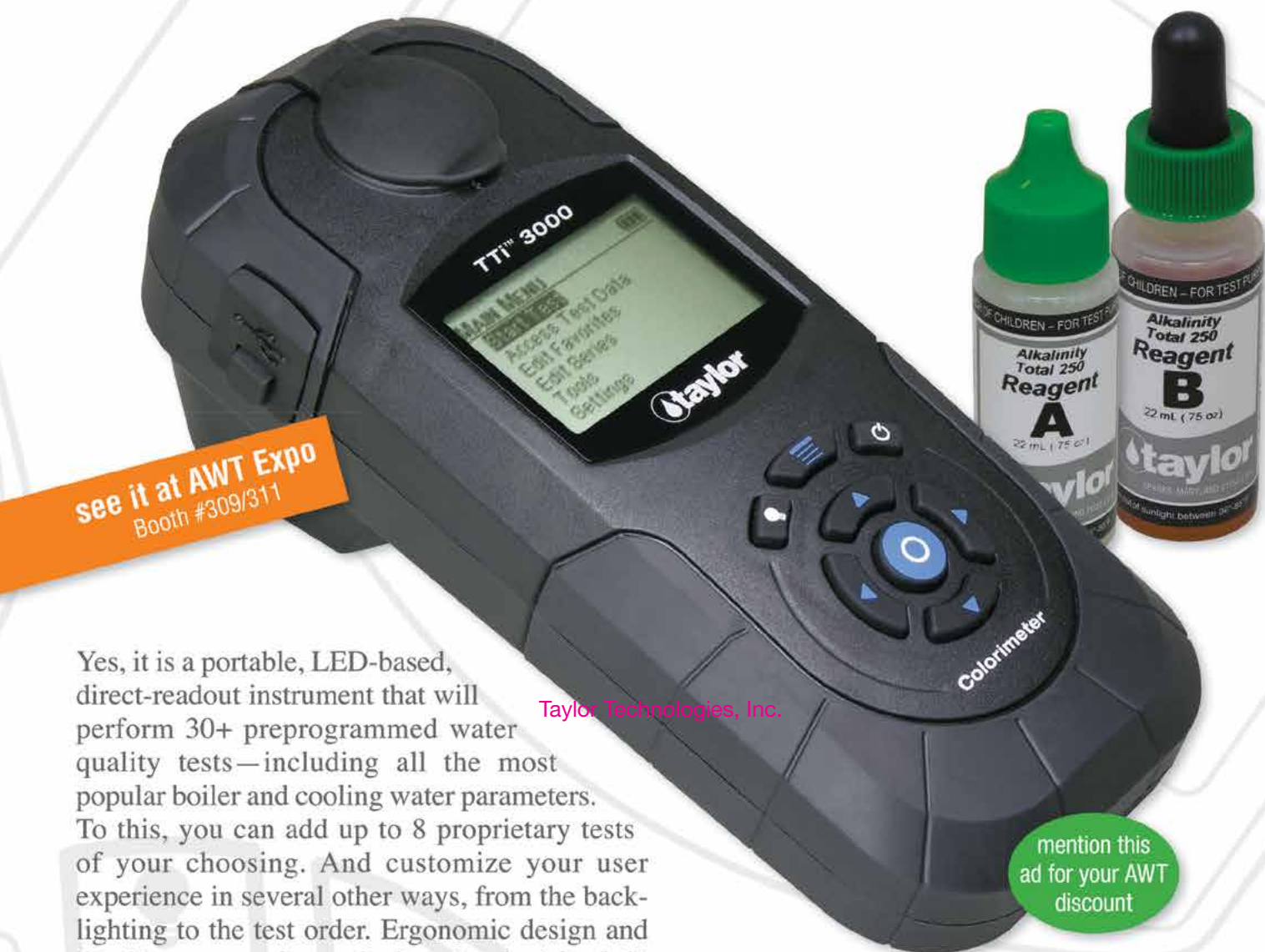
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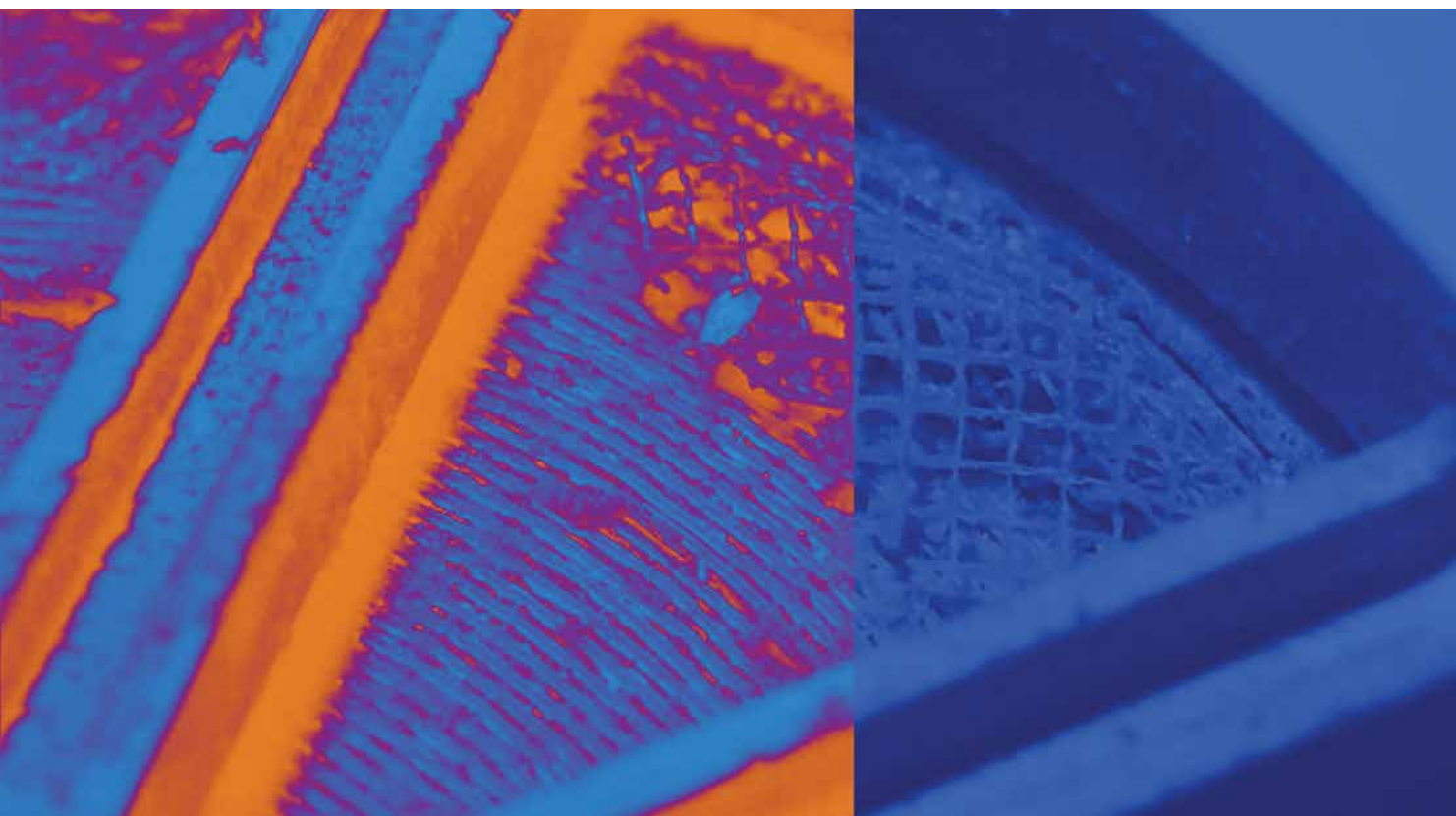
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Maximizing the Life and Performance of Reverse Osmosis Membranes in Industrial Water Purification Systems

By Gregg Poppe, Dow Water & Process Solutions

In a challenging economic environment, even more attention than usual is placed on lowering operating costs. If utilities, such as the water treatment system, can deliver the required output for less cost, profits can improve. Fortunately, several proactive steps can be taken to lower the operating cost of a reverse osmosis (RO) plant. These steps include extending the life of the installed membranes by optimizing both the cleaning frequency and the cleaning method. Also, when the membranes operate in an environment with potential to foul, it is important to make wise and well-informed choices regarding membrane selection, when it is finally time to replace them.

Proper tracking of system performance, combined with optimized cleaning, will add to the bottom line through reduced chemical, electrical and membrane replacement costs.

Keeping the Current Membranes Running Optimally

Proper maintenance is the key to protecting the investment that has already been made in the membranes that are currently installed. There are some very helpful guidelines that can be applied to extend the productive life of the membranes and reduce overall operating costs of the RO plant.

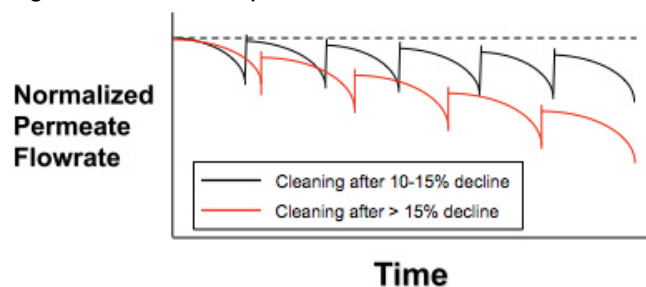
The loss of permeate flow during operation is normal for a membrane system, so the first question is “when to clean?” The frequency depends on the feed water source operating parameters such as flux, and pretreatment. Commonly, systems are cleaned 23 times/year with well water, 34 times/year with city water, and 46 times/year with surface water. But it really depends on the specific situation, so it is important to be vigilant and look for signs of fouling. Any of the following observations should trigger a cleaning:

- Normalized permeate flow declines by 10-15%
- Normalized feed pressure increases by 10-15%
- Pressure drop increases by 10-15%
- Normalized salt passage increases by 5-10%

To make proper judgments, it is absolutely necessary to normalize the permeate flow, feed pressure, and salt passage to a standard reference point. Otherwise, fluctuations in feed temperature, salinity, or pressure will either mask or accentuate the trends, leading to inaccurate conclusions about when it is time to clean. Membrane suppliers can help provide tools to normalize the data to make the best judgment.

Figure 1 illustrates the consequence of waiting too long to clean. The foulants can usually be cleaned from the membrane surface with the right cleaning chemicals and good technique, but waiting too long can permanently reduce RO performance.

Figure 1: Reduced RO performance.



Cleaning Conditions for Maximum Results

Before cleaning, it is very important to determine the type and location of the fouling:

- Colloidal and particle fouling is specific to the first stage (these types of foulants tend to be caught in the feed screen of the first elements in the system).
- Scaling appears in the second stage (as more product water is recovered with the addition of stages, the feed water becomes more concentrated, possibly exceeding the solubility limit of certain salts).
- Organic and microbiological fouling can occur in either the first or second stage of the system.

Figures 2 through 4 illustrate a membrane element that has been fouled by particle fouling (Figure 2), scaling (Figure 3), or biofouling (Figure 4). Before starting to clean, also identify the pH and temperature limits of the membranes being cleaned and make sure the cleaning chemicals are compatible.

Figure 2: Particle fouling of a membrane.

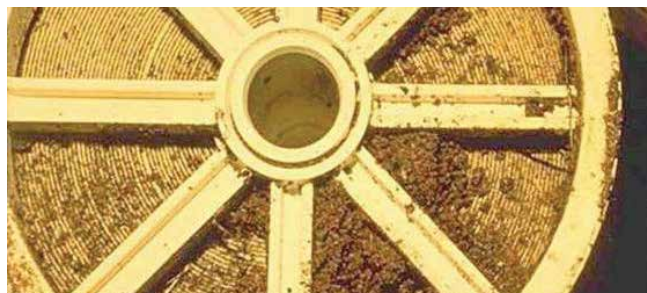


Figure 3: Scaling of a membrane.

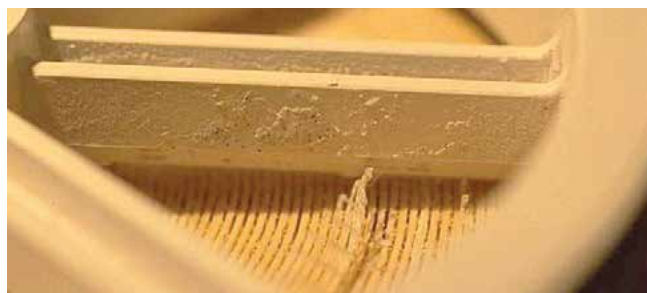


Figure 4: Biofouling of a membrane.

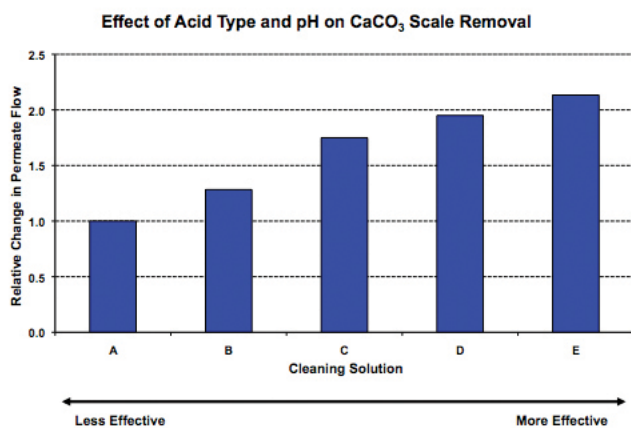


Clean with alkaline cleaners first and then, if necessary, with acid. High pH cleaners are more likely to break down fouling layers. Acid may react with organics, silica, and biofouling, possibly leading to irreversible performance decline; therefore, it is recommended to remove these foulants first with an alkaline cleaner. Clean at the appropriate pH and temperature to remove the foulants.

- To remove biofouling, cleaning at pH 12 is much more effective than pH 11—about an order of magnitude better at restoring permeate flow. It is important to know the temperature range that is permissible for the membrane type at the high pH.
- To remove calcium carbonate scale, permeate flow is restored more fully at lower pH and higher temperature, as shown in Figure 5. Some plants try to use citric acid (Cleaner A) to remove scale, but it is usually not very effective in comparison to HCl @ pH 1 (Cleaners D and E).

Higher/lower pH is more effective at removing foulants, but be cautious. Not all membrane manufacturers allow cleaning as high as pH 12 or as low as pH 1. It is important to determine the limits before cleaning.

Figure 5: Effect of acid type and pH on CaCO_3 scale removal.



Different foulants require different cleaning protocols to achieve effective results. As an aid, the following guidelines can be used. But make sure first that the pH and temperature limits are within the membrane manufacturer's allowance.

- Inorganic salts (such as CaCO_3): 0.2% (by wt.) HCl, 25–40°C, and pH 1–2.

- Metal oxide (such as iron): 1.0% (by wt.) sodium hydrosulfite ($\text{Na}_2\text{S}_2\text{O}_4$), 25°C, and pH 5.
- Inorganic colloids (silt), silica, biofilms, and organic compound: 0.1% (by wt.) NaOH, 35°C max, and pH 12 or 0.1% (by wt.) NaOH and 0.025% (by wt.) Na-DSS, 35°C max, and pH 12.

Tips for an Effective Cleaning Protocol

The procedure used to clean is also important. When mixing the cleaning solution, ensure that all the chemicals are dissolved and well mixed before circulating it through the membrane elements. When the cleaning solution is first introduced to the RO system, use a low flow rate while the water in the system is displaced. Also, use only enough pressure to compensate for the pressure drop to avoid driving foulants into the membrane surface. Dump the concentrate stream at first, for as long as it is necessary, to prevent diluting the cleaning solution during the recycle.

Once the cleaning chemicals have displaced the water, recycle the concentrate and permeate to the cleaning tank. Measure the pH and adjust, as needed. Monitor the color of the cleaning solution; a color change indicates that foulants are being removed. Then, dispose of the heavily contaminated cleaning solution and mix a fresh solution. Continue this for as long as it appears new foulants are being removed, but with an acid cleaning, recirculating for longer than 20–30 minutes increases the risk of any heavy metals falling out of suspension and becoming permanently embedded on the surface of the membrane, making it more difficult to clean.

A fresh cleaning solution should be prepared for the soaking step. The length of the soak is variable. While alkaline cleanings may require an overnight soak, acid cleanings typically only require a 30-minute soak. To maintain the desired elevated temperature during an extended soak, use a slow recirculation rate through the elements. As before, monitor the color of the cleaning solution and dispose of, or refresh, the solution when a color change is observed.

