The Fundamentals of Water Treatment Technology

A Training Workshop for STASMO

Presented By:

ChemCal INCORPORATED

Content System Review

- Cooling Water System: Overview
- Cooling Water Problems and Solutions
- Scale
- Corrosion
- Fouling
- Biological Problems
- Total Cooling System Management

Typical HVAC Cooling System

Makeup Meter

Tower

Chemical Control

Bleed

Pump

Pump

Chiller

Chilled Loop

Air Handler

U.S. WATER SERVICES

Cooling Tower Process

A tower cools water by evaporation by drawing high volume air across the water surface, which transfers heat to the atmosphere.

Tower Fill

Induced Draft Fan

Distribution Deck

Basin

Return Water

Tower

Basin

Supply Water

Recirc Pump

Why Use Water for Cooling?

- Abundant
- Holds a large amount of heat
- Relatively cheap
- High heat of Vaporization
- High boiling point
- Easily Handled

Two Types of Water

Surface Water

- Low Mineral Content
- High Suspended Solids
- Can Vary Seasonally

Well/Ground Water

- Low Suspended Solids
- High Dissolved Solids
- Content characterized by minerals in surrounding rock formations

Important Properties of Water

1. Conductivity
2. Hardness
3. Alkalinity
4. pH
5. Silica
6. Other impurities: Iron, Chlorides, Phosphate, Chlorides, Sulfate, etc.

Problems in Open Cooling Systems

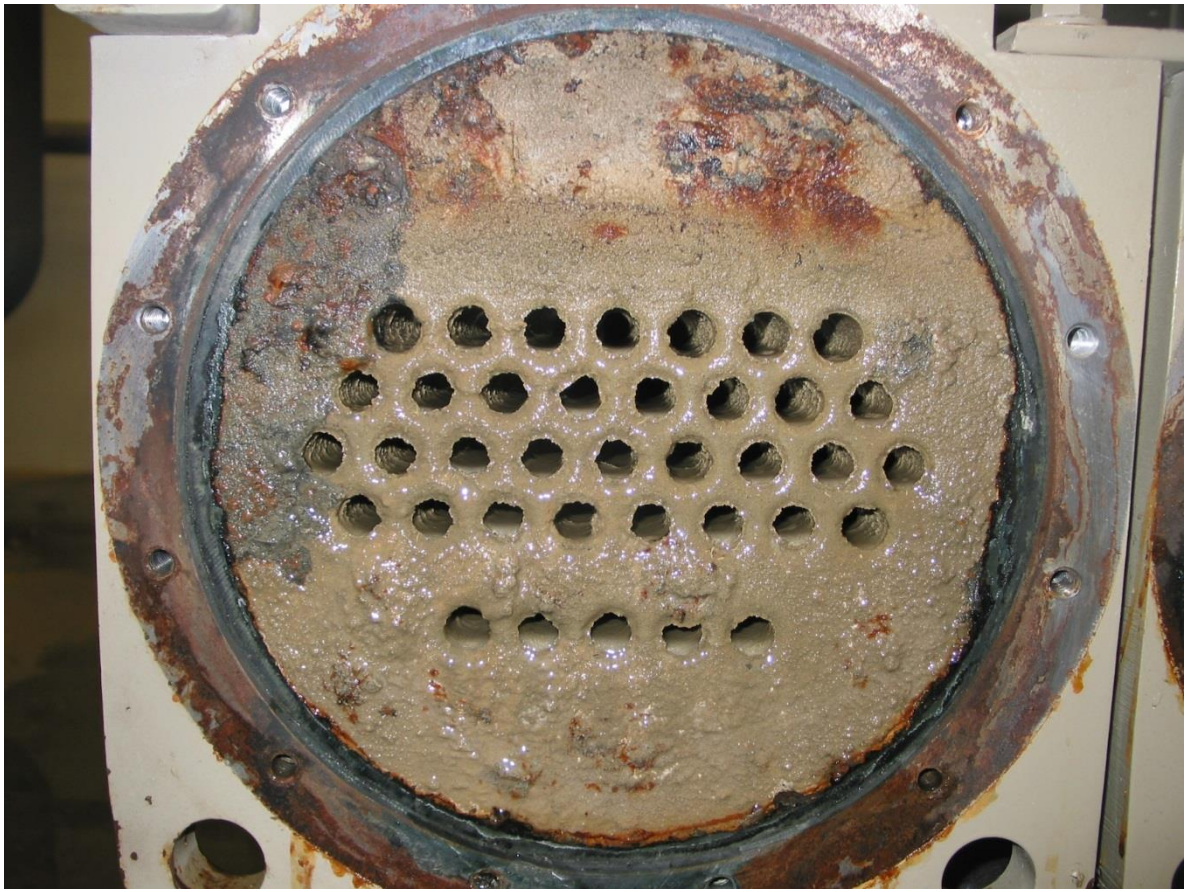
- ✓ Scale
- ✓ Corrosion
- ✓ Fouling
- ✓ Microbiological Growth

