FEDERAL UTILITY PARTNERSHIP WORKING GROUP SEMINAR

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Water Management: The Dynamic Challenges of Evaporative Cooling Systems

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Hosted by:

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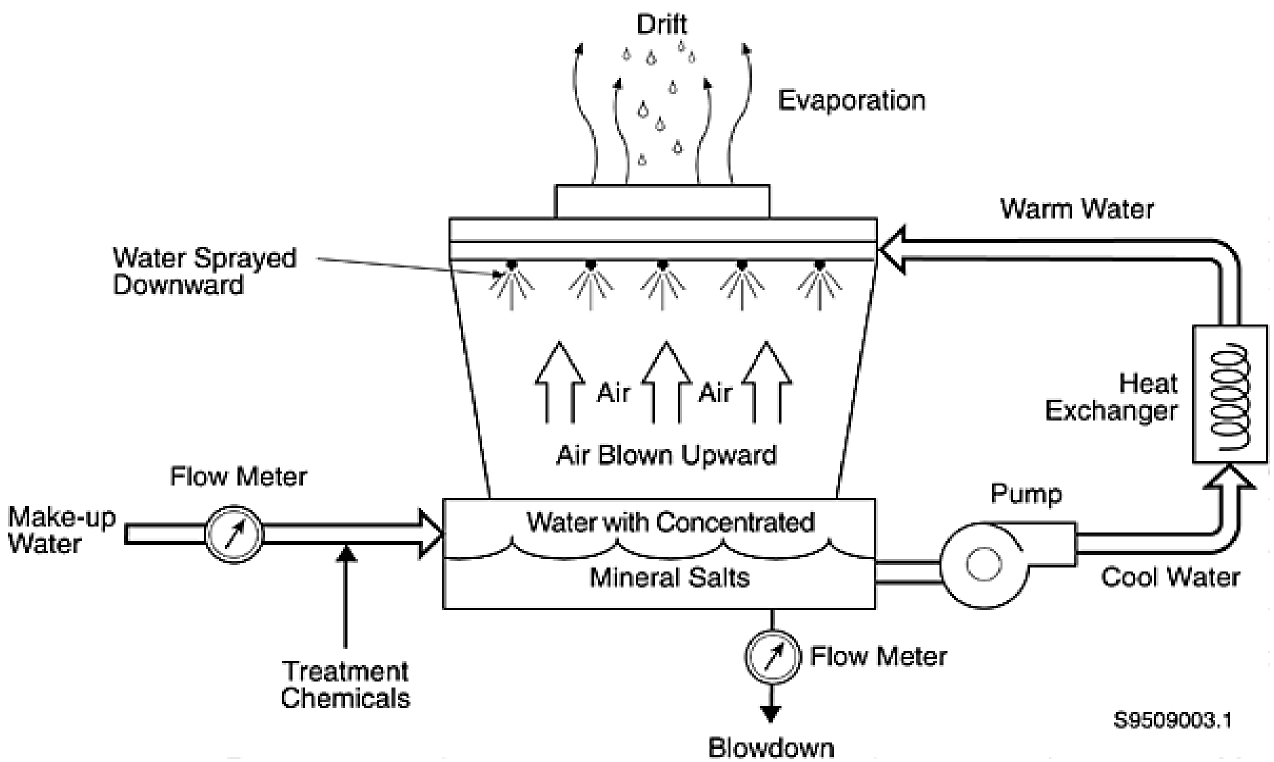
Overview

Cooling towers are dynamic systems with inherent mechanical, operational, and chemical challenges

Concerns include corrosion, fouling, scale, and microbiological growth

Understanding and managing these challenges is critical for efficient and safe operation

Cooling Tower Overview



Open recirculating systems are open to the atmosphere at the tower. As water flows over the tower, heat picked up by the process is released by evaporation. The cooling water then returns to the heat exchangers to pick up more heat.