After the soak, recirculate the cleaning solution at a high flow rate for 30–60 minutes to flush out foulants removed from the membrane surface. Finally, flush out the cleaning solution using RO permeate or deionized water. During the flush, the minimum temperature should be 20°C.

Selecting Advantaged Membranes

When it is finally time to replace the RO membrane elements, plant owners dealing with fouling waters can take advantage of the technology developments introduced by membrane manufacturers to help mitigate the fouling. For example, there has been a growing acceptance that elements with 34mil spacers foul less quickly and are easier to clean than those with thinner spacers. Membrane manufacturers continue to develop new innovations around optimized spacer geometry intended to flush the membrane surface more effectively. Work is also advancing to improve the fouling-resistant properties of the spacer material or membrane surface.

All these membrane development efforts are meant to extend the time between cleanings, improve the effectiveness of cleaning, and extend the overall lifetime of the membranes. The payoff comes back to the plant owner in the form of lower operating costs via:

1. consumption of less cleaning chemicals due to less frequent cleanings,
2. use of less electricity due to slower increases in feed pressure, and
3. lower membrane replacement costs due to longer life.

Summary

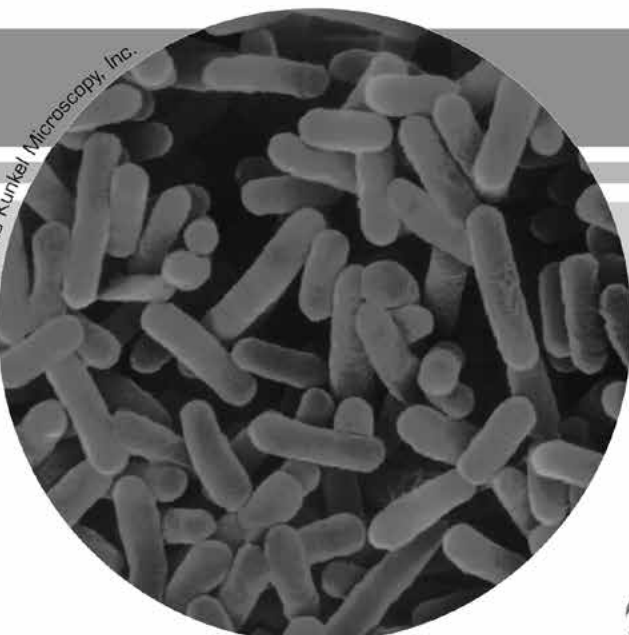
Operating and maintenance budgets are under constant pressure, but timely and proper membrane maintenance is necessary to ultimately achieve the lowest operating costs.

Monitor the condition of the plant, normalize the data, and clean according to the provided signals, so that the performance of the membranes is not irreversibly reduced. Before starting to clean, determine the type of fouling and its location, so the proper cleaning chemical can be used. Cleaning with higher and lower pH is much more effective, but always check first with the membrane manufacturer's literature to determine the allowable pH range for cleaning.

Waiting too long to clean will lead to shorter membrane life and even more money will be spent replacing the membranes than would have been required to keep them healthy. ☺

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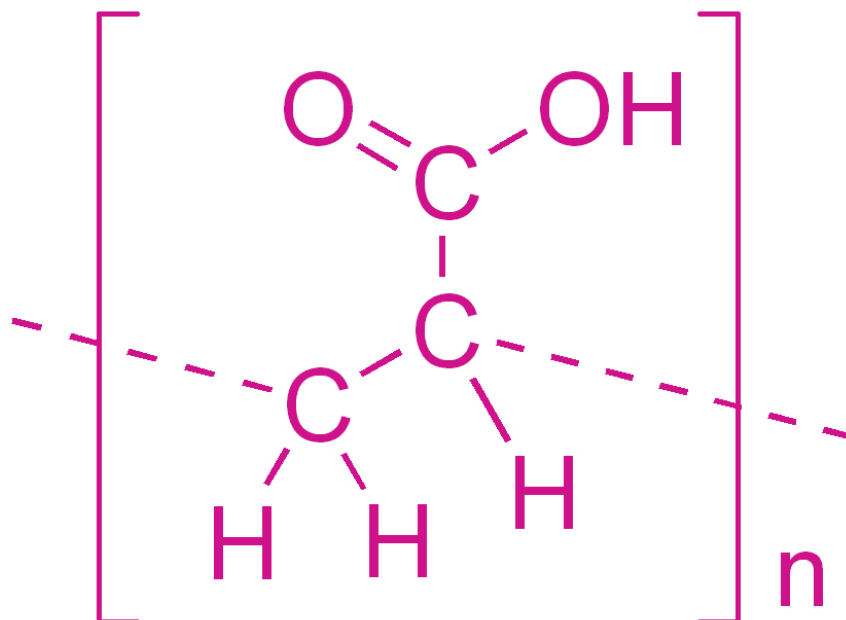
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Water Treater Deposit Control Polymer Evaluation Criteria and Considerations

By Zahid Amjad, Ph.D., and Robert W. Zuhl, P.E.,
Lubrizol Advanced Materials, Inc.



Abstract

Industrial systems that use water are often faced with a variety of challenges including scaling, fouling, microbiological growth, and corrosion. To combat these operational problems, water treaters have developed and apply effective treatment programs. This article presents new information on the comparative performance of poly (acrylic acids) made in different polymerization solvents, acrylate terpolymer, and polymer blends.

Introduction

Water treatment technologists develop treatment programs to minimize corrosion, mitigate microbiological fouling, and prevent scaling / particulate deposition in water systems using combinations of synergistic components. Multifunctional deposit control polymers (DCPs) that disperse particulates, inhibit scale formation, and stabilize metal ions are essential components of nearly all water treatment formulations.¹ Lubrizol's paper presented at the AWT 2011 Annual Convention² evaluated and compared the performance characteristics of a low molecular weight water-polymerized polyacrylate (PAA), a high performance acrylate terpolymer (ATP), and a 50/50 (active solids basis) blend of the PAA & ATP. The article herein is based on Lubrizol's paper and presentation at the AWT 2012 Annual Convention³ which compared the performance of two similar molecular weight (MW) polyacrylates (PAAs) made by different manufacturing processes (water & solvent polymerization), the ATP, and 50/50 blends of each PAA and the ATP. The data provide insights as to the selection and blending of DCPs as components of water treatment formulations.

Experimental

Materials

Reagent grade chemicals and grade-A glassware were used. The polymers tested are listed in Table 1. The stock solutions of these polymers were prepared in distilled water on an active solids basis.

Table 1: Polymers Evaluated

Product	Composition	Acronym
K-7028*	Water polymerized 2.3k MW poly(acrylic acid)	PAA-W
K-752*	Solvent polymerized 2k MW poly(acrylic acid)	PAA-S
K-798*	Water polymerized <15k MW poly(acrylic acid: 2-acrylamido-2-methylpropane sulfonic acid: sulfonated styrene) or "AA/SA/SS"	ATP
Blend W	1:1 active solids blend of PAA-W & ATP	TPB-W
Blend S	1:1 active solids blend of PAA-S & ATP	TPB-S

*Carbospense™ K-700 polymer supplied by Lubrizol Advanced Materials, Inc.

Polymer Evaluation Protocols

Calcium Phosphate Inhibition

Calcium phosphate precipitation experiments in the presence and absence of polymers were carried out using the pH-stat set-up, as described previously.⁴ Unless specified otherwise, the calcium phosphate inhibition

test conditions were as shown in Table 2. Experiments involving Fe^{3+} were performed by adding a FeCl_3 solution to the phosphate solution to which polymer was added before adding the stock calcium chloride solution.

Table 2: Calcium Phosphate Inhibition Test Conditions

Parameter	mg/L	Parameter	Value
Calcium (Ca^{2+})	140	pH	8.5
Phosphate (PO_4^{3-})	9	Temperature	50°C
Iron (Fe^{3+})	0 to 3	Time	22 hr
Active polymer	0 to 20		

The progress of precipitation process was determined by spectrophotometric analysis of filtered (0.45 μm , Millipore Corporation) aliquot of the test solution for the phosphate ion. The efficacy of polymer as a calcium phosphate inhibitor was calculated using Equation 1:

$$\% \text{ Inhibition} = \frac{[\text{PO}_4]_{\text{sample}} - [\text{PO}_4]_{\text{control}}}{[\text{PO}_4]_{\text{initial}} - [\text{PO}_4]_{\text{control}}} \times 100 \quad (1)$$

Where the terms above are as follows:

Inhibition (%) = % I

$[\text{PO}_4]_{\text{sample}}$ = PO_4 concentration in the presence of inhibitor at the end of the test

$[\text{PO}_4]_{\text{control}}$ = PO_4 concentration in the absence of inhibitor at the end of the test

$[\text{PO}_4]_{\text{initial}}$ = PO_4 concentration at the beginning of the test

Calcium Carbonate Inhibition

The efficacy of polymer as calcium carbonate (CaCO_3) inhibitor was tested using the test procedure described previously.⁴ The test conditions employed to evaluate polymer performance are shown in Table 3.

Table 3: Calcium Carbonate Inhibition Test Conditions

Parameter	mg/L	Parameter	Value
Calcium (Ca^{2+})	560 as CaCO_3	Calcite saturation (LSI)	56x (1.89)
Bicarbonate (HCO_3^-)	630 as CaCO_3	pH	≈ 8.3
Carbonate (CO_3^{2-})	30 as CaCO_3	Temperature	66°C
Active polymer	0 to 5.0	Time	24 hr

Polymer efficacy as a calcium carbonate inhibitor was calculated using Equation 2:

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$$\% \text{ Inhibition} = \frac{[\text{Ca}^{2+}]_{\text{sample}} - [\text{Ca}^{2+}]_{\text{control}}}{[\text{Ca}^{2+}]_{\text{initial}} - [\text{Ca}^{2+}]_{\text{control}}} \times 100 \quad (2)$$

Inhibition (%) = %I

$[\text{Ca}^{2+}]_{\text{sample}}$ = Ca^{2+} concentration in the presence of inhibitor at the end of the test

$[\text{Ca}^{2+}]_{\text{control}}$ = Ca^{2+} concentration in the absence of inhibitor at the end of the test

$[\text{Ca}^{2+}]_{\text{initial}}$ = Ca^{2+} concentration at the beginning of the test

Calcium Sulfate Inhibition

Polymer efficacy as calcium sulfate inhibitor was evaluated under spontaneous precipitation conditions using the test procedure described previously.⁴ Table 4 summarizes the water chemistry to evaluate polymer performance. Polymer efficacy as a calcium sulfate inhibitor was calculated using Equation 2.

Table 4: Calcium Sulfate Inhibition Test Conditions

Parameter	mg/L	Parameter	Value
Calcium (Ca^{2+})	1,800	pH	7.0
Sulfate (SO_4^{2-})	4,320	Temperature	66°C
Active polymer	0 to 2.0	CaSO_4 saturation	2.2x
		Time	24 hr

Iron Oxide Dispersion

The simulated industrial water used in the dispersion tests was made by mixing standard solutions of CaCl_2 , MgCl_2 , Na_2SO_4 , NaCl and NaHCO_3 using the test protocol described previously.⁴ The water composition and iron oxide dispersion test conditions are shown in Table 5. Polymer performance as percent iron oxide dispersed (%D) was calculated based on %T readings taken as a function of time and using Equation 3, which includes an adjustment for readings obtained in the absence of polymer.

Table 5: Iron Oxide Dispersion Test Conditions

Parameter	mg/L	Parameter	Value
Calcium (Ca^{2+})	100	Iron	200mg/L
Magnesium (Mg^{2+})	30	pH	7.6 to 7.8
Sodium (Na^+)	314	Room Temperature	~22°C
Chloride (Cl^-)	571	Time	0 to 3 hr
Sulfate (SO_4^{2-})	192	Active polymer	0 to 5 mg/L
Bicarbonate (HCO_3^-)	60		

$$\%D = [100 - (1.11 \times \% \text{ transmittance})] \quad (3)$$

Results and Discussion

Calcium Phosphate Inhibition

Polymer and Dosage Effects

A polymer's ability to inhibit calcium phosphate (Ca/P) formation is a very important function in phosphate and phosphonate-based treatment programs. Figure 1 shows %I as a function of polymer dosage up to 10 mg/L for the water and solvent polymerized PAAs (i.e., PAA-W & PAA-S) and the AA/SA/SS terpolymer (ATP). As shown, performance increases as a function of polymer dosage for all three polymers. PAA-S provides somewhat better performance than PAA-W albeit both PAAs provide poor performance (<20%) at dosages below 8.5 mg/L whereas ATP exhibits excellent performance (>90%) at dosages above 7.5 mg/L.

Figure 1: Ca/P Inhibition vs. Polymer Dosage ≤ 20 mg/L

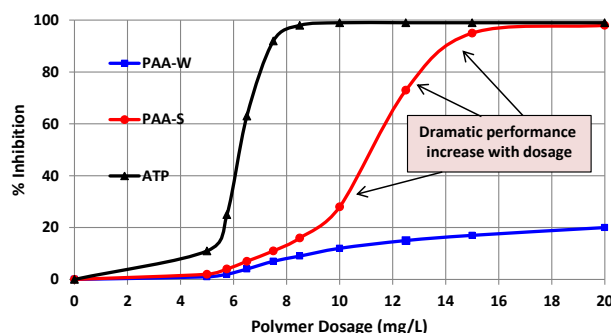


Figure 1 also shows the effect of increasing polymer dosages from 10 to 20 mg/L. As indicated, PAA-S performance improves dramatically compared to an incremental increase for PAA-W. The unexpected PAA-S performance is attributable to special architectural properties resulting from a proprietary manufacturing process.

The Ca/P inhibition performance of the PAA-ATP blends (i.e., 1:1 active polymer basis blends of PAA-W & ATP [TPB-W] and PAA-S & ATP [TPB-S]) as a function of dosage compared to the component polymers is shown in Figure 2 and summarized as follows:

- The performance of both PAA-TPB blends (i.e., TPB-W & TPB-S) increases with dosage.
- The performance of both TPB-W and TPB-S is much better than expected based on the component polymer performances especially for TPB-W incorporating PAA-W, which by itself provides poor performance across a broad dosage range.



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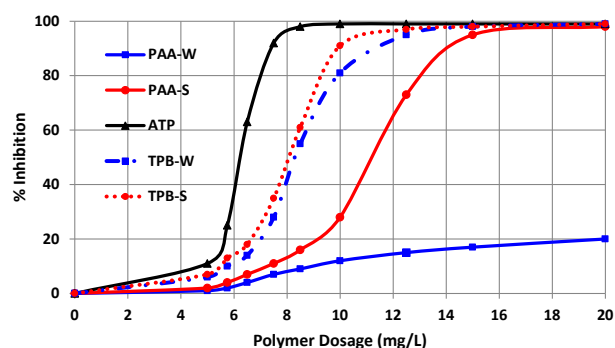
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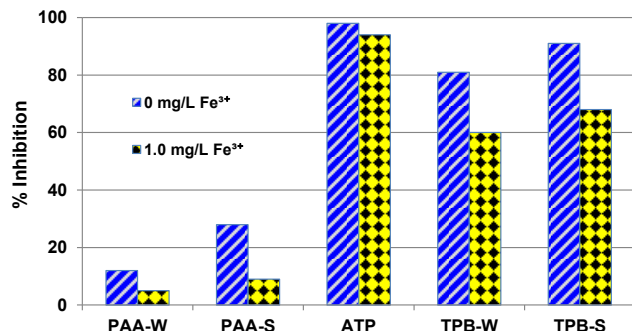
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Figure 2: Ca/P Inhibition by Polymers & Blends vs. Dosage



Effect of Fe^{3+}

Figure 3 also presents the effect of 1.0 mg/L Fe^{3+} on the PAAs, ATP, and the polymer blends. As shown, adding 1.0 mg/L Fe^{3+} has a negligible impact on ATP performance, $\geq 50\%$ performance decreases for both PAAs, and reduces the performance for the PAA-ATP blend by $\approx 25\%$. The adverse impact of soluble iron for both PAA-ATP blends is less than expected if based on an additive effect for the component polymers.