Left unchecked these problems cause

- Loss of heat transfer
- Reduced equipment life
- Equipment failures
- Lost production
- Lost profits
- Increased maintenance costs
- Plant shutdown

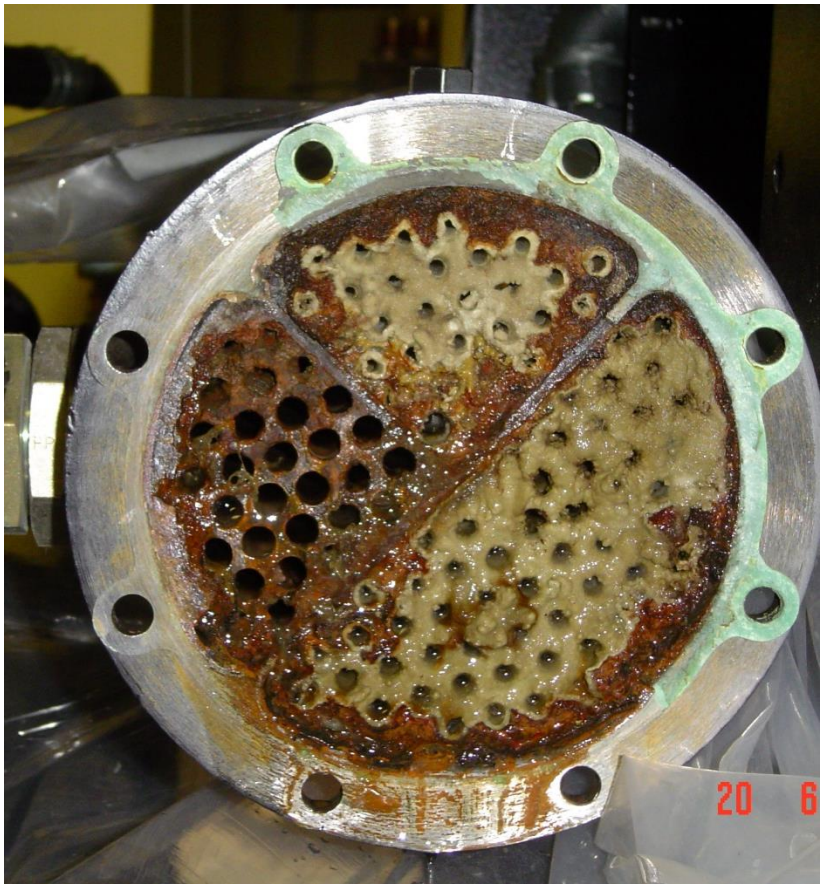
Problems in Open Cooling Systems

Scale



What Problems Does Scale Cause?

- Loss of Efficiency
- Overheating of Equipment
- Flow Problems
- Increased Pumping Costs
- Premature Equipment Replacement
- Downtime



What Problems Does Scale Cause????

What Does An Hour Of Downtime Mean To Your Campuses???

Ways to Prevent Scale

- Temperature and Flow
- Water pH
- Mineral Concentration
- Bacterial Fouling
- Correct Heat Exchange Valve Settings
- Proper Acid Feed and pH Control
- Proper Tower Bleed and Chemical Feed
- Maintain System Cleanliness with Biocides and Maintenance