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Important Chemical Properties of Water

- Conductivity
- Hardness
- Alkalinity
- pH

Two Sources of Water

Surface Water

- Low in dissolved solids
- High in suspended solids
- Quality changes seasonally and with weather

Ground Water

- High in dissolved solids
- Low in suspended solids
- High in iron and manganese
- Low in oxygen, may contain sulfide gas
- Relatively constant quality and temperature

Hardness

Dissolved Calcium and Magnesium

- Inversely soluble with temperature
- Reacts with other minerals such as carbonate alkalinity, phosphate, and sulfate to form deposits on heat exchange surfaces
- Scaling potential affected by alkalinity levels

Alkalinity

Carbonate and Bicarbonate

- Reacts with hardness to form scale (calcium carbonate – lime scale)
- Must be maintained within prescribed range

High Alkalinity: Scale/deposit formation

Low Alkalinity: Corrosion

pH

- pH 7.0 ⇨ “Neutral” not “pure” water
- Balance between hydrogen & hydroxyl ions in the water
- Maintaining good pH control is critical to cooling system operation
- Low pH: Corrosion
- High pH: Scale

Conductivity

Conductivity is the measure of how well water will “conduct” an electrical current

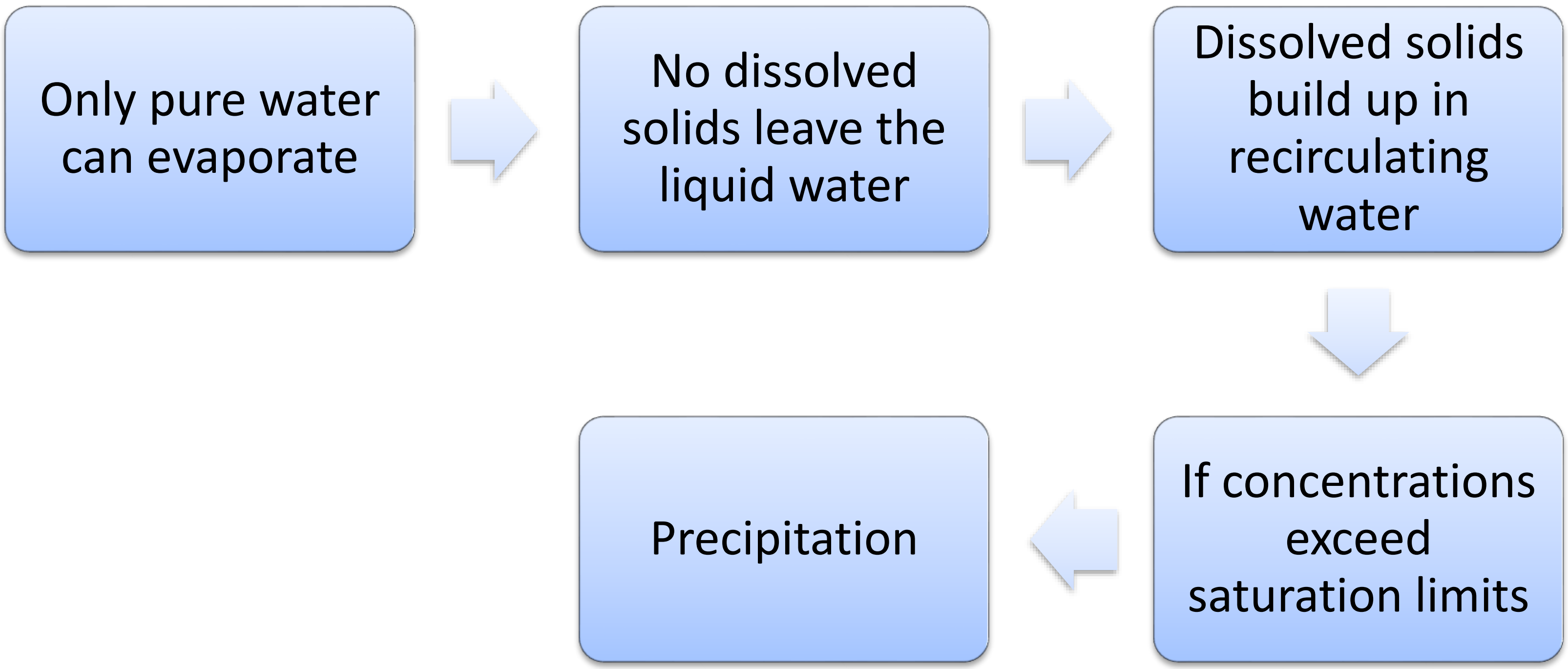
Pure water without dissolved minerals will not conduct an electrical current

As minerals accumulate in the water, conductivity increases

Conductivity is a direct measurement of the amount of dissolved solids in the water

As the conductivity of the water increases, so does the potential for corrosion and scale formation

Concentration of Dissolved Solids