Figure 3: Influence of Fe^{3+} on Ca/P Inhibition by Polymers (10 mg/L)

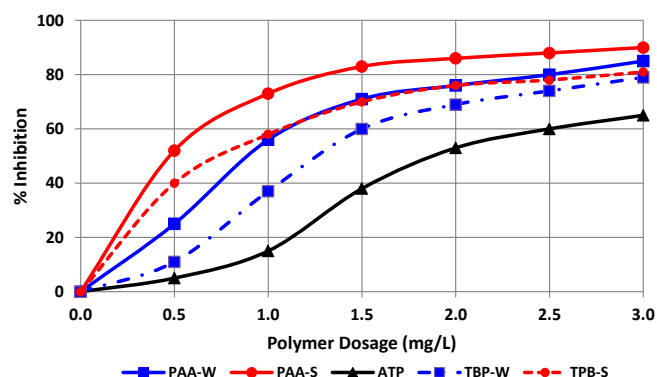
Calcium Carbonate Inhibition

Figure 4 shows CaCO_3 inhibition data as a function of dosage for the polyacrylates, ATP, the polymer blends leading to several observations discussed below.

1. PAA-S performs better than PAA-W with relatively small dosages of PAA-S (>0.7 mg/L) and PAA-W (>1.25 mg/L) providing $>60\%$ CaCO_3 precipitation inhibition.
2. ATP CaCO_3 precipitation inhibition performance is inferior to that for the PAAs. These results indicate that ATP incorporating non-carboxyl co-monomers groups (e.g., SO_3H as well as bulkier and hydrophobic

styrene) reduces CaCO_3 inhibition performance. The results also suggest that COOH group present in the PAAs strongly interacts with the Ca present in CaCO_3 crystallites formed during the precipitation process.

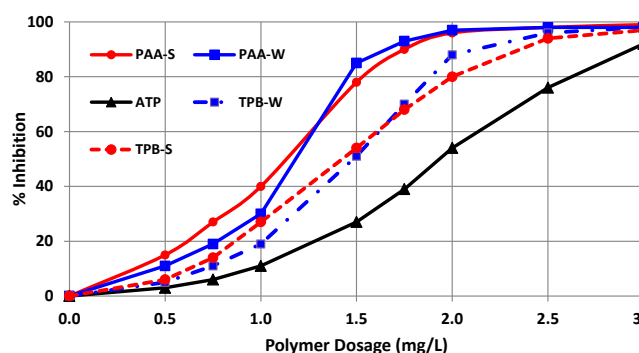
3. The performance for both PAA-ATP blends lags but closely parallels the PAA performance.

Figure 4: CaCO_3 Inhibition by Polymers vs. Dosage

Calcium Sulfate Inhibition

Figure 5 presents gypsum inhibition data as a function of dosage for the PAAs, ATP, and the polymer blends leading to the following observations:

1. The PAAs perform better than ATP, which is attributable to the higher carboxyl content of the PAAs.
2. The performance of the PAAs is very similar; the polymerization solvent does not appear to make a significant difference under these laboratory test conditions.
3. The performance for both PAA-ATP blends appears to be an additive effect or performance that is midway between that of the two components.

Figure 5: CaSO_4 Inhibition by Polymers vs. Dosage

Iron Oxide Dispersion

Polymer Dosage Effect

The influence of PAA-S and ATP dosages (0.25 to 1.0 mg/L) on iron oxide dispersion as a function of time (0 to 3 hr) is shown in Figures 6 and 7, respectively. It is evident from Figure 6, that PAA-S performance increases with time and dosage with the biggest increase occurring between 0.25 and 0.5 mg/L dosages.

Figure 6: Iron Oxide Dispersion as Functions of PAA-S Dosage & Time

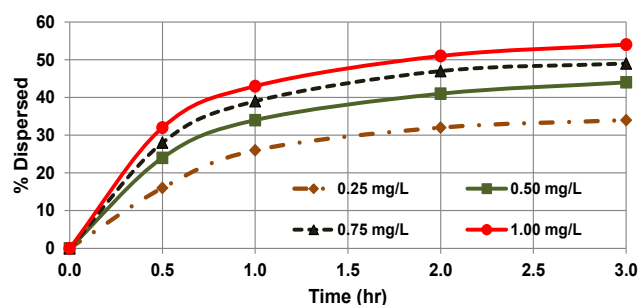
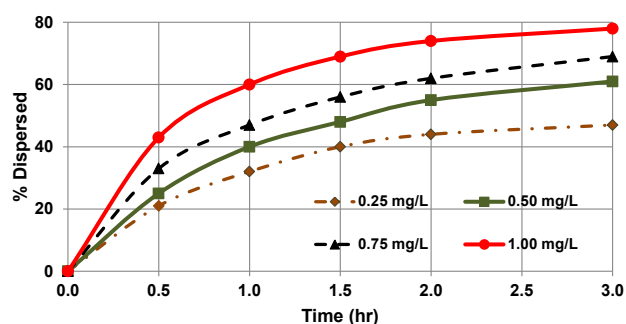


Figure 7 presents iron oxide dispersion data for ATP and indicates a “normal” dosage-response relationship; i.e., performance increases with polymer dosage. Increasing ATP dosage and/or test duration increases iron oxide dispersion. However, increasing ATP dosage above 1.0 mg/L (i.e., from 1.0 to 2.0 mg/L) as shown in our previous study,² has an insignificant iron oxide dispersion improvement. This suggests that ATP adsorption on iron oxide particles is essentially complete at ≈ 1.0 mg/L dosage and indicates that ATP is a highly effective iron oxide dispersant.

Figure 7: Iron Oxide Dispersion as Functions of ATP Dosage & Time

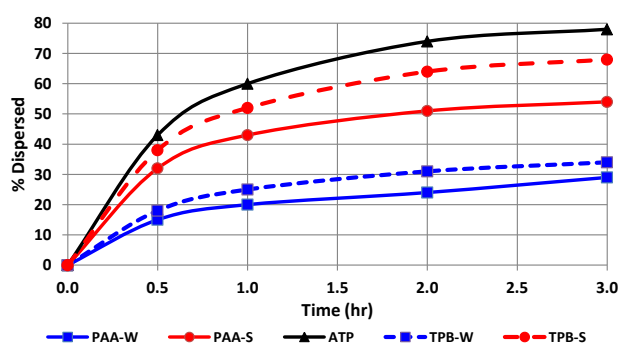


Polymer Composition Effect

Figure 8 presents comparative iron oxide dispersion performance data for the two PAAs, ATP, the PAA-ATP blends (i.e., 1:1 active polymer basis blends of PAA-W & ATP [TPB-W] and PAA-S & ATP [TPB-S]) at 1 mg/L dosages vs. time. The results can be summarized as follows:

- As expected based on the compositional, differences ATP outperforms the two PAAs.
- The solvent polymerized PAA (PAA-S) provides approximately double the performance of the water polymerized PAA (PAA-W) during the test period.
- The performance of both PAA-ATP blends (TPB-W & TPB-S) increases with dosages.
- The performance of TPB-W closely parallels the PAA-W component.
- The performance for TPB-S appears to be hybrid of the two component polymers (PAA-S and ATP) suggesting some synergy and is linked to the PAA-S component performance discussed previously.

Figure 8: Iron Oxide Dispersion by Polymers (1mg/L) vs. Time



Summary

Water treatment formulation development incorporates the use of synergistic components to effectively control corrosion, scaling, and microbiological fouling in the industrial water system. Using multiple deposit control polymers as components of treatment programs is a common practice based on the expectation of synergism and optimizing cost vs. performance. A series of laboratory screening tests were used to evaluate the performance of ≈ 2 k MW water and solvent polymerized PAAs (i.e., PAA-W and PAA-S, respectively), a high performance acrylate terpolymer (ATP), and two PAA-ATP blends (i.e., 1:1 active polymer basis blends of PAA-W & ATP [TPB-W] and PAA-S & ATP [TPB-S]). The data presented herein indicate the following:

1. ATP compared to the PAAs provides superior Ca/P inhibition and iron oxide dispersion, which is due to ATP's two sulfonic acid groups.
2. PAA-W & PAA-S because of their greater carboxylate content provide better CaCO_3 and CaSO_4 inhibition than ATP.

3. Blends of the PAAs and ATP provide performance characteristics that are a hybrid of the components and some synergism most notably with solvent polymerized PAA (PAA-S).
4. PAA-S provides unexpected Ca/P inhibition and Fe_2O_3 dispersion properties that are attributable to the special architectural properties resulting from Lubrizol's solvent polymerization manufacturing process including distinctive end groups and branching not reflected in water polymerized polymers such as PAA-W.

Other deposit control polymers and/or ratios of homo- and copolymers may lead to alternative performance rankings. In addition, water technologists developing formulations and treatment programs must take several other factors into consideration including:

- Formulation component performance, synergy, and costs.
- Working capital and operating cost implications associated with maintaining and using multiple and/or a wide range of water treatment formulating components.
- Formulated product stability.
- Field experiences.

Acknowledgements

The authors thank Scranton Associates' Robert R. Cavano for his questions regarding the performance, economics, and wisdom of combining homopolymers and copolymers as components of water treatment formulations that were the key driver for this paper. 

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OSHA Hazard Communication Update

By Frederick C. Hopkins, CHMM, Consultant, and Thomas C. Kuechler, Ph.D. and Kindra Levels, M.P.H., Occidental Chemical Corporation

Abstract

The new OSHA Hazard Communication Standard was published in the Federal Register on March 26, 2012. All AWT members will be required to comply with this new standard. The fundamental change is the adoption of the international Globally Harmonized System for the Classification and Labeling of Chemicals (GHS). This will result in significant changes in Safety Data Sheets (SDS) and product labeling for chemicals. Information provided will include some historical background, the hazard classification process, the new requirements for SDS and labels, and compliance deadlines.

OSHA HazCom Standard Revised

On March 26, 2012, OSHA published the final rule¹ which modified the OSHA Hazard Communication (HazCom) Standard, often known as the “Right to Know” Standard. This Standard governs how the potential dangers of hazardous chemicals should be communicated to workers handling these material via the use of labels, SDS and training. The changes in the HazCom Standard are aimed at ensuring that workers are apprised of the chemical hazards to which they may be exposed and thus reducing chemical-related occupational illnesses and injuries.

The new HazCom Standard adopts the Global Harmonization System (GHS) and will make significant changes in the labels and SDS for all hazardous chemicals. One change is that Material Safety Data Sheets (MSDS) will become Safety Data Sheets (SDS). There are several deadlines for implementation of the various phases of the new HazCom Standard. Many companies will soon begin to modify labels and SDS to comply with the new HazCom Standard. Therefore, the first deadline is for employee training so they can understand these changes. Companies using hazardous chemicals must train their employees on the new label elements



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and changes in the SDS before December 1, 2013. If you haven't begun training your employees already, you need to start immediately.

This paper describes the basic changes in the HazCom Standard, the basic features of GHS, the upcoming changes in labeling and SDS, the various deadlines for compliance, and how to find help in complying with the new HazCom Standard.

What is GHS?

GHS, as adopted by the new HazCom Standard, consists of two major parts:

1. It defines detailed procedures for determining whether a chemical is classified as hazardous in any of the 28 hazard classes. If so, the degree of hazard is also determined. Data from multiple tests may be required to determine the proper classification for a given hazard class.
2. GHS then defines a specific signal word, a specific pictogram, a specific hazard statement and one or more specific precautionary statements to be used for each applicable hazard category. These must be used on the product label and the SDS.

A given chemical might belong to several hazard categories. All of the relevant hazard categories must be considered when labeling the product and preparing the SDS.

The Global Harmonization System for classifying hazardous chemicals was proposed by the United Nations (UN) in 1992. OSHA was very involved in the development of the GHS. The initial version was adopted in 2002 and was published in 2003 as the "Purple Book". The current 2011 version is about 537 pages long.

The detailed tests for classification are described in a separate manual, the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*. Note that the new HazCom Standard actually adopts the 2009 version of GHS, which is available at <http://www.unece.org/?id=3636>. Any future changes to the HazCom Standard to adopt later versions of the GHS require OSHA's rulemaking procedures.

The GHS was developed because various countries, or even different agencies within one country, had developed different systems for classifying and labeling hazardous chemicals. As a result, a product often had to be labeled differently when exported to different countries. In addition, the MSDS had to have different content for each country, not just translated into a different language. The GHS allows a product to be classified and labeled the same way for all countries. Countries which have already adopted the GHS include the European Union (as part of REACH in 2010), Canada, Australia, Brazil, China, and Taiwan, with more planning to do so. However, minor variations still remain between different countries.

Figure 1: Definition of hazard categories for acute oral toxicity by LD₅₀ (mg/kg), with category description
(Adapted from Figure 1.2 on <http://www.osha.gov/dsg/hazcom/ghs.html>)

U.S. Organization	Hazard				
	Very High	High	Medium	Moderate	Low
ANSI/A 129.1		<50 Highly toxic	50 - 500 Toxic	500 - 2000 Harmful	
OSHA (old HazCom)		<50 Highly toxic	>50 and <500 Toxic		
CPSC/FHSA		<50 Highly toxic	>50 and ≤500 Toxic		
EPA/FIFRA		≤50 Category I	>50 and ≤500 Category II	500 and ≤5000 Category III	>5000 Category IV
DOT (49 CFR 173.133)	≤5 PG I	>5 and <50 PG II	>50 and <300* PG III		
NFPA 704	≤5 Rating 4	>5 and ≤50 Rating 3	>50 and ≤500 Rating 2	>500 and ≤2000 Rating 1	>2000 not classified
NFPA 400		≤ 50 Highly toxic	>50 and ≤500 Toxic		
NPCA/HMIS	≤1 Rating 4	>1 and ≤50 Rating 3	>50 and ≤500 Rating 2	>500 and ≤5000 Rating 1	>5000 Rating 0
GHS & OSHA (new HazCom)	≤5 Category 1	>5 and ≤50 Category 2	>50 and ≤300 Category 3	>300 and ≤2000 Category 4	>2000 and ≤5000 Category 5**

ANSI = American National Standards Institute
 OSHA = Occupational Safety and Health Administration
 CPSC = Consumer Product Safety Commission
 EPA/FIFRA = Environmental Protection Agency / Federal Insecticide, Fungicide and Rodenticide Act
 DOT = Department of Transportation

NFPA = National Fire Protection Association
 NPCA/HMIS = National Paint and Coatings Association / Hazardous Materials Identification System
 * Prior to 2007, different ranges were specified for solids and liquids.
 ** GHS only, Category 5 not adopted by OSHA

Even within the U.S., different agencies and code organizations have classified hazardous chemicals in different ways for many years, leading to confusion. For example, Figure 1 shows various definitions for acute toxicity. The terminology and definition of the hazard categories vary between different agencies, thus a product could have different rankings by different agencies. The different numbering systems used add to the confusion. The category number increases from I to III (DOT) or IV (EPA) from most toxic to least toxic, but the ordering is from 4 to 0 from most to least toxic for NFPA and HMIS. Some systems did not assign a numerical value for acute oral toxicity, but used either “Highly toxic” or “Toxic” descriptions.

For comparison, the bottom row of Figure 1 shows the GHS hazard categories for acute oral toxicity. In the new HazCom Standard, the category number for acute toxicity increases from 1 to 4 from most hazardous to least hazardous.

The GHS classification system is meant to apply during all phases of a chemical’s life cycle, except for some exempt products, such as pharmaceuticals, food additives, and cosmetics, which are governed by other regulations. If all of these agencies and organizations would adopt the same (GHS) definitions, there would be less confusion in the market, for both chemical manufacturers and end users. However, this is still far off, since the U.S. EPA is making very slow progress on converting to GHS and the NFPA has stated that it is not converting to GHS.

The Classification System

It is the responsibility of a chemical manufacturer to classify a product so that it can be properly labeled. Classification of a chemical by GHS is criteria based, rather than being limited to some official list that can become outdated or difficult to change. On the other hand, the EU has published a list of currently accepted classifications for a large number of chemicals as part of their Classification, Labeling and Packaging (CLP) Regulation².

When classifying a chemical, the manufacturer must consider all of the different hazard classes (16 physical hazard classes, 10 health hazard classes, and 2 environmental hazard classes), not just the one which is the major hazard.

For each potential hazard, the GHS classification system prescribes how to determine the degree of hazard, that is, which hazard category is appropriate. The most hazardous category is always Category 1. The lowest hazard category is the largest number used for that potential hazard, but this varies for different hazards. In the case of acute oral toxicity, Figure 1 shows that the category for the lowest hazard is Category 4 for the new HazCom Standard. If a product has essentially no hazard potential, then it is not assigned a category, that is, the product is “not classified”. The following sections provide some examples of how products are classified for different health hazards, physical hazards, and environmental hazards.