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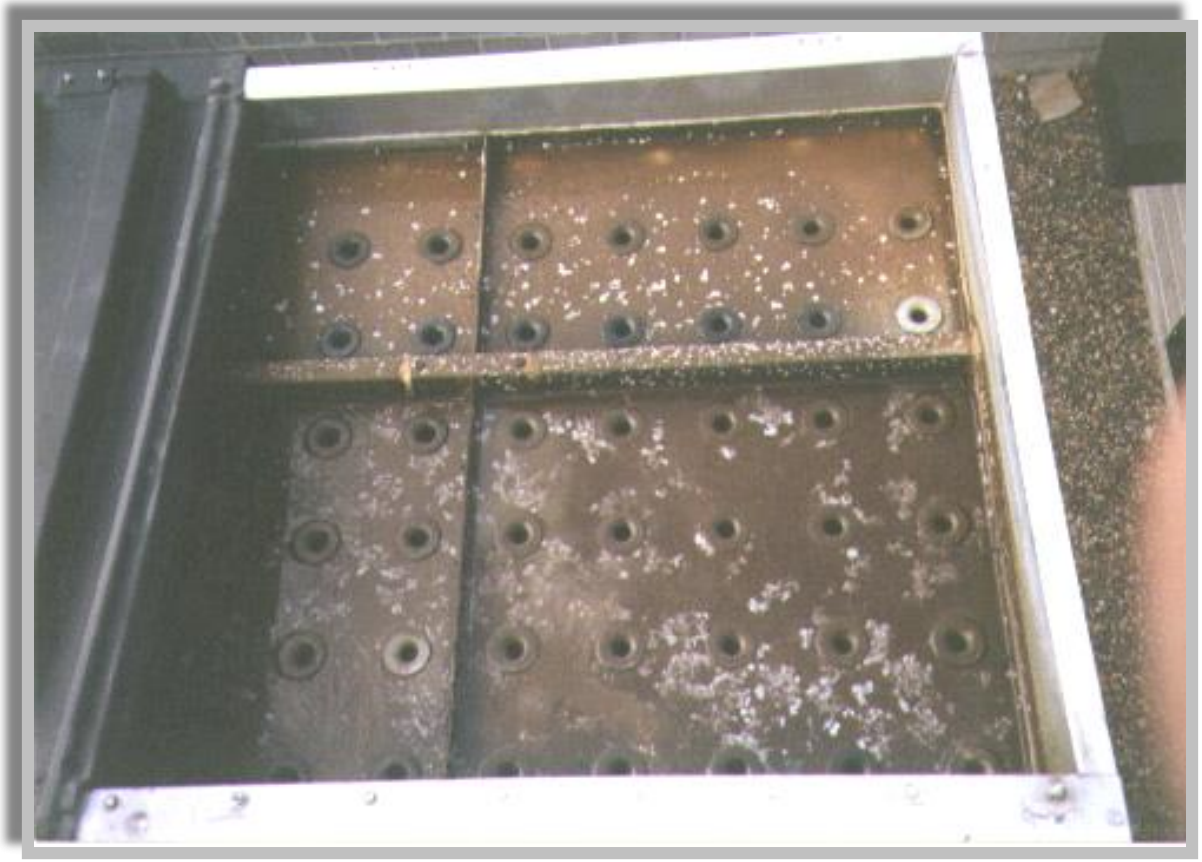
Problems in Open Recirculating Cooling Systems

- Scale
- **Corrosion**



Corrosion

Natures Electrochemical Process That Allows a Metal to Return to its Lowest Energy State. (Natural State)

Types of Cooling Water Corrosion

- General Corrosion: Metal loss occurs uniformly over the entire surface.
- Localized or Pitting Corrosion: Extremely localized type of corrosion resulting in pits or holes in the metal.
- Galvanic Corrosion: Different metals in contact in a system creating a difference in potential

Affects of Corrosion

- Destroys cooling system metal
- Corrosion product deposits in heat exchangers
- Heat transfer efficiency is reduced by deposits
- Leaks in equipment develop
- Process side and water side contamination occurs
- Water usage increases
- Maintenance and cleaning frequency increases
- Equipment must be repaired and/or repaired
- Unscheduled shutdown of plant

Methods to Control Corrosion

- Use corrosion resistant alloys: $
- Adjust (increase) system pH: Scale
- Apply protective coatings: Integrity
- Use “sacrificial anodes”: Mg
- Apply chemical corrosion inhibitors

Sacrificial Anodes

- Zinc blocks or donuts used to provide a sacrificial corrosion site where the majority of the corrosion occurs.
- Corrodes sacrificially to the metal of lower electronic potential.

When Does Most of the Corrosion Occur

During idle periods, due to:

- Moisture exposure
- Oxygen exposure
- General fouling-debris, silt, particles, etc...