Since the GHS replaces the old hazard ranking system in the old HazCom Standard, some evaluation criteria have changed, at least to some extent. For example, a chemical with an LD₅₀ of 1000 mg/kg was not classified under the old HazCom Standard, but is classified as Category 4 in the new HazCom Standard. So each hazard class should be carefully evaluated when compiling a GHS-compliant SDS.

Health Hazards

OSHA defines a health hazard chemical as “... a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard.”

Health hazard classification, as described in Appendix A of the new HazCom Standard, involves three elements: acquisition of relevant data, identification of all hazard(s), and final hazard evaluation including determination of the degree of each hazard.

The text of the new HazCom Standard indicates that there is no need for additional testing to establish hazard classifications. This may not always be accurate. The standard assumes a minimum level of documentation adequate to establish prior HazCom classifications for the various physical and health hazards as well as DOT hazard classifications. In some cases, especially with proprietary formulated mixtures, this data may be sparse, and previous



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hazard classifications may need to be revisited. For some materials, investment in tests to document benchmark data points or to fill data gaps may be warranted.

Appendix A in the new HazCom Standard contains hazard criteria tables and “tiered approach” flow charts for use in classifying a material. The hazard criteria tables provide the quantitative ranges to be used to determine the degree of each hazard. The flow charts provide a prioritized decision making process for each potential health hazard.

The first example in Appendix A addresses acute toxicity which is defined as follows: “*Acute toxicity* refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.”

Four degrees of acute toxicity hazard are defined, see Figure 2. These apply to five exposure routes, i.e., oral, dermal, and inhalation of gases, vapors, or dusts and mists. It is a straightforward process to match up the oral and dermal rat LD₅₀s (lethal dose for 50% of test animals, in mg/kg bodyweight) or inhalation LC₅₀s (similar to LD₅₀s, but here the lethal concentration in air) with the hazard categories in the table. If the toxicity data for a material results in a different hazard category by oral, dermal or inhalation exposures, the most hazardous category takes precedence.

Notes: Gas concentrations are expressed in parts per million per volume (ppmV).

- a. Inhalation LC₅₀s are based on 4 hour exposures. Inhalation toxicity data for a 1 hour exposure is converted by dividing by a factor of 2 for gases and vapors and 4 for dusts and mists.
- b. For some substances the test atmosphere will be a

combination of liquid and gaseous phases. If the test atmosphere is nearly all gaseous, classification is based on ppmV as shown above for gases.

Definitions—Dust: solid particles suspended in air; Mist: liquid droplets suspended in air; Vapor: the gaseous form of a substance or mixture released from its liquid or solid state.

The tiered approach flow chart for toxicity establishes a prioritized list of consideration in a specified sequence. This provides a framework for evaluation of hazard based on the total weight of evidence and expert judgment. (An example and a more detailed discussion of the tiered approach flow charts will occur later relevant to classifying corrosives and irritants.)

Classifying a material in accordance with Appendix A allows the objective identification of all of the applicable hazards, and the corresponding degree of hazard, based on quantitative data. The hazard determination is harmonized worldwide, and also harmonized with DOT criteria, since both the GHS and DOT criteria are based on the same UN test methods.

If one examines 49 CFR 173.133, Assignment of DOT Packing Group and Hazard Zones for Division 6.1 Materials, you find similar criteria and groupings. DOT oral toxicity PGI (Packing Group I) criteria correspond with OSHA HazCom acute oral toxicity Category 1. DOT toxicity PGII & PGIII (Packing Group II and III) corresponds with OSHA hazcom oral acute toxicity Categories 2 & 3. However, GHS defines additional Categories 4 & 5, which do not appear in the DOT classifications.

Persons classifying chemicals whose toxicity is not well documented, but that are similar to other materials having good documentation, are allowed to use what OSHA calls bridging principles. “Bridging”, as used

Figure 2. Acute toxicity classification criteria in Appendix A of the new HazCom Standard (based on LD₅₀ or LC₅₀ where available)

Exposure route	Category 1	Category 2	Category 3	Category 4
Oral (mg/kg bodyweight)	≤5	>5 and ≤50	>50 and ≤300	>300 and ≤2000
Dermal (mg/kg bodyweight)	≤50	>50 and ≤200	>200 and ≤1000	>1000 and ≤2000
Inhalation - Gases (ppmV) ^(a)	≤100	>100 and ≤500	>500 and ≤2500	>2500 and ≤20000
Inhalation - Vapors (mg/l) ^(a,b)	≤0.5	>0.5 and ≤2.0	>2.0 and ≤10.0	>10.0 and ≤20.0
Inhalation - Dusts and Mists (mg/l) ^(a)	≤0.05	>0.05 and ≤0.5	>0.5 and ≤1.0	>1.0 and ≤5.0

here, refers to methods used to bridge data gaps. For example, in the determination of degree of toxicity:

if a tested mixture is diluted with a diluent that has an equivalent or lower toxicity classification than the least toxic original ingredient, and which is not expected to affect the toxicity of other ingredients, then: (a) the new diluted mixture shall be classified as equivalent to the original tested mixture; or (b) the additivity formula (paragraph A.1.3.6) shall be applied.

Skin corrosion is another health hazard commonly associated with water treatment products. Figure 3 illustrates the classification system for skin corrosion. As with acute toxicity, the criteria are harmonized with international and US DOT criteria. Consequently, any DOT PG II corrosives will be classified as OSHA Corrosive Category 1, subcategory 1B. Any DOT PG III corrosives (corrosive to skin, as opposed to metal) will be classified as OSHA Category 1, subcategory 1C.

Figure 3. Skin corrosion classification criteria in Appendix A of the new HazCom Standard

Category 1: Corrosive	Corrosive sub-categories	Corrosive in ≥ 1 of 3 animals	
		Exposure	Observation
	1A	≤ 3 min	≤ 1 h
	1B	> 3 min and ≤ 1 h	≤ 14 days
	1C	> 1 h and ≤ 4 h	≤ 14 days

Figure 4 illustrates the tiered flow chart for evaluation of skin corrosion and irritation potential. Human and animal test data are the preferred basis for evaluation, so they appear in step 1. As a person works down through the chart, the evaluation is based on less and less definitive criteria. Step 2 is based on other existing skin data in animals, such as findings related to corrosion or irritation from dermal toxicity or skin sensitization studies. Step 3 allows reference to existing skin corrosion *ex vivo* or *in vitro* data. *Ex vivo* data are generated by performing tests on human or animal skin “outside the body,” i.e., cultured skin cells or cadaver materials. An example of *in vitro* data, fairly common in the U.S., is data from the Corrositex test using synthetic skins available from In Vitro International in Irvine, CA.

Figure 4. Evaluation of skin corrosion and irritation in the new HazCom Standard (adapted from Figure A.2.1 in Appendix A)

Step	Parameter & Finding	Conclusion
1	Existing human or animal data demonstrating skin corrosion... skin irritation... absence of skin corrosion or irritation...	Corrosive, Category 1 Irritant, Category 2 No skin hazard
2	Other existing skin data in animals, such as incidental findings related to corrosion or irritation from dermal toxicity or skin sensitization studies if reported to be corrosive... if reported to be an irritant...	Corrosive, Category 1 Irritant, Category 2
3	Existing skin corrosion <i>ex vivo</i> or <i>in vitro</i> data if reported to be corrosive... if reported to be an irritant... if reported to not be an irritant...	Corrosive, Category 1 Irritant, Category 2 No skin hazard
4	pH-Based assessment, pH ≤ 2 or ≥ 11.5...	Corrosive, Category 1
5	Validated Structure/Activity (SAR) models if found to be corrosive... if found to be an irritant...	Corrosive, Category 1 Irritant, Category 2
6	Total weight of evidence considered in light of expert judgment “especially when there is conflict in information available” if the weight of evidence favors a corrosive classification... if the weight of evidence favors an irritant classification... if the weight of evidence favors an absence of any skin hazard...	Corrosive, Category 1 Irritant, Category 2 No skin hazard

If none of the data for Steps 1-3 are available, Step 4 allows classification of a material as corrosive if the pH is 2 or less or if the pH is 11.5 or greater. However, the text in Appendix A indicates weak support for the pH classification approach. A footnote stresses the desirability for a companion “assessment of alkali or acid reserve (buffering capacity)” but then notes that there is “no scientifically validated or internationally accepted method to assess” buffering capacity. Also, a material meeting either end of the pH range as specified will frequently ship as DOT corrosive. Consequently, there will often be documentation to support the DOT packing group designation included in the corrosive item shipping description. That documentation would often provide the evaluator with data for steps 1, 2, or 3,

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DBNPA (5 %)
DBNPA, Time Released Tablets (40 %)
Glutaraldehyde (45 %)
Glutaraldehyde (15 %)
Isothiazolin (1.5 %)
Isothiazolin, Copper Free (1.5 %)
Terbuthylazine (4 %)
Bronopol (10 % / 30 %)
Tributyl tetra decyl phosphonium chloride (5 %)
ISO / Bronopol Blend
GLUT / QUAT Blend
Hydrogen Peroxide / Silver Blend (*Green Chemistry*)

Raw Materials

PMA & PAA
Maleic acid copolymer
PCA
PCA / AMPS
AA / AMPS
(ATMP)
(HEDP)
(PBTC)
(DTPMP)
TTA (50 %) & *The Copper Bullet*
Cyclohexylamine
Morpholine
DEAE
DEHA
DTEA II
Sodium Molybdate Dihydrate
Sodium Molybdate Solution (35 %)

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making pH a secondary level of evidence. (DOT does not allow packing group designation on the basis of pH.)

Bridging principles also apply to the classification of corrosive and irritant chemicals. Where a given solution or mixture is bounded by identical more concentrated and less concentrated materials, both of which have been categorized by test data and both are in the same hazard category, then the unknown solution or mixture should be classified in that same category.

For example, if one has good human, animal or *in vitro* data showing that a formulated mixture is Corrosive Category 1, subcategory 1B (DOT corrosive PGII), then a more concentrated formula of the same ingredients at the same ratio can be assumed to be at least Corrosive Category 1, subcategory 1B. If the second (unknown) more concentrated formula is less concentrated than the raw material corrosive ingredient(s) and that (those) ingredient(s) is Corrosive Category 1, subcategory 1B (DOT corrosive PGII), then the undocumented material can be assumed to also be Corrosive, Category 1, subcategory 1B. In other words, if a material is bracketed by less concentrated and more concentrated materials of the same nature and both of those materials are documented to be in a certain corrosive or irritant category and subcategory—the material so bracketed can also be classified in that same category and subcategory.

Use of bridging principles and expert judgment may be allowed in a variety of special, nuanced situations. Readers are encouraged to refer to the Appendices in the new OSHA HazCom Standard and make case by case decisions.

Detailed hazard criteria tables and tiered approach flow charts specify how one should work through the classification process for products that are potential sources of eye damage, eye irritants, skin sensitizers, germ cell mutagens, carcinogens, reproductive toxins, specific target organ toxins (single and repeated/prolonged exposures are handled separately), and chemicals that present potential aspiration hazards.

Physical Hazards

Physical hazard classification is described in detail in Appendix B (Physical Hazard Criteria) of the new HazCom Standard. OSHA defines a physical hazard chemical as “a chemical that is classified as posing one

of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas.” As with health hazards, physical hazard classification involves the same three elements: identification of relevant data, review of the data to ascertain which hazards are present, and determination of the degree of each hazard.

One example is flammable liquids. Figure 5 illustrates the OSHA GHS hazard classification criteria for flammable liquids. Here again, an effort was made to harmonize the criteria with DOT, but the match is not as seamless. The OSHA GHS hazard flammable liquids classification scheme does not use the combustible liquid terminology. Consequently, an OSHA Category 4 flammable liquid is a DOT combustible liquid, PGIII.

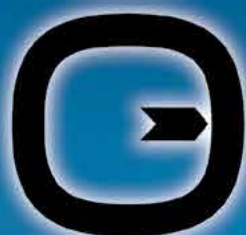
Figure 5. Physical hazard classification criteria for flammable liquids (from Table B.6.1 in Appendix B of the new HazCom Standard)

Category	Criteria
1	Flash point < 23°C (73.4°F) and initial boiling point ≤ 35°C (95°F)
2	Flash point < 23°C (73.4°F) and initial boiling point > 35°C (95°F)
3	Flash point ≥ 23°C (73.4°F) and ≤ 60°C (140°F)
4	Flash point > 60°C (140°F) and ≤ 93°C (199.4°F)

In the water treatment industry, the hazards presented by aqueous solutions of alkyl amine steam line additives are often of interest. If one were to classify a cyclohexylamine based steam line product, and the flash point was 130 degrees F, the material would be an OSHA GHS Category 3 flammable liquid (and a DOT Class 3, PGIII flammable liquid).

No method for estimation of flash points for mixtures and solutions is included in Appendix B. This implies a need for benchmark flash points for a number of products sufficient to bracket the remaining untested flammable liquids.

The classification of oxidizing solids under GHS is the same as under DOT regulations, since both are based on the same test protocol. GHS defines three categories



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(1, 2 and 3) which correspond exactly to DOT Packing Groups I, II and III under Class 5.1. For example, OxyChem's Towerchlor® 90 Tablets (trichloro-s-triazinetriene) are classified as GHS Oxidizing Solid Category I and DOT Class 5.1, PGI while Towerchlor® 56 Granules (sodium dichloro-s-triazinetriene dihydrate) are not classified under GHS as an Oxidizing Solid and are not classified as an oxidizer under DOT.

Environmental Hazards

Environmental hazards are not included under OSHA jurisdiction, so OSHA mandated GHS compliance does not include environmental hazard determinations and corresponding warnings. Efforts in this area are more likely to be driven by customer needs related to sewage treatment district issues; NPDES (National Pollution Discharge Elimination System) discharge permits; documentation requests following chemical spills to soil, ground water, or surface water; and customer requests for green products. Refer to the ANSI GHS documents or UN GHS documents for further guidance.

Mixtures

Many chemicals in commerce are not present in the pure state, but are ingredients in a formulated product which is a mixture of several components. Evaluation of the health hazards of mixtures is based on data for the mixture as a whole when such data are available. However, in most cases, test data on the mixture are not available. Instead, formulas are provided in Appendix A of the new HazCom Standard for calculating the weighted average toxicity for an untested mixture from the characteristics of the individual components. A process is also described for establishing toxicity estimates and adjusting the hazard category when an ingredient with unknown toxicity is present.

Note, however, that the calculation method always produces a conservative result. The calculated LD₅₀ for a mixture is always weighted towards the most toxic component (with the lowest LD₅₀). If the LD₅₀s of the two components differ by a factor of 10 or less, then the calculated LD₅₀ is not too far from a straight average.

Figure 6. Eight required GHS pictograms (from Figure C.1 in Appendix C of the new HazCom Standard, the non-mandatory Environmental Hazard pictogram is not shown)

Flame  Flammables Self Reactives Pyrophorics Self-heating Emits Flammable Gas Organic Peroxides	Flame Over Circle  Oxidizers	Exclamation Mark  Irritant Dermal Sensitizer Acute Toxicity (harmful) Narcotic Effects Respiratory Tract Irritation	Exploding Bomb  Explosives Self Reactives Organic Peroxides
Corrosion  Corrosives	Gas Cylinder  Gases Under Pressure	Health Hazard  Carcinogen Respiratory Sensitizer Reproductive Toxicity Target Organ Toxicity Mutagenicity Aspiration Toxicity	Skull and Crossbones  Acute Toxicity (severe)

However, when the LD₅₀s of the two components differ considerably, say by a factor of 100, then the calculated LD₅₀ is heavily weighted towards the more toxic component.

Changes for Labeling

Determination of a hazard classification triggers a specific signal word, pictogram, hazard statement, and an associated set of precautionary statements—all of which must appear on the GHS compliant label. The signal word, pictogram, hazard statement and precautionary statements required for each hazard category are provided in Appendix C (Allocation of Label Elements) of the new OSHA HazCom Standard. Guidance for label construction is provided in Annex 7 (Examples of Arrangements of the GHS Label Elements) of the GHS Purple Book or in Section 4 of OSHA's Guide to GHS at <http://www.osha.gov/dsg/hazcom/ghs.html>.

The following sections describe the required signal words, pictograms, hazard statements and precautionary statements in more detail.

Signal Words

The use of three signal words has been common for decades on pesticide labels, and some consumer product. The use and meaning of two of the signal words, Danger and Warning, by GHS is, for the most part, a continuation of past practice. However the third signal word, Caution, has been discarded in GHS and the new OSHA HazCom Standard.

Danger is used to denote a high risk of injury or harm. For example, corrosive liquids (Category 1, subcategory 1A, 1B, or 1C) warrant the Danger signal word as do several categories of acute toxicity. There are also examples among the physical hazards. Flammable liquids, Categories 1 & 2 both use the Danger signal word.

Warning is used to denote a lesser, but still significant, hazard. For example, an irritant powder that might cause temporary irritation to hands following contact would show the Warning signal word on the label. Some granular phosphates would be categorized in this manner.

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Pictograms

Each hazard classification is also associated with one of nine pictograms. Refer to Figure 6 for eight of the nine pictogram images. The rationale behind the use of these graphic symbols includes the following. Some workers can't read, and the graphics allow them to get the hazcom message unavailable to them via text. Some workers can't read in the language present on some of the labels in their workplace, so they can also get the message by recognizing the graphic. Similarly, some workers can't read labels because their vision is poor or the print size is too small.

You also have the wisdom behind the time honored saying, "one picture is worth a thousand words."

A recognizable graphic can be very effective. Most workers know what the skull and crossbones means without any training. The DOT symbol for corrosive material is also widely recognized as are the flammable material and oxidizer graphics.

However, use of the pictograms is not a substitute for training. All workers handling hazardous materials should be trained to understand what the GHS pictograms mean. In particular, the Exclamation Mark and Health Hazard pictograms are new to GHS, are not self-explanatory and cover a number of possible health hazards. Without training, these two pictograms would not convey much meaning to a worker.

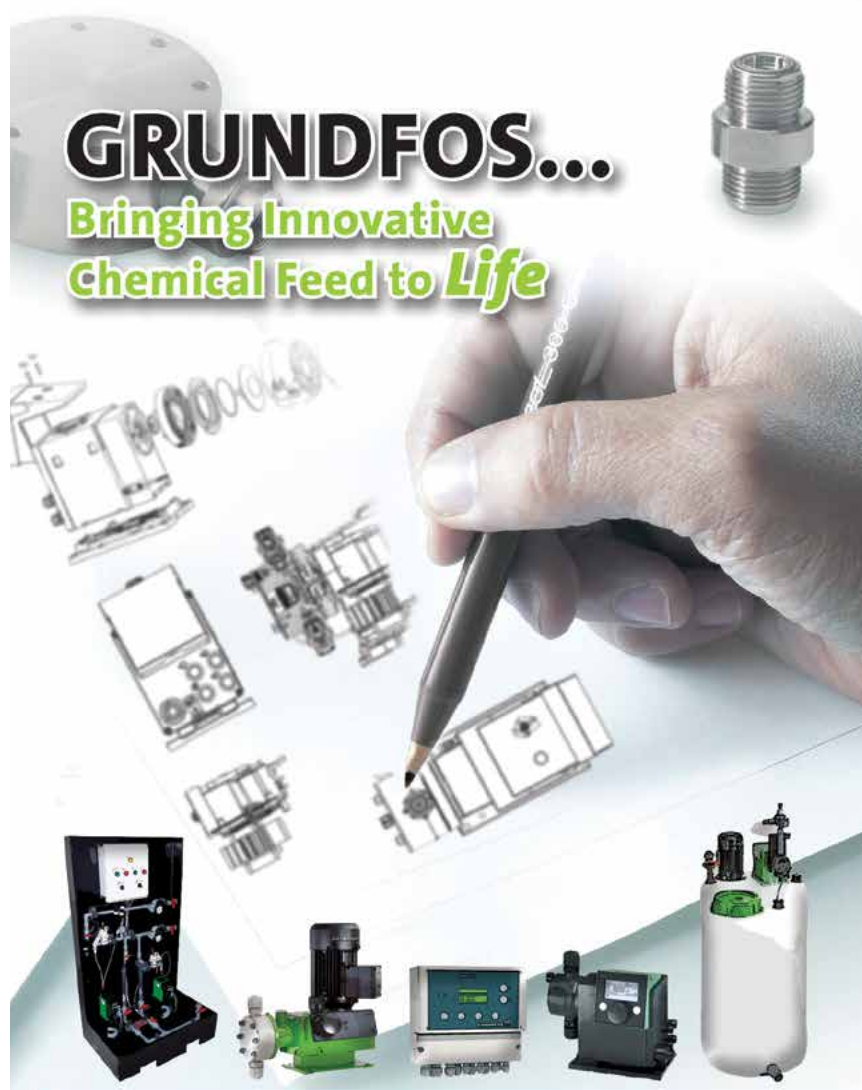
When a pictogram is indicated, but a DOT label with a nearly identical graphic is also required by 49 CFR, the GHS pictogram must not be used. Only the DOT label is to appear. For example, labeling for a 50% sodium hydroxide solution or a similar strong caustic will include the DOT Corrosive label and exclude the GHS Corrosive pictogram.

Hazard Statements

Each hazard category is associated with one hazard statement. The various hazard statements have standard GHS wording that is not subject to editing. To refer again to the caustic example—50% sodium hydroxide (and other high pH caustic materials)—the health hazard classification is Corrosive Category 1, subcategory 1B (DOT corrosive, PGII materials). The corresponding hazard statement is:

Causes severe skin burns and eye damage

In the UN GHS system this phrase is numbered as H314 (H for hazard statements and P for precautionary statements), however, these numbers do not appear on the product labels.



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When a material has multiple hazard classifications, there may be multiple hazard statements. For example, 50% sodium hydroxide and other high pH solutions will also have the physical hazard classification for corrosive to metal. That second hazard classification calls for the following second standardized hazard statement:

May be corrosive to metals

Precautionary Statements

Appendix C of the new HazCom Standard also specifies four kinds of standardized precautionary statements. These cannot be edited, except as specified. The four types of precautionary statements are prevention, response, storage and disposal. Each hazard classification may have several precautionary statements. If a material is classified in more than one hazard category, it may have a large number of precautionary statements on the label.

A high pH liquid caustic label will include several prevention statements. One is:

Wear protective gloves/protective clothing/eye protection/face protection.

Appendix C notes that the chemical manufacturer, importer or distributor is to specify the type of equipment. So, when there are standardized precautionary statements contain diagonal marks of this nature, the person laying out the label will have options as to prioritizing the order of these entries (in this case, personal protective equipment) or, possibly, eliminating items. In other cases, there are blanks left in the standardized language where the label author needs to insert an appropriate phrase.

Readers are encouraged to review Appendix C for additional guidance that may apply to their label text. As the compliance dates approach, there will be an evolution of compliant label language. The labels generated by the larger chemical manufacturers will probably be instructive in this regard.

The response statements contain directions for first aid and must be constructed from the given statements. The storage and disposal statements are brief and unlikely to cause questions. The storage statement is generally a one sentence direction, such as "Store locked up." The disposal statement is often "Dispose of contents/container

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to...” the blanks are to be filled in with something along the lines of... in accordance with local/regional/national/international regulations. The note that accompanies this statement in Appendix C says “to be specified” by the company authoring the label.

Additional, supplementary wording may be allowed on labels if it provides further detail and does not contradict the standardized hazard information.

EPA Registered Biocides

Labels for EPA registered biocides remain untouched by the GHS requirements. However, comparable information is already present on most biocide labels. Biocides lacking a DOT hazardous goods label do not have a pictogram type graphic, but the other text based information is already present, often in greater detail than that specified by GHS. The exact text of precautionary statements specified by the EPA is somewhat different than similar GHS statements. Biocide labels will continue to use the EPA specified wording.

However, the SDS will provide the GHS specified precautionary statements. This may lead to some confusion. Simply be aware that both types of precautionary statements are required and they do not have to be exactly the same verbiage.

In addition, the signal word on an EPA registered label may be different from the GHS signal word. Biocide labels continue to use the signal word “Caution” for less severe hazards. For example, the label of a biocide that has an oral LD₅₀ of 550 mg/kg would bear the signal word “Caution” under FIFRA, but would require the signal word “Warning” under the GHS. When such inconsistency exists, EPA recommends that registrants include the FIFRA label information and a brief explanation for any such differences in Section 15 (Regulatory Information) of the SDS. For more details, see EPA’s PR Notice 2012-1.³

Changes for the Safety Data Sheet

There will be many changes to the MSDS because of the new HazCom Standard. The most obvious change is that the MSDS will now be known as the SDS. While the “M” has been lost, it is essentially the same document that serves to inform the user about the hazards associated with the product. The following paragraphs highlight the more significant changes to the SDS.

Additional information on SDS requirements can be found in the new HazCom Standard, see 29 CFR 1910.1200(g) or Appendix D.

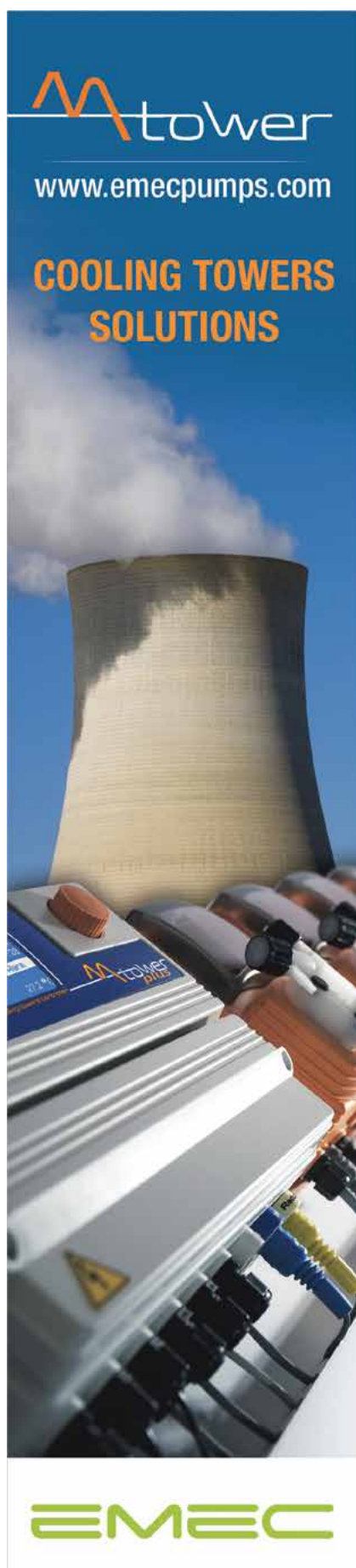
The new HazCom Standard requires the SDS to have 16 sections, in the order listed, as follows:

Section 1	Identification
Section 2	Hazard(s) identification
Section 3	Composition/information on ingredients
Section 4	First-aid measures
Section 5	Fire-fighting measures,
Section 6	Accidental release measures
Section 7	Handling and storage
Section 8	Exposure controls/personal protections
Section 9	Physical and chemical properties
Section 10	Stability and reactivity
Section 11	Toxicological information
Section 12	Ecological information
Section 13	Disposal considerations
Section 14	Transport information
Section 15	Regulatory information
Section 16	Other information

The regulations require that Arabic numbering (1,2,3...), not Roman numerals, are to be used with each section. If there is no information for any section or required subsection, then wording such as “not applicable” or “no data available” must be displayed.

Section 1 (Identification) must now include information on the recommended uses. Any uses that are restricted or advised against must also be given here.

The most noticeable changes to the SDS will be seen in Section 2 (Hazards Identification). This is where the GHS classification will be given, with the associated pictograms, signal words and precautionary statements. An additional piece of information in Section 2 is the “Hazards Not Otherwise Classified (HNOC)” classification, if applicable. This classification is unique to OSHA and is not present in the original UN GHS. Based on the OSHA definition (see 29 CFR 1910.1200(c)), this classification is defined as “an adverse physical or health effect identified through the evaluation of scientific evidence during the classification process that does not meet the specific criteria for physical and health classes addressed in this section”. An example would be the frostbite hazard associated with vinyl chloride monomer. This chemical is



classified under GHS as a flammable gas and a carcinogen. However, the HNOC subsection would inform the user that contact with liquid VCM may cause frostbite to eyes and skin. This hazard is relevant and needs to be communicated to users, but the adverse health effects do not fall within the criteria of the hazard classifications identified. This will be an important section for a user to read.

Section 2 (Hazards Identification) will also include a new piece of information about the acute toxicity of mixtures that was not required before. If a mixture has not been tested as a whole to determine the acute oral, dermal and inhalation toxicity values, then the acute toxicity of the mixture will be calculated from the toxicity of the components. If there is a component with unknown toxicity, then the SDS must state that X% of the mixture consists of ingredient(s) of unknown toxicity. This way, the user knows that the hazard classification was made without data for one of the components.

Section 4 (First-Aid Measures) must now identify the most important symptoms and effects of acute and delayed exposure to the product.

Section 7 (Handling and Storage) must now present the product incompatibilities. This information also needs to be listed in Section 10 (Stability and Reactivity).

Section 9 (Physical and Chemical Properties) must now list all of the required physical/chemical subsections. If no data is available or if the property is not applicable, this must be stated.

Section 11 (Toxicological Information) may include the calculated Acute Toxicity Estimates (ATE's) for mixtures. The LC50 and LD50 acute toxicity data for components will still be listed in this section as well. Thus, the information used to make the acute toxicity hazard classification is presented to the user.

Sections 12 - 15 are now required to be included on the SDS. However, the information included in these sections is outside of OSHA's jurisdiction, so OSHA will not be enforcing the information requirements in these sections. Details can be found in the Standard at 29 CFR 1910.1200(g)(2)(xvi).

Section 16 (Other Information) must now include either the date of preparation of the SDS or the date of the last change to the SDS.

Deadlines for Compliance

The new HazCom Standard requires a number of changes to labels, SDS and the systems used to communicate product hazards. There are several deadlines for manufacturers, distributors and employers to comply with the new OSHA HazCom Standard:

1. by December 1, 2013 - Employers shall train employees on the new GHS label elements, the required SDS format, and how their internal company hazard labeling system will align with the new standard.
2. by June 1, 2015 - Chemical manufacturers, importers, distributors and employers shall comply with all provisions of the new standard, except for item 3.

That is, all manufacturers, distributors and employers must have all of their chemicals classified according to the new standard. All manufacturers must use labels and SDS that are GHS compliant on new production.

3. by December 1, 2015 - Distributors shall not ship containers labeled by manufacturers or importers unless the label is GHS compliant. This gives distributors an additional six months to get rid of any non-GHS labeled product and any non-GHS SDS.
4. by June 1, 2016 - Employers are required to update any alternative workplace labeling and their hazard communication program, as necessary, and provide any additional employee training for newly identified physical or health hazards.

There is a lot of work that needs to be done by each of the compliance dates. However, with some help, your company can be ready on-time.

Employee Training

Employers need to inform and educate their personnel regarding the new elements that are beginning to appear on labels and SDS. Employees don't need to be trained on everything in the standard, but they need to be trained on the parts of the standard that impact their activities. Notable examples include the new pictograms, the new standardized text for hazard statements and precautionary statements, and the new elements incorporated into SDS, like statements on restrictions on product use and the various components of Section 2, Hazards Identification.

For example, workers that formulate water treatment chemicals should be trained on the raw materials they handle during production. A lesser amount of time should also be devoted to the hazards associated with the finished goods. The content of the training should focus on the hazards that workers face and how the various new

hazard communication elements will help them recognize potential problems and help them understand how to best minimize the risk of those potential problems occurring.

Similarly, sales and service field personnel should be trained primarily on the hazards of the finished chemical products that they handle or sell, and the hazards of reagents that they use in testing. If part of a company's interaction with customers is to provide periodic HazCom training, people who do that should receive their own relevant "train the trainer" training.

Employees who lay out product labels or author SDS will require a high level of training, because their work will require a thorough working knowledge of the new HazCom Standard. They will need to be able to implement the hazard classification process and construct SDS and labels with all of the required elements.

Resources available to help with training are available from many companies and individuals that provide environmental, health and safety services. If in-house



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staff have responsibility for label creation, SDS authoring or HazCom training it may be prudent to send such individuals to outside sources for training. As the new HazCom Standard requires significant changes, it may also be advisable to get outside help with the initial implementation of labeling, SDS generation or employee training. Some assistance and content for training related to specific chemicals (and SDS/label content) may be available directly from the SDS and labels created by the chemical manufacturers who supply raw materials and biocides. AWT members would be well advised to pay

close attention to the GHS compliant SDS and labels that large manufacturers will be distributing over the coming months. ☺

References

1. Federal Register, March 26, 2012, 77(58) 17574-17896, which amends Title 29 of the Code of Federal Regulations, section 1910.1200.
2. The list of classifications is given in Table 3.1 of Regulation (EC) No. 1272/2008, or the EU data base can be searched at <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>.
3. See http://www.epa.gov/oppead1/cb/csb_page/updates/2012/label-requirements.html.