90% of the *corrosion* happens in the Idle periods!

Problems in Open Recirculating Cooling Systems

- Scale
- Corrosion
- **Fouling**

Fouling

Organic and inorganic materials, other than scale, that coat heat transfer surfaces and block flow through piping.

There are two types of foulants: Microbiological and Other.

Examples of Foulants

Sand/Leaves

Trash

Insects

Bird Nests

Others:

Broken Fill

Corrosion Products

Affects of Fouling

- Foulants form deposits in hot and/or low flow areas of cooling systems
- Shell-side heat exchangers are the most vulnerable to fouling
- Deposits ideal for localized pitting corrosion
- Corrosive bacteria thrive under deposits
- Metal failure results

Preventing Fouling

Prevention

- Good Control of Makeup Quality
- Good Control of Corrosion, Scale, & Microbio

Reduction

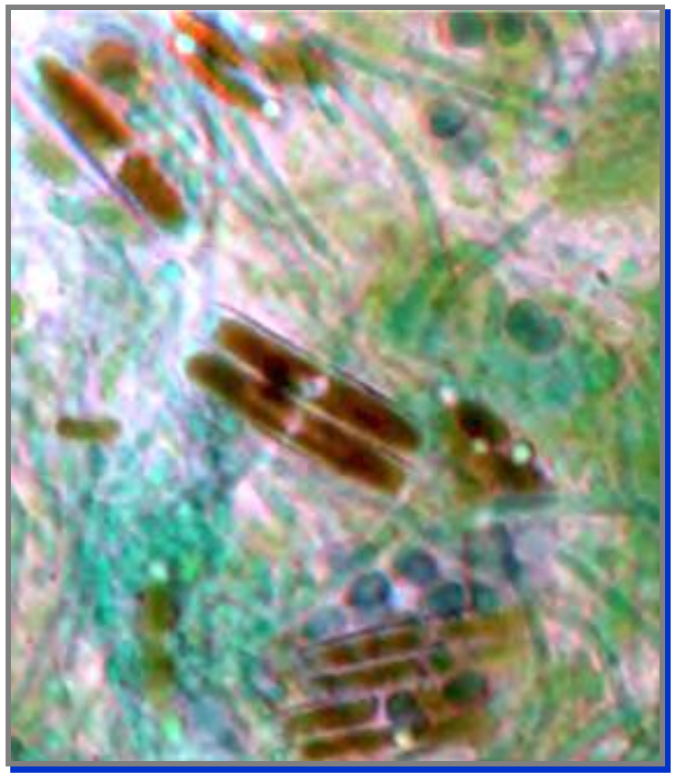
- Increase Blowdown
- *Sidestream Filter*

Ongoing Control

- Annually Clean Cooling Tower
- Chemical Treatment

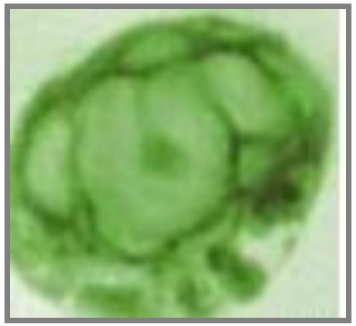
Problems in Open Recirculating Cooling Systems

- Scale
- Corrosion
- Fouling
- **Microbiological Growth**

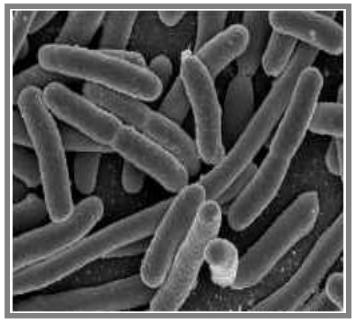


Examples Microbiological Growth

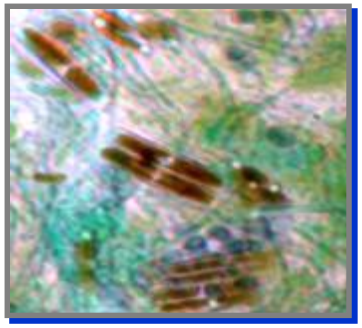
- Algae



- Bacteria



- Fungi



Why is Microbiological Growth in Cooling Towers Hard to Control?

Why is Microbiological Growth in Cooling Towers Hard to Control?

- Towers operate at incubation temperature (usually 85^{o} - 95^{o})
- Plenty of oxygen is available
- Food and nutrient sources are plentiful from outside air or from process leaks
- Sunlight is available
- Remote/stagnant locations available
- Physical cleaning is difficult

By Controlling Microbiological Growth We Will:

- Prevent Corrosion, Scaling & Fouling
- Reduce Chemical Consumption
- Maximize Equipment Efficiency
- Maximize Equipment Life (Wood Rot)
- Reduce Liabilities of Legionella and Other Related Risks

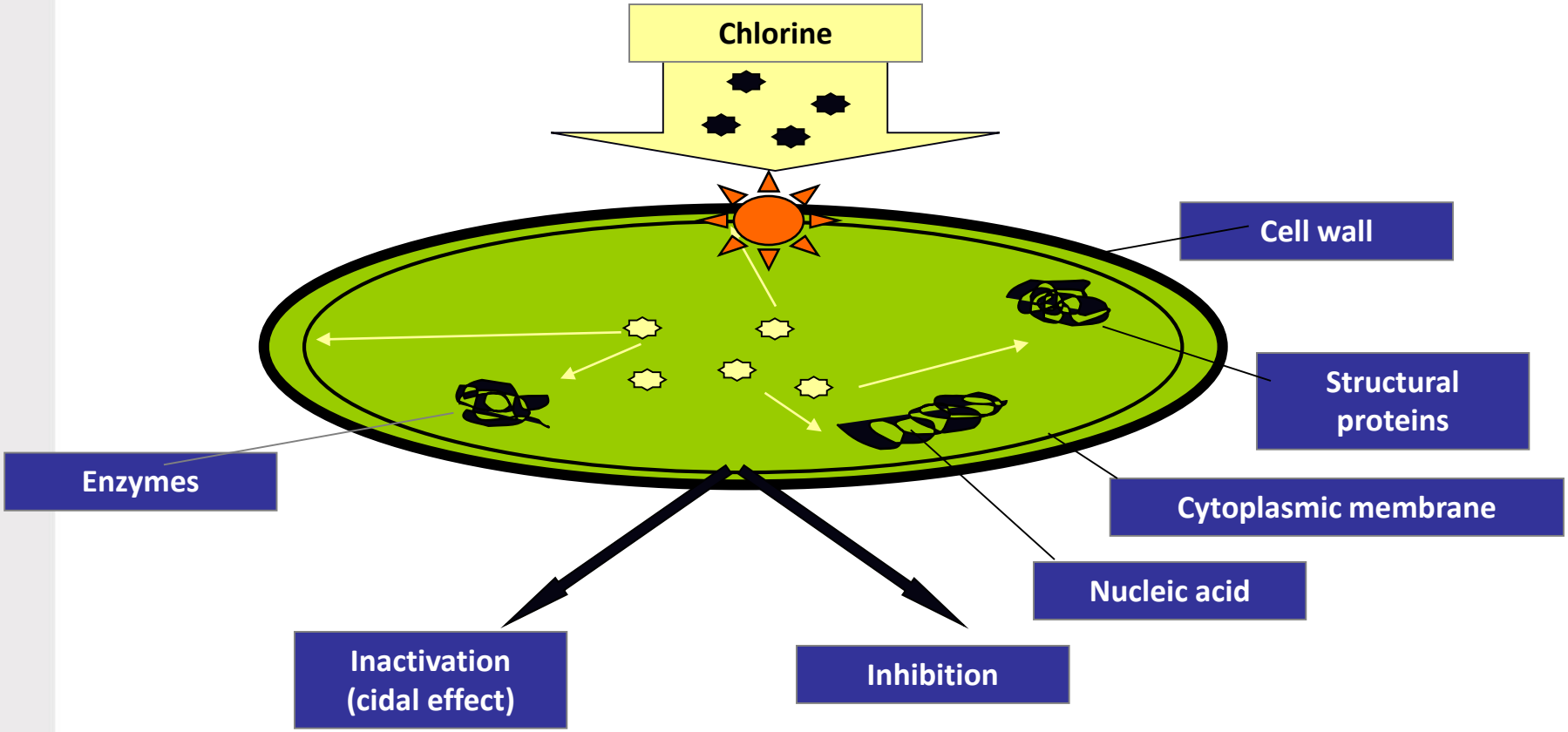
How Do We Keep Cooling Systems Clean?