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Bookstore Feature

Cooling Water Treatment: Principles & Practice
by Colin Frayne, CWT

Through a practical and international approach, this comprehensive book addresses modern theory, practice, management and marketing of cooling water systems in one volume. This book analyzes:

- factors that may compromise and interfere with the optimal functioning and management of cooling water systems,
- treatments, including specialty chemicals, formulations, programming and pre-treatment equipment, and
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This book, as well as many others, can be found on the AWT Bookstore at <https://store.awt.org>.

Join a Committee!

AWT utilizes a committee structure to operate on behalf of its members. These committees are made up of you, our members—people who are out in the field and involved in the industry. Participating in a committee not only increases your understanding of water treatment, but also introduces you to water treatment professionals and suppliers nationwide, better establishing you in the industry. To join a committee contact us at (240) 404-6477 or visit our website at www.awt.org.

Update Your Contact Information Online

Remember that, at any time, you can update your company, and employee, information, as it relates to AWT. Whenever you have an edit to your company's data, simply log on to the Members Only portion of the website and update the record to reflect it. Nothing could be simpler!

Online Training

Did you miss the AWT Technical Training Seminars that took place in March and April of this year? Well, it's not too late to get in on the action!

The online sessions can be purchased individually or as a package and each webinar comes with the accompanying downloadable PDF of the PowerPoint presentation.

When you register, you will be sent a login and password. If you purchase an individual webinar, you will be able to access it for 14 days. Purchasing all 15 seminars as a package will allow you access for 90 days. The webinars include:

Basic Chemistry and Cooling Water	(100 min.)
Basic Pretreatment, Boiler Equipment and Treatment	(105 min.)
Boiler Plant Survey and Calculations	(46 min.)
Boiler Water External Treatment and Equipment	(85 min.)
Boiler Water Testing	(48 min.)
Chelant Chemistry for the Prevention of Scale	(65 min.)
Cooling Plant Survey and Calculations	(70 min.)
Cooling Water Chemistry Corrosion and Scale	(130 min.)
Cooling Water Microbiology and Biofilms 1 and 2	(95 min.)
Cooling Water Testing	(40 min.)
Feed Water and Tray Deaeration	(107 min.)
Regulatory and Safety Issues	(110 min.)
Water Chemistry Part 1	(68 min.)
Water Chemistry Part 2	(72 min.)
Water Softening, Resin and Pretreatment	(105 min.)

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Membership Benefits



AWT offers high quality business products and services to help AWT members save time, increase productivity, and add dollars to their bottom lines. We carefully research these programs and, because of the size of our membership, gain advantage for individual members. Two of our programs include:

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Members with less than 40 employees, visit <http://www.officemaxworkplace.com/> and have your AWT OfficeMax Partner Advantage Program Username: 0729341w and Password: t5BKbNc3 available to start saving now! Members with 40 or more employees call 1-800-636-2377 to request information on setting up your account.

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Local Firm Teams Up to Help Tornado Relief

Muskogee manufacturer, Advantage Controls, has teamed up with the Oklahoma Parkinson's Disease Association (OPDA) to provide personalized help following the catastrophic May 20th tornado in Moore, OK. The organizations have gathered and delivered supplies and cash to persons in need. Volunteers are distributing food and assistance from the home of one of the survivors.

"This is an effort to help a small group of people in a very personal way." OPDA coordinator, Jennifer Johnson saw both the need and the opportunity to help after speaking with her friend in Moore. "I felt the need to do something, and to do it quickly," Johnson said. "That is when I reached out to the OPDA network, and donations started flowing in."

Advantage Controls CEO, Dan Morris, serves as the president of the OPDA Board of Directors. "When I got the email from Jennifer, I thought this would be a great vehicle to help. Many of our employees had expressed the desire to do their part, and this provided a means to do so. We have gathered donated items including a generator, gas grill, and numerous food and convenience items. The first load was delivered on Wednesday afternoon," Morris stated.

In addition to the donated items, many employees donated cash, or the cash equivalent, of one or more days of vacation. "We are glad to help our fellow Oklahomans in need, and I am personally very proud of both the members of the OPDA Board of Directors, and the employees of Advantage Controls for stepping up at this critical time," Morris stated. For more information, contact Dan Morris at (918) 686 6211 or dan@advantagecontrols.com.

Environmental Testing Lab Celebrates 10th Anniversary With Jobs Growth and Nationwide Service

SanAir Technologies Laboratory recently celebrated its tenth anniversary with steady growth to national status in the growing fields of industrial hygiene testing and identification of harmful microorganisms in public venues.

The company started in 2003, with three employees testing primarily for mold and bacteria on a regional basis. Today SanAir has a staff of 25 working with a national client base.

The company's specialties have grown to include analytical and consulting services to detect and identify asbestos and lead as well as mold, bacteria, *Legionella* and other environmental hazards through environmental microbiology and materials testing.

"Those services are important because environmental pathogens can affect just about all of us," said Sean McGlynn, SanAir's president. "People cannot detect harmful microorganisms on visits to shopping malls, offices or hospitals, for example, but our company can through sophisticated electronic microscopy and other means. Service to the public at large, through our clients, has been a hallmark of our success in addition to our emphasis reliable test results.

"Major landmarks in our growth," McGlynn said "have included earning national accreditations for asbestos and environmental lead testing, and establishment of our Northeastern Regional Service Corridor covering more than a third of the nation's population."

SanAir's asbestos testing is accredited by NVLAP (the National Voluntary Laboratory Accreditation Program of the National Institute of Standards and Technology). The recognition represents the highest standards for the asbestos testing industry. The company's microbiology and environmental lead testing program is accredited by the American Industrial Hygiene Association, the nation's premier organization for occupational and environmental health and safety professionals.

"Those landmarks and others have helped us expand our employment base as well as double our office and laboratory space in spite of a national recession," McGlynn said.

SanAir opened its doors 10 years ago in smaller space and then moved to Powhatan County's Oakbridge Industrial Park in 2005. Most recently the larger and expandable space at Oakbridge enabled San Air to double in size and add a new affiliate that is currently ramping up to provide drug testing in fast-growing pain management and criminal justice applications.

"Needless to say, the Richmond Region has served us well as a base for our now nationwide reach," McGlynn said. "For example, shipments in of materials to be tested and quick turnaround of our results—factors critical to our success and service—are well-served by the region's location and logistical services."

SanAir is based in Oakbridge Industrial Park in Powhatan County, Virginia near the Watkins Center and Westchester developments, major components in Richmond's rapid multi-use business growth. SanAir's clientele includes industrial hygienists, engineers, governments and restoration and remediation contractors. For more information, visit www.sanair.com.

APTech Group Names Technical Director

APTech Group is proud to announce the hiring of Mike Hunter as Global Technical Director. Hunter will serve as an additional key, senior APTech Group technical resource, responsible for providing support for APTech Group water treatment distributors. In addition, Hunter will tap his multi-decade industry experience and Solid Chemical Water Treatment background in order to foster recognition and acceptance of APTech Group's unique technology.

Hunter has over 35 years of sales, service and management experience in commercial water treatment. He began his career at Houseman Hegro as a sales and service trainee in 1977, after obtaining his Bachelor of Science degree in Chemistry from Salford University. During his 22 year career at Housemen, Hunter progressed through a series of sales and technical responsibilities to senior management roles.

In 1999, Hunter left Houseman and joined Halox Technologies based in Connecticut, as VP Sales and Marketing, where he was a key contributor to the introduction of a revolutionary new chlorine dioxide generator. Along with three partners, Hunter launched Waterchem (UK) in 2004. As Sales Director of the Water Division at Waterchem, Hunter was also responsible for the technical support function and product development aspects of the chemical range within the company. In 2010, Waterchem was sold to Green Compliance PLC.

For more information contact Tim Barngrover at tim.barngrover@aptechsolids.com or (513) 247-2467 or visit www.endurosolv.com or www.aptechgroup.com.

Hydraulic Institute Announces 2013 Board Of Directors and Officers

The Hydraulic Institute (HI), the global authority on pumps and pumping systems, announced the 2013 Board of Directors and Officers during its Annual Meeting recently held in Fort Myers, Florida. The new Board will be primarily responsible for providing organizational oversight to the Institute and guiding the direction of its strategic plan.

Dean Douglas, President, Dover Pump Solutions Group, will remain as Chairman of the Board. Dennis Wierzbicki, General Manager, Grundfos, USA, will remain as HI President.

The Board includes three new officers: Michael S. Cropper, Director, Product Development, Sulzer Pumps (US) Inc. was elected to serve as Vice President, Technical Affairs; John Miersma, President & CEO, Iwaki America Inc., will remain as Vice President, Member Services; Andrew Warrington, President, Peerless Pump Company, will remain as Vice President, Knowledge & Education. Additional Board members include:

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- John White, Jr., President & CEO, TACO, Inc.
- Jeff Wiemelt, President, Sundyne

Past Presidents of the Hydraulic Institute, Al Huber, President, Patterson Pump Company, Dennis Ziegler, President & CEO, GIW Industries, and Ken Napolitano, President, Xylem Inc - Applied Water Systems, will continue active participation in the organization as ex-officio members of the Board.

The mission of the Hydraulic Institute is to be a value-adding resource to member companies, engineering consulting firms, and pump users worldwide by developing and delivering comprehensive industry standards,

expanding knowledge by providing education and tools for the effective application, testing, installation, operation, maintenance, and performance optimization of pumps and pumping systems, and by serving as a forum for the exchange of industry information. For more information on the Hydraulic Institute, its member companies and its Standards Partners, visit www.Pumps.org.

Mid South Chemical Company Announces New Staff

Mid South Chemical Company is proud to announce and welcome Alex Chan as the company's Chemical and Technical Development Manager. Alex comes to Mid South with 34 years of experience at Engelhard Canada and Carus Corporation, where he was head of Technical Services and later International Sales Manager. For more information, go to www.midsouthchemical.com.

MIOX Partners With Simply Water

MIOX Corporation, the industry leader in on-site chemical generation technology, announces it has signed an exclusive distribution agreement with Simply

We Create Solutions (and Dispersions and Dry Mixes)

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Water, LLC for North America aquatics. Simply Water has represented a broad range of on-site generation technologies, and is an expert in aquatics water disinfection.

MIOX Corporation and Simply Water have worked together for many years prior to entering into an exclusive distributor agreement. Simply Water has installed MIOX patented Mixed Oxidant Solution (MOS) on-site generation systems at indoor and outdoor pools ranging from 20,000 gallons to 1 million gallons of water, at facilities such as YMCA's, parks and recreation, school districts, and universities.

Rick Dempsey, CEO of Simply Water, reports customer success with MIOX on-site generators where the unique characteristics of the disinfection technology results in clearer and cleaner water, improved air quality, and higher levels of safety for pool operators.

"The mixed-oxidant system provides the industry with the most advanced technology for treating pool and spa water in the world," said Dempsey. "The MIOX and Simply Water partnership will prove invaluable to the Swimming Pool and Spa industry in the United States."

Steve Garcia, MIOX Business Developer commented, "We are very excited to have Simply Water as our exclusive partner in this market. They are driven to provide the best equipment and processes available to the customer, and we are glad to be their exclusive supplier of on-site generation equipment."

MIOX designs and manufactures systems that provide on-demand disinfection chemistry, eliminating the need to transport hazardous chemicals and reducing carbon footprint. MIOX systems are used in multiple applications through a wide range of products, cost-effectively producing disinfection chemistry from 1.0 to 3,000 pounds per day FAC (free available chlorine). With this flexibility, potential use of MIOX systems ranges from large industrial cooling towers, water and wastewater treatment, and frack fluid disinfection to clean-in-place and dairy farm applications. For more information, visit www.miox.com.

TEL Venture Capital Invests in MIOX Corporation

MIOX Corporation announced a strategic investment by TEL Venture Capital, Inc., the corporate investment arm of Japanese semiconductor capital equipment manufacturer Tokyo Electron Ltd. This marks the first investment by an Asia-based investor in MIOX.

The TEL investment complements grants awarded to MIOX by the National Science Foundation (NSF) targeted toward the pursuit of coupling MIOX's core on-site oxidant generation technology with ultraviolet photolysis in an effort to provide a powerful and cost-effective water remediation process. MIOX is a venture capital-backed water technology company focused on on-site chemical generation whose current investors include DCM, Sierra Ventures, Flywheel Ventures, and Schlumberger Limited.

"We believe it will be beneficial to learn more about water treatment and the industry's needs," says Kay Enjoji, President of TEL Venture Capital. "This is an exciting investment in a company that has the leading technology in their field."

"We are honored by TEL Venture Capital's commitment to our company and their dedication to solve capacity-limiting water issues," says Craig Beckman, MIOX President and CEO.

While investment in cleantech as a whole has declined since 2011, investment in water technology by corporate venture capitalists continues to grow. According to market research firm Cleantech Group, water and wastewater investments increased 34% between 2011 and 2012 to \$355 million across 65 deals. Analysts at Artemis Water Strategy have observed corporate strategic investors, family offices and private equity firms increasing their investment in water technologies over the last two years. Corporate VCs view new technologies for water management as a critical strategic advantage to improving their bottom line.

"MIOX is one of the ten companies that Artemis has identified for emerging growth investments," commented Laura Shenkar, Principal at Artemis Water Strategy. "Water companies are hitting a glass ceiling in scaling their operations beyond \$10M a year. Rapid growth



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requires strategic partnerships, a strong pipeline of new technology and a seasoned team. MIOX stands apart as a company that has built strong partnerships in several industries, including oil & gas and food processing.” For more information, go to www.miox.com.

Iwaki America Announces Breakthrough In Pumping



Iwaki America is pleased to announce a breakthrough in pumping slurry type liquids. The Iwaki “SB” slurry bearing is ideal for slurry applications with concentrations up to 10% by volume and particle sizes as large as 100 Micron. Our uniquely modified silicon carbide bearings are ideal for slurries such as diatomaceous earth, metal oxides and other tough abrasive liquids.

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Waves of Change at Houghton Chemical Corporation

As a leading manufacturer and distributor of Heat Transfer Fluids, Antifreeze and Specialty Water Treatment Products, Houghton Chemical is enthusiastic to announce our recent developments. Our long time Heat Transfer Fluid Business Manager, Steve Pescatore, has retired as of April 1st. With

this transition, Leisa Corbett, Specialty Water Treatment Product Manager, began merging the interconnected departments in order to strengthen and expand our industry capacity.

Leisa began her employment at Houghton Chemical as a chemist and quickly broadened her expertise beyond the laboratory, eventually becoming a significant contributor to the Heat Transfer Fluids Department. After acquiring comprehensive Industry knowledge, Leisa developed an interest in the Water Treatment Industry. Inspired by her vision to incorporate relevant and related products into the Houghton Chemical line up, she began cultivating the Specialty Water Treatment Department.

For the past 20 years, while maintaining our powerful and diverse Heat Transfer Fluids Department, Leisa simultaneously established and managed a versatile Water Treatment product line. Therefore, we are eager to announce Leisa Corbett as Heat Transfer Fluids / Water Treatment Division Manager. She merges expertise in both industries in order to offer contractors and developers a wider range of inhibited glycol and Specialty Water Treatment Products.

Leisa Corbett states, “Applications of inhibited glycol often include the need for water treatment products. It is important to interconnect these two industries in order to maximize efficiency and productivity.” For more information, visit www.houghton.com.

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Peabody Engineering Adds New Size To Gemini Squared Dual Containment Tank Product Line



Gemini Squared Dual Containment Tank - 40 Gallon Size
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Among its solid Gemini² Dual Containment Tank product line, Peabody Engineering recently added a 40 gallon size. With a larger capacity, in the same footprint, 22% more than the Gemini cylindrical tank, it's a viable economical solution where space might be an issue.

Gemini Tanks are specifically designed for use in the Water Treatment Industry. When workplace safety and the environment are of utmost importance. The Gemini Squared Tank makes a great secondary containment tank system. It is built out of durable polyethylene to withstand chemicals, caustics and acids without corroding over time. It exceeds EPA's (49 CFR) Dual Containment Requirement while supporting up to 2.0 Specific Gravity contents and handling below freezing to 140 F temperatures.

The Gemini² Tanks are also available in 10, 20, and 70 gallon sizes with more sizes being developed. These plastic tanks come standard in blue or natural colors and custom colors are available. For more information, please visit <http://www.etanks.com/>.

Severn Trent Services Donates Drinking Water Treatment System to Haitian Hospital

Severn Trent Services, a leading global supplier of water and wastewater solutions, partnered with Operation Blessing International (OBI), a global humanitarian organization, to install and commission a ClorTec® T-6 Series sodium hypochlorite generation disinfection system for the Hôpital Universitaire de Mirebalais in Mirebalais, Haiti. The system is capable of producing six pounds of sodium hypochlorite per day, which can disinfect up to 165,000 gallons of water daily for the hospital. The recently completed 300-bed teaching hospital will provide primary care services to about 185,000 people

and secondary and tertiary care to all of central Haiti and areas in and around Port-au-Prince.

"Our ClorTec electrolytic technology is ideal for use in isolated locations where water purification, waste treatment or surface disinfection is required," said Jean-Paul Monali, product manager for Severn Trent Services. "Severn Trent Services and Operation Blessing have been longtime partners doing philanthropic work in Haiti. We are just happy to help continue to make clean, safe drinking water available to communities in need."

OBI, which first provided humanitarian services in Haiti in 2009 at the request of Partners in Health, drilled five water wells for the new hospital. The wells included a primary hospital well (8" x 300') and backup (6" x 200'), an off-site well for hospital staff housing (4" x 200') and two community wells (4" x 100') for public use. While the primary well was being drilled, OBI also funded construction of the hospital's cistern and delivered several truckloads of drinking water every day for over a month.

A Severn Trent technician and OBI staff worked together on the installation and commissioning of the system. OBI continues to provide technical support and maintenance for the water system, ensuring the hospital has water that meets the U.S. standards for water quality available at every tap.

As one of the technologies that recently earned Severn Trent Services a Global Water & Wastewater Disinfection Systems Technology Leadership Award from Frost and Sullivan, ClorTec on-site hypochlorite generation systems are the most reliable and efficient in the industry. With more than 3,000 ClorTec installations worldwide, on-site generation is a proven, cost-effective, reliable and safe alternative disinfection treatment method.

For more information about Severn Trent Services, visit www.severntrentservices.com.



Kathy Cox, Market Analyst
Taylor Technologies, Inc.

What prompted you to start volunteering with AWT?

Taylor Technologies is committed to supporting the mission and work of AWT. Throughout the years,

Taylor team members such as Chris Golden, CWT, Tom Metzbowyer, and Mike Scott have contributed by serving on committees and providing training. When Taylor asked me to volunteer, I was glad to continue the tradition. The Marketing/Communications Committee was the logical place for me, given my MBA and career in marketing.

How has volunteering improved your professional career?

Through volunteering I get the opportunity to work on projects that are different from ones I encounter in my everyday life. Besides providing a nice change-up, these projects tend to expand my perspective on things because I'm interacting with people outside my "corporate culture." Volunteer work has fostered some new skills along the way, too. For instance, I first explored voiceover production for AWT, and now I do them all the time for Taylor's website product demos.

Why would you encourage others to become a volunteer?

Volunteering is an enriching experience where you can make a difference in your industry while expanding your knowledge and professional network. There are many opportunities to match one's skills and talents with AWT's needs—doing things you really enjoy, whether it is mentoring a student member, writing an article, or delivering a webinar.

What is a past project that your committee produced that you feel has had the greatest impact on AWT and why?

Over the years, the Marketing/Communications Committee has led many projects that have greatly benefited the AWT membership. The project I have worked with most closely is the Student Education and Enrichment Development (SEED) Program, which was

envisioned by AWT leadership to promote industrial water treatment as a career path for college students. AWT now has 43 student members as a result of university career center contacts, an AWT internship website portal, members' outreach to universities, and AWT's LinkedIn student group.

Tell us about a current project you or your committee is working on?

As part of the SEED program, the Committee is exploring how we can collaborate with university professors on senior student projects involving water treatment. We're also investigating how our members can best provide mentoring to students who show an aptitude for, and an interest in, our industry.

What has been the most rewarding thing about volunteering?

It is very rewarding to discuss ideas in Committee and be there when they yield tangible results in practice. With dedicated leadership from Pam Simmons and skillful execution by Heidi Zimmerman, CAE and her creative staff, I have seen initiatives such as the IFMA and AFE ad campaigns help water treaters reach their prospects. Witnessing the SEED program take off—giving these students a career option they may never have discovered otherwise—has been particularly gratifying to me because I am a big believer in education. The future belongs to the people who prepare for it today!

How have you been able to utilize the expanded business connections you've made while volunteering?

Taylor supports industrial water treatment professionals with accurate, reliable water-testing products such as our new colorimeter. Piquing interest about additions to Taylor's product line is easier when personal relationships between us and our buyers already exist. I have found it to be true that, all other things being equal, people prefer to do business with their colleagues. I've also found that being active within AWT means I hear news sooner than I would if I were not integrally involved.



The Certified Water Technologist (CWT) exam is the only legally defensible exam that represents the highest professional credential in the industrial and commercial water treatment field. Designed and tested by AWT, it provides professional recognition for individuals involved in water treatment and technology to indicate to the general public, co-workers, employers and others that an individual has achieved a certain level of experience, knowledge and education in the water treatment industry. The CWT designation ensures that the water treatment professional possesses a core body of knowledge and has extensive professional experience in all aspects of water treatment.

Preparation materials, such as the types of questions to be asked on the exam, can be obtained from this column and from selected text and manuals. The reference materials available for purchase, through the AWT bookstore at www.awt.org, are as follows:

- *AWT Technical Reference & Training Manual*
- *AWT Raw Materials Specifications Manual*
- *AWT Reference Guide for Water Treatment Companies*
- Textbook, *Water Treatment: Industrial, Commercial and Municipal*
- Textbook, *Boiler Water Treatment: Principles and Practice, Volumes I & II*
- Textbook, *Cooling Water Treatment*

1. The European Union's Registration, Evaluation, and Authorization of Chemicals (REACH-2007) Regulations affect all U.S. chemical suppliers, and guidance is given in ASTM F2725-08. What is the primary purpose of REACH?
 - a. To restrict U.S. exports to Europe
 - b. Promotion of European exports to the U.S.
 - c. Prevent pollution of the rivers, seas, and oceans
 - d. Protection of human health and the environment
2. ASHRAE has issued a guideline "Minimizing the Risk of Legionellosis Associated with Building Water Systems". What is the number of this guideline?
 - a. Title 12
 - b. Title 17
 - c. Title 22
 - d. Title 43
3. U.S. healthcare facilities have to follow a plan that provides for "processes for managing pathogenic biological agents in cooling towers, domestic hot water, and other aerosolizing water systems". Who issued the plan?
 - a. ASHE
 - b. OSHA
 - c. JCAHO
 - d. ASHRAE
4. When conducting a *Legionella* walk-through investigation, OSHA Technical Manual SECTION III: CHAPTER 7: recommends no further action is necessary if operating temperatures measured at water heaters and the delivery temperature at distant faucets are at least what?
 - a. 60 °C (140 °F) and 50 °C (122 °F)
 - b. 50 °C (122 °F) and 40 °C (104 °F)
 - c. 55 °C (131 °F) and 45 °C (113 °F)
 - d. 65 °C (149 °F) and 55 °C (131 °F)

Answers: 1. D; 2. A; 3. C; 4. A



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Doug Frassa, CWT
Director of Water Treatment,
QualiChem

What prompted you to obtain your CWT?

QualiChem is a value-added blender for water treatment professionals.

We are committed to providing industry-leading technical support, as well as unmatched formulary experience for our customers. To achieve that goal, we realized that it is important to be recognized and certified to the highest standard in the industry—the Certified Water Technologist (CWT) through the Association of Water Technologies (AWT).

Prior to joining QualiChem, I spent more 24 years in the industrial division of a large national water treatment company. When I moved to QualiChem, my focus shifted to working with independent water treatment professionals. In that role, it just seemed natural for me that getting the CWT certification was the next step in my career. I clearly recognized the value brought by affiliation with AWT.

My vision for QualiChem is to create a team of water treatment experts within the framework of a formulating manufacturing company dedicated to supporting our customers' technical needs. To that end, we now have three CWTs on our staff.

What advice would you give those thinking about taking the exam?

For those just entering the industry, as you go through your daily activities, never stop asking questions to gain the practical knowledge that will be helpful for the test.

Keep an open mind; there are sometimes multiple ways

to address a problem.

Be observant to the cause-and-effect relationships with your treatment strategies. Above all, be thorough in preparing for the exam. It's tough, but it's worth the effort.

What was the most difficult aspect of the exam?

The four-hour test pulls from everything you have learned over a career: from experiential-learning to book-learning. It is a very good test that measures industry knowledge, particularly practical know-how, for which no amount of textbook studying can completely prepare you. Reviewing case studies and technical papers can help refresh that practical knowledge.

How did you prepare for the exam?

Even with my extensive field experience and the Betz technical training that laid the foundation for my professional and industry knowledge, I felt I needed to be completely prepared for the exam. I read the *AWT Technical Reference and Training Manual* and *AWT Raw Material Specification Manual*, various articles on boilers and cooling systems from the Members Only section in the AWT website and the Certification Corner questions in the *Analyst*. I skimmed through the Nalco and Betz handbooks, as well as technical manuals from my previous employers. I took the CWT CEU practice quizzes found on the Members Only section of the AWT website. While not everything on the test is from experience, the Technical Training Seminar was very worthwhile and helped as a refresher.

Why do you feel this credential was important to have?

Being recognized as a Certified Water Technologist adds credibility to water treatment professionals and the companies they work for. The certification is recognized in the industry as the highest standard of

excellence as sanctioned by AWT. The CWT certification also brings a level of quality assurance to our QualiChem customers, which in turn, brings value to their operations.

What are the advantages of having the CWT designation?

Professionals with the CWT stamp are recognized in the industry as someone who has been accredited and considered an expert in their field as they have passed the extensive peer-reviewed application process, and have established a commitment to the highest level of water treatment excellence. Also, as a supplier, I feel the CWT demonstrates to our customers that we have walked in their shoes and shared their experiences.

How has your CWT improved your professional career?

The CWT certification has provided a new set of contacts and resources through other CWT water treatment professionals within AWT. This important peer networking opportunity has led to new business for our company and also provides a level of credibility in the water treatment industry.

What has been your greatest professional accomplishment?

My 24+ years in the water treatment business have been very satisfying professionally. In addition to the knowledge and experience I have gained, I have learned how to manage a team of professionals. At this stage in my career, I would say my greatest professional accomplishment has been building a support team of outstanding CWT experts at QualiChem, as well as being a part of the great AWT family with a singular focus of providing excellence in the industry.

What do you think are the most prominent issues facing the water industry today?

There are tremendous opportunities for hardworking, dedicated, eager and talented water treatment professionals focused on providing the end-user with value. It's critically important for them to keep abreast of industry trends, emerging technologies and water treatment products. I encourage them to join and take an

active role in AWT, which provides a useful forum to learn from experts and network with peers. Likewise, I urge them to pursue the CWT certification as an important step in their careers. 

Congratulations To Our Newest CWTs

Please join us in congratulating the latest individuals to become CWTs (April 24 – July 18, 2013)

- Eric Adjei, CWT, *Cascade Water Services, Inc.*
- Joshua Bradley, CWT, *Energy Guard Water Technologies*
- Mike Brown, CWT, *QualiChem, Inc.*
- Mark Johnson, CWT, *ChemCal, Inc.*
- Mike Kajdasz, CWT, *Baker Hughes*
- Tim Rich, CWT, *ChemCal, Inc.*
- David Rowland, CWT, *Fremont Industries, Inc.*

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Our partnership with the International Facility Management Association (IFMA) and the Association for Facilities Engineering (AFE) to help bring greater visibility for AWT members and CWTs to facility managers continues. Recently, AWT has:

- Developed a survey of facility managers as to what they need from their water treatment professional.
- Enhanced the *Find a Water Treater* page on the AWT website.
- Sent another IFMA e-newsletter to go to about 4,000 facility managers.
- Run ads in the Facility Management Journal (FMJ).
- Run weekly ads in the IFMA Insider, an e-newsletter for facility managers.
- Run banner ads with the Association for Facilities Engineering (AFE).
- Secured a booth at the IFMA World Workplace Conference.

Get Your Name In Front of Facility Managers

We continue to look for short articles and tips for the eNewsletter, *Facility Insider*, which is sent to facility managers around the country. This is another great way to get added exposure for yourself and your company! A sample of the newsletter can be found here: <https://www.awt.org/about/news.cfm>. If you have topic ideas, articles or tips you would like to share for possible inclusion in the newsletter, please send them to Julie Hill at jhill@awt.org.

Get Involved

Attending meetings and volunteering with other organizations is a great way to gain more visibility in the marketplace for you and your company. If there isn't an IFMA chapter (<http://ifma.org/community/chapters.htm>) or AFE chapter (<http://afe.org/chapters/index.cfm>) in your area, check out some other organizations.

- **Building Owners and Managers Association International (BOMA):** <http://www.boma.org/About/FindYourLocalBOMA/Pages/default.aspx>
- **U.S. Green Building Council (USGBC):** <http://www.usgbc.org/DisplayPage.aspx?CategoryID=24>

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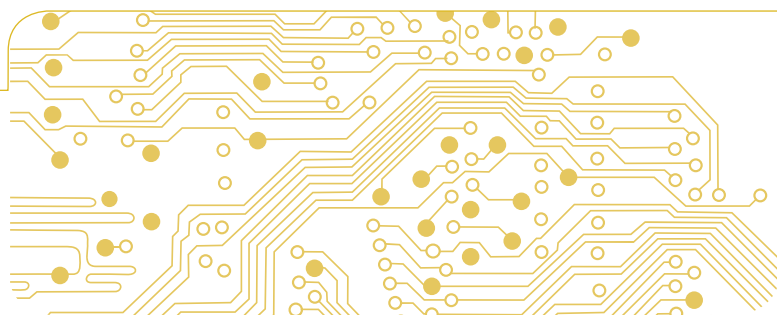
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Question One

I have never worked with nano water for boiler water makeup. What do I need to be concerned about, other than pH?

Answer One

Nano filtration is defined as:

- Operates at 80 – 150 psi
- $\approx 0.001 - 0.05$ Microns
- Nanofiltration removes divalent ions (calcium and magnesium).
- Removal will be similar to RO efficiencies.
- Removes metal ions and salts.
- Calcium, magnesium and other divalent ions can concentrate up in the reject to the level where scaling can occur, similar to the scaling potential found on RO membranes.

- Antiscalants and/or crystal modifiers can be fed to prevent scaling.
- Filter membrane should be cleaned periodically to remove scales.
- Iron can be a significant foulant on the membranes and pretreatment to remove iron is recommended.

Therefore, you should plan on using an antiscalant similar to that used on an RO on the nano membrane and the boiler program will be similar to that of an RO program:

- Oxygen scavenger, either sodium sulfite or DEHA, if possible.
- Caustic for alkalinity.
- Dispersant, either an AA/SA with PCA or if the boiler is over 300 psi, you should consider AA/SA with 10,000 - 30,000 MW Polymethacrylate.
- Amine would be minimal, if needed at all.

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How Can We Improve Granular Media Filter Operation?

Ken Mercer, American Water Works Association (AWWA)

Important operational factors affecting filtration include pretreatment, loading rate, filter run time, and backwashing. The means by which a filter is returned to service following backwash is also important, especially if the system doesn't provide for filter-to-waste. Pretreatment optimization aside, there are several ways to improve filter operation, such as a filter performance assessment program to identify potential deficiencies and filter surveillance to address problems.

Benchmark Filter Performance

Using existing records, such as filter profiles and monthly reports, assess performance characteristics—filtered water turbidity, particle counts, run time, and head-loss development—based on operational variables, such as loading rate, backwash rate, and backwash volume, as well as nonoperational variables that affect filtration, such as influent or clarified water quality. Characterize performance on a seasonal basis to account for demand-related changes in loading rates and temperature-related viscosity effects. It's important to develop apples-to-apples performance comparisons based on similar operational and water quality variables; otherwise, differences may be lost or misleading.