- Regular Microbiological Testing
- Physical Cleaning of the System; Quarterly or Annually
- Bio-dispersant Program if indicated
- Record Keeping of Test Results and Biocide Additions
- Complete Biocide Program: Oxidizing & Non Oxidizing Biocides

Why Use Oxidizing Biocides?

- They Are Inexpensive
- Very Fast Acting (Kill Quickly)
- They Kill by Burning the Cell (Resistance Can Not be Improved)
- Very Broad Spectrum
- Many Sources and Types

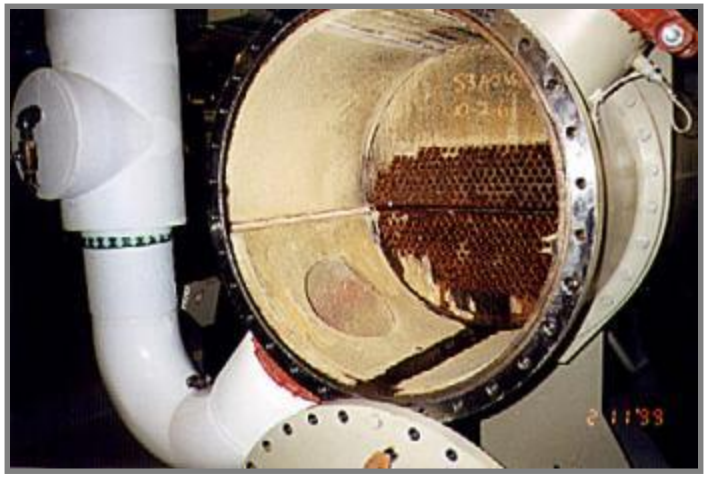
Oxidizing Biocides Burn Cell



Source: C. Chauret. Controlling Encysted Parasites with Disinfection Processes. OWWA Seminar on Disinfection in Drinking Water Treatment. Toronto. April 2000.

Chiller Inspection

- Should be done yearly on the condenser and every few years on the evaporator.



- A boroscope may be used to get a closer look inside the chiller tube bundle.

Automation & Feed Control

ChemCal Reports

Where Water and Technology Meet™

Chemical Feed and Water Control for Cooling Systems

- Scale Control
- Corrosion Inhibitors
- Biocide Feed

- Tower Bleed Control
- Water pH Control
- Monitors and Alarms
- Automatic Data Logging

Why Use Automation?

- Reliability of Program Application is Critical
- Quickly Adjusts to Varying System Demands
- Troubleshooting is Much Easier
- Energy Savings Due to Tighter Control
- Automatic Data Logging for Permit Reports

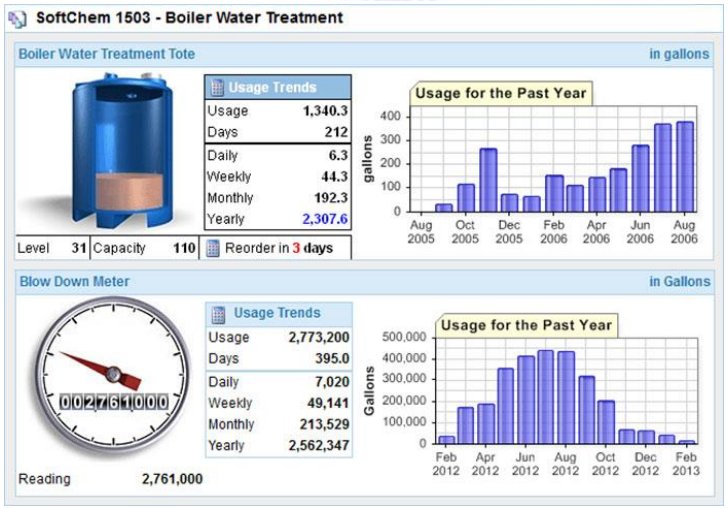
Data Logging and Trending Software

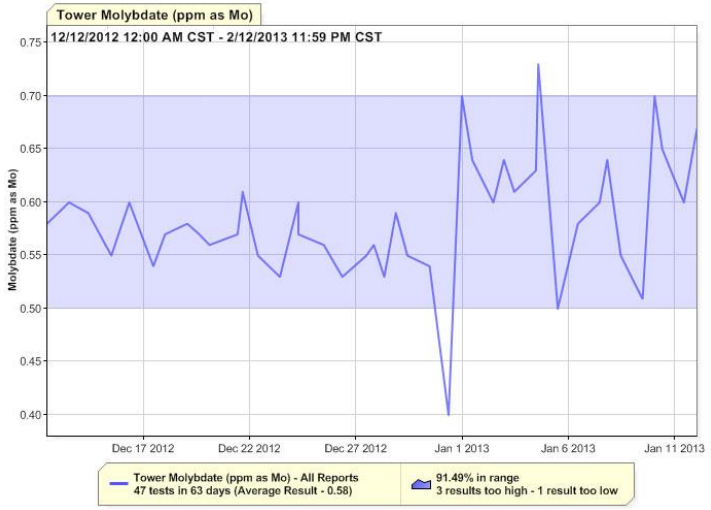
ChemCal Reports

Where Water and Technology Meet™

- Web Based
- Electronic Log Book
- Inventory Tracking
- Trending
- Troubleshooting Tool
- Storage for Reports

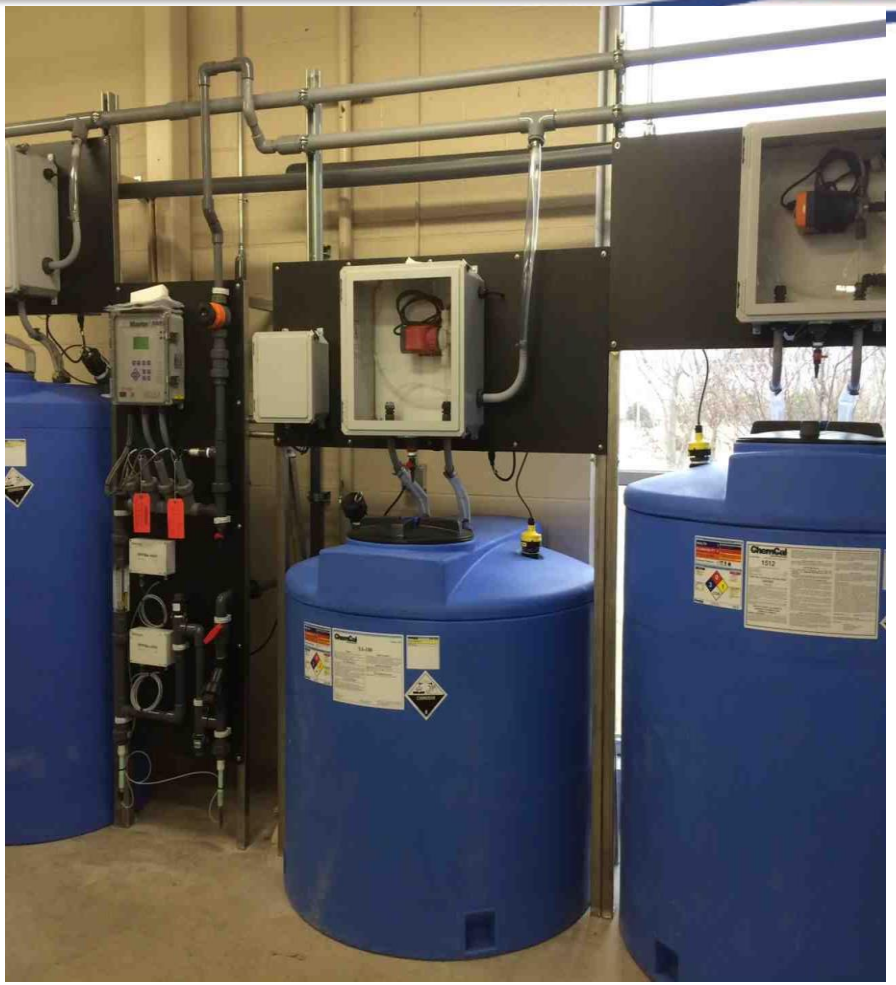
- Accessible from Remote Computers with Password





EZ-Feed Mini-Bulk Handling Systems

- ChemCal EZ-Feed Systems
- Tank within a tank design
- 30-400 gallon
- Small Footprint
- Chemical Level indicator
- Tanks filled by ChemCal personnel
- No Chemical Handling
- Automatic reordering



THANK YOU

- *Thank you for your attention!*