Compare the filters performance with its historical efficacy. Long-range comparisons of performance benchmarks may be needed to detect degradation, because differences may be subtle. When assimilating the data, try to determine the reasons for filtered water turbidity spikes, such as a shock in hydraulic loading caused by backwashing, changes in pretreatment or influent water quality, or other factors. Other filtration performance variables include the following.

Unit Filter-Run Volume (UFRV)

The amount of filtered water produced over the length of a filter run normalized by the filter surface area is UFRV (gal/ft²). UFRV quantifies the gross production per filter run length. At typical filtration rates of 2 - 8 gpm/ft², UFRV should be at least 5,000 gal/ft².

Head-Loss Buildup

As a filter accumulates particles, pressure loss across the filter increases. The cause of filter runs showing higher-than-normal head-loss development (in./hour), compared with historical performance, may be too much surface filtration instead of desired-depth filtration. In addition,

a sudden increase in head-loss development might indicate air binding in the filter.

Filter Bed Solid Retention

Filter bed solid retention measures the amount of turbidity trapped in each layer of the filter media. A comparison should be made before and after filter backwash, and comparisons can be made against their historical averages. A properly backwashed filter bed should retain about 30 – 60 ntu per 100 grams of media, but a plant-specific average range should be determined, with deviations from the average potentially indicating problems. Turbidity of more than 300 ntu could indicate the presence of mudballs.

Backwash Water Turbidity

Excessive washing can result in a need for longer filter ripening times and wasted water, so optimization is recommended. Measuring turbidity during backwash can reveal the wash's effectiveness; about 10 ntu is a common target to attain before ending a wash. Head losses in clean beds can also indicate backwash effectiveness. Higher-than-expected initial head loss could indicate mudballs or the need to revise backwash procedures.

Filter Surveillance

Performance degradation may be apparent during the benchmarking process. However, it's more likely that operators will observe signs of poor performance during the course of their normal duties. This can include anything out of the ordinary, such as boils (short-circuits) during backwash, media in the backwash troughs, rotary sweeps malfunctioning during surface wash, or uneven bubbles across the filter during air scour. If a filter is identified as having a problem, filter surveillance may be required. A regular surveillance program is recommended.

A good place to start for filter surveillance techniques is to create a filter surveillance team to review benchmark data, records, standards, and specs, and talk to the operators. When the team is familiar with the plant and operating procedures, general surveillance steps may be followed:

- Visually inspect the filter. Drain the filter and ensure the surface is smooth, i.e., free of cracks, depression, or mounds. Check for media in wash water troughs.
- Determine if the wash water troughs are level (lengthwise, across the trough, and from trough to trough).
- Measure freeboard (from top of back wash trough to top of media) to check for media loss. Take about six measurements per trough, three per side.
- Use a metal rod, marked in 1-inch units, to measure from the media top to the gravel layer/underdrain system. Compare media depths with records.
- Inspect media filter. Look for mudballs by digging into the media with your hands and sifting it through your fingers.
- Filter core at prescribed depths before and after backwash. Measure layer depth; the interface shouldn't exceed 6 inches. Conduct sieve analysis of media for comparison with specifications. Look at the media under a microscope; smooth edges may indicate excessive wear during backwash.
- Check filter bed expansion during backwash, which should be in the range of 30 percent. Expansion is the length of media rise divided by total media depth.
- Observe surface wash and determine if it effectively stirs up the first inch of media and that all nozzles are working.

When conducting filter surveillance, remember to stand on a plywood board, not directly on the media. Filter media are contaminated following coring and other intrusive examination, so disinfection is recommended before returning the filter to service. 

Ken Mercer is the Senior Manager of Research and Utility Programs at the American Water Works Association (AWWA). Ken can be reached at kmercer@awwa.org or (303) 347-6191.

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Strategic Business Planning: Goals Set Your Focus

By Linda Bailey, Topaz Software

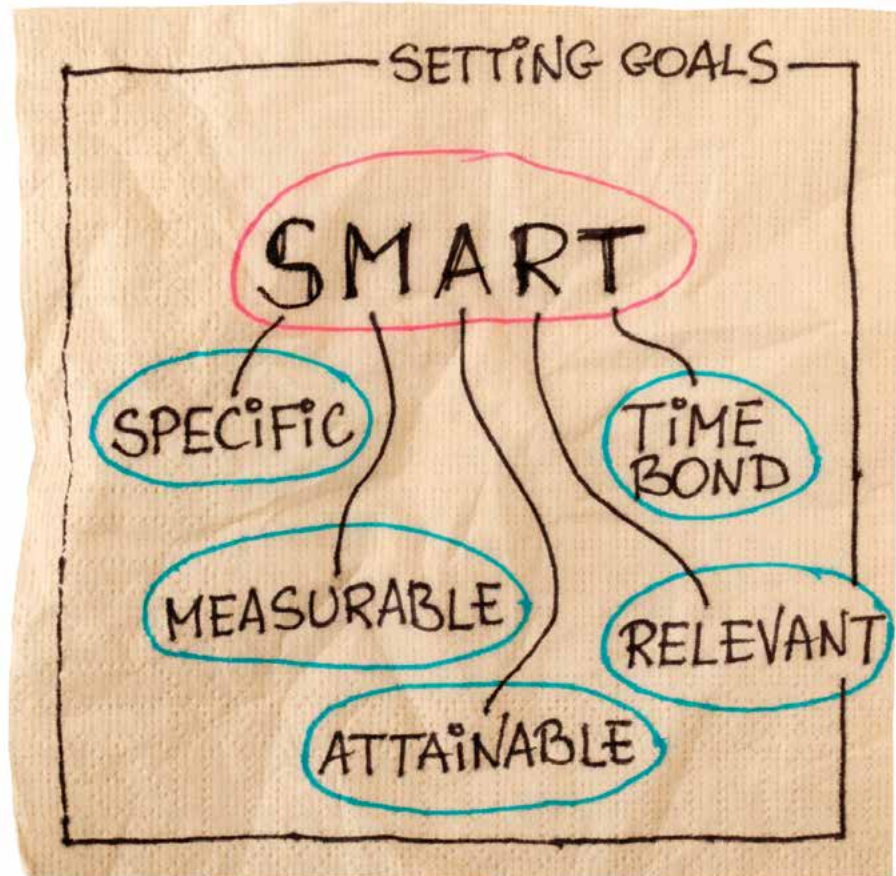
In this changing marketplace, it is more essential than ever to know where you're going. Goals act as your roadmap. They keep you on the path by helping determine where you spend time and money. Without goals, it's easy to waste time and let opportunities pass you by.

"I always reach for the sky when setting my goals," said Brad Smith, RE/MAX Carriage House Nashville Realtor. "I looked at last year and what months were my strongest to determine what I could do going forward. I look at prior year sales, leads and then try to estimate my goals."

With clear goals, you can prioritize tasks—daily, weekly and monthly. You will prioritize your energy on what really matters, what will profit you the most. Your goal might be to increase income, have more effective partnerships, or increased referrals.

Goals are different for each individual agent and team, but the need to set them is applicable to all.

Tom Wilser, Broker, CRS and GRI, states "The big picture does not change drastically. If interest rates shoot up fast, I might focus my actions on lender and foreclosures more. If I meet a builder, I might adjust my actions to the new home market. If you adjust the annual goals, say due to a personal injury, I would keep the weekly goals and modify the actions."



When setting goals, you need to understand what they are and why they benefit you:

- Goals provide a defined direction. To be effective, you should map out a clear, definite path for the next two to three years. For example, you might want to increase new home buyer sales such as the "just married" crowd; develop stronger relationships with new homebuilders; concentrate on a new area of town; or develop and open your own brokerage.

- Goals are crucial to an effective time management system. By remembering your specific goals and priorities, you know if a task helps you or not.
- Goals help you develop new approaches and insights. It helps you identify your unique selling talent and areas where you want to improve. For instance, you may want to become more technically savvy by learning new software or improving your website.
- Goals help you think like a professional and seize available opportunities. For example, there is now a slight increase in foreclosures. If you determine that this trend will continue in your area, you might set a goal to educate yourself in foreclosures.
- Goals prepare you to respond to anticipated, and unanticipated, events. You may learn you need to delegate to get more accomplished.

Types of Goals

There are two types of goals: top-line goals and enabling goals. The top-line goal is your ultimate target. For instance, you might have a top-line goal to make an income of \$250,000. You cannot “make money” by focusing on “making money”.

The enabling goals are the driving forces that you can control and accomplish. Enabling goals are built on assumptions of marketplace trends, your strengths and weaknesses, and facts.

Assumptions ⇒ Drivers Enabling Goals ⇒ Top-Line Goals

Top-Line Goal	Make income of \$250,000
Enabling Goal (driver)	Lead-to-close rate from 4% to 8%
Task	Hire a coach by September 2013
Task	Install business support software by October 2013
Task	Use customized actions task lists by November 2013
Enabling Goal (driver)	Write Marketing Plan by September 2013
Task	Have report that shows marketing expenses by inquiry by November 2013
Task	Set up advertising campaign by December 2013

Goals Change When Assumptions Change

Goals exist to aid you. It is important to reflect periodically and test your assumptions to make sure they are realistic, timely and relevant. Have the forces in the environment changed so much that your goal is no

longer realistic? If so, you should consider changing them. However, do not change goals in reaction to obstacles such as, fear of cold calling, objections, or other challenges.

You change your top-line goals when the underlying assumptions change, if the average sales prices increase or decrease significantly in your area, you may take a mid-course correction. Or if you assume that your advertising will generate the same number of leads as last year, but they drop in half, or there is new competition in your farm area, then your income goal will be impacted. You will need to create different plans addressing strong lead generation.

Getting Started

For goals to work effectively, they must be specific, defined, prioritized, in measurable terms, with an associated deadline. Creating a simple chart helps to clarify your goals.

Broker Tom Wilser says “Try to maintain the big picture—but it’s the steps along the way that get you to that.” Goals should be challenging, support your desired family life, and achievable. If they are too high or too low, it can hurt your motivation. Set your goals based on realistic assumptions, then you are on the way to finding all the opportunities you need to achieve your desires. ☺

Linda Bailey is president-owner of Topaz Software (www.topazsoftware.com) a business planning CRM and sales support corporation. She also is a retired adjunct faculty member of the University Of Texas McCombs School Of Business where she taught strategic planning and IT project management, an owner/founder of four successful small businesses, and a member of the Women’s Council of Realtors.

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10 Ways to Cut Your Debt Now

For many, the decision to get out of debt is preceded by weeks, months or possibly years of worry about these obligations. But it's important to know that getting rid of debt can actually start with some very small steps and strategies that you can begin today.

Advice is a good first step. A meeting with a financial planner can help you investigate all sources of income and total up all your obligations—most will make you bring all your bills with you—and tailor a plan that matches your needs and circumstances. But in general terms, here are 10 steps you should follow.

1 Get a grip on the amount of debt you have: You can't overcome a debt problem without knowing how much you owe. Start pulling together every bill with a balance where you're charged non-tax-deductible interest—credit cards and auto loans for a start—and get a total. If you've missed any payments on any of these balances, bring those current first. Then organize the rest of the debt with interest rates and set a payment order that attacks your highest rate balances first. Also, this is a good time to check your credit reports to make sure there are no other surprises in your credit picture. You are entitled to three free credit reports each year on AnnualCreditReport.com. Any other credit report with the word "free" in its name that asks for a credit card number will likely charge you—avoid those.

2 Put the credit cards away: Cut up your cards if you have to, but at the very least, put them in a safe place where they're far away from your wallet and your phone or computer (so you don't use them for catalog or web orders). Once your debt is paid off, then you can consider which accounts you will use—sparingly—in the future.

3 Now get a grip on spending: It's time to make a budget. For a month, start tracking your spending—every dime. You can do this on paper or on a computer-based solution like Quicken or Mint.com. As you go through the numbers weekly, start identifying things you can live without—coffee and doughnuts, expensive lunches (carryout is a huge budget-buster) and any other frills that can be cut or eliminated. Once you start to suspect that a particular spending item isn't absolutely essential, cut them immediately—don't wait for the end of the month. When you get to the end of the month, build a spending plan that covers the essentials and then direct any additional savings you've identified toward paying off the debt.

4 Try to refinance your home debt: If you have not recently refinanced your mortgage or home equity debt, see if there's an opportunity to do so while rates are still low. You'll need at least 10 percent equity in your home and a credit score exceeding 740 to qualify for the best rates, but start negotiating with your current lender first and see how well you do.

5 Try to refinance your credit card debt: If you are facing an overwhelming amount of credit card debt, talk to each credit card company directly to see if you can lower rates or monthly payment amounts. Don't fall for the 2:00 a.m. come-ons from debt resolution companies—they generally charge high fees and take the payment process out of your hands, which may mean late or missed payments. It's not easy to negotiate a better deal and you may need to insist to speak with several supervisors. But if you succeed at getting a more favorable deal, it's better if you keep the payment process in your hands so you can keep a constant eye on how your situation is improving.

The Revolution Continues

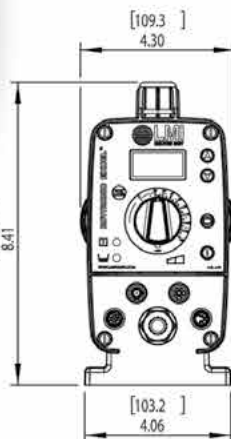
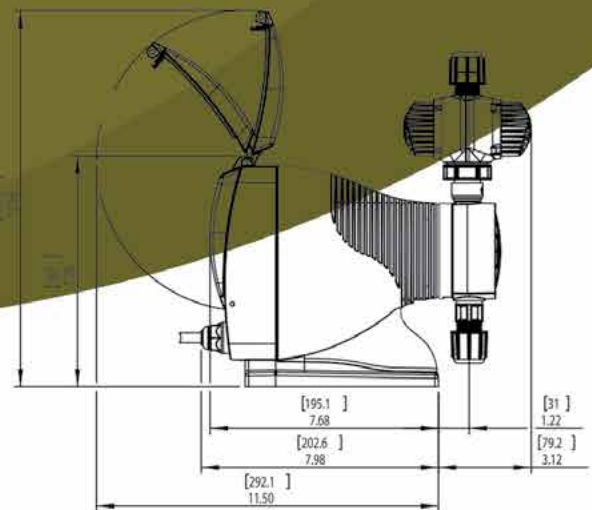
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6 If you need outside help, use some smarts: The Credit Card Act that took effect in February 2010 requires credit card issuers to print a toll-free number for a nonprofit credit counseling service on every bill. It's important to know that the credit card companies fund these nonprofits, so they're not acting completely in your interest. Nor are they foolproof in making sure bills get paid on time—any time you let someone else handle your finances you face that risk. But if you are looking for outside assistance and negotiation with your balances, these agencies are a better option than those credit-repair agencies you'll see advertised on TV. Yet a financial planner may be able to offer specific negotiation tips that can help you keep better control of your debt issues.

7 Learn to use cash or debit: Try to migrate as much spending as you can to cash as long as you get receipts that help you track that spending. A more efficient solution—particularly if you download your bank transactions into a financial tracking computer program—is the debit card. Debit cards wearing a bankcard logo are typically welcome at most stores where

credit cards are accepted. This way, you pay cash without carrying cash. If you don't have such a card, you can probably get one from your bank to replace your traditional ATM card. But remember to tell them to limit your buying power on the card to only what you have in your account. And use overdraft protection to avoid fees.

8 If you can do it safely, do it yourself: You don't have to pay for a hand car wash or a lawn service if you can do such things yourself. For any home or auto maintenance chores you may have during the year, learn as much as you can about those tasks and how much skill, money and time it takes to do them. Previous generations made do-it-yourself a necessity. See if that option is right for you and you might save a considerable amount of money doing it. Also, for bigger jobs, pair up with friends and family and help each other save money.

9 Plan your shopping in advance: Impulse buying had its own role in the debt crisis. It's time to stamp it out at least until your debt issues are fully under control. Start making a centralized list of necessary shopping items—keep the list for grocery, discount store and other locations on one page so you can see everything you're considering. Mark off what seems less than necessary. Use coupons and other discounts—the same goes for online purchases. Always do a search for coupon and discount codes to save money on shipping and overall purchase price. Oh, and when you can, buy used—recycled clothes, furniture and home goods will save you money, and if you're making smart purchases, no one will care. Again, direct all savings toward debt.

10 At the end of the rainbow, don't restart the problem: Once the slate is clean, don't start spending again. Start saving and investing. ☺

The preceding content was originally published on the Financial Planning Association® website, www.FPAnet.org.

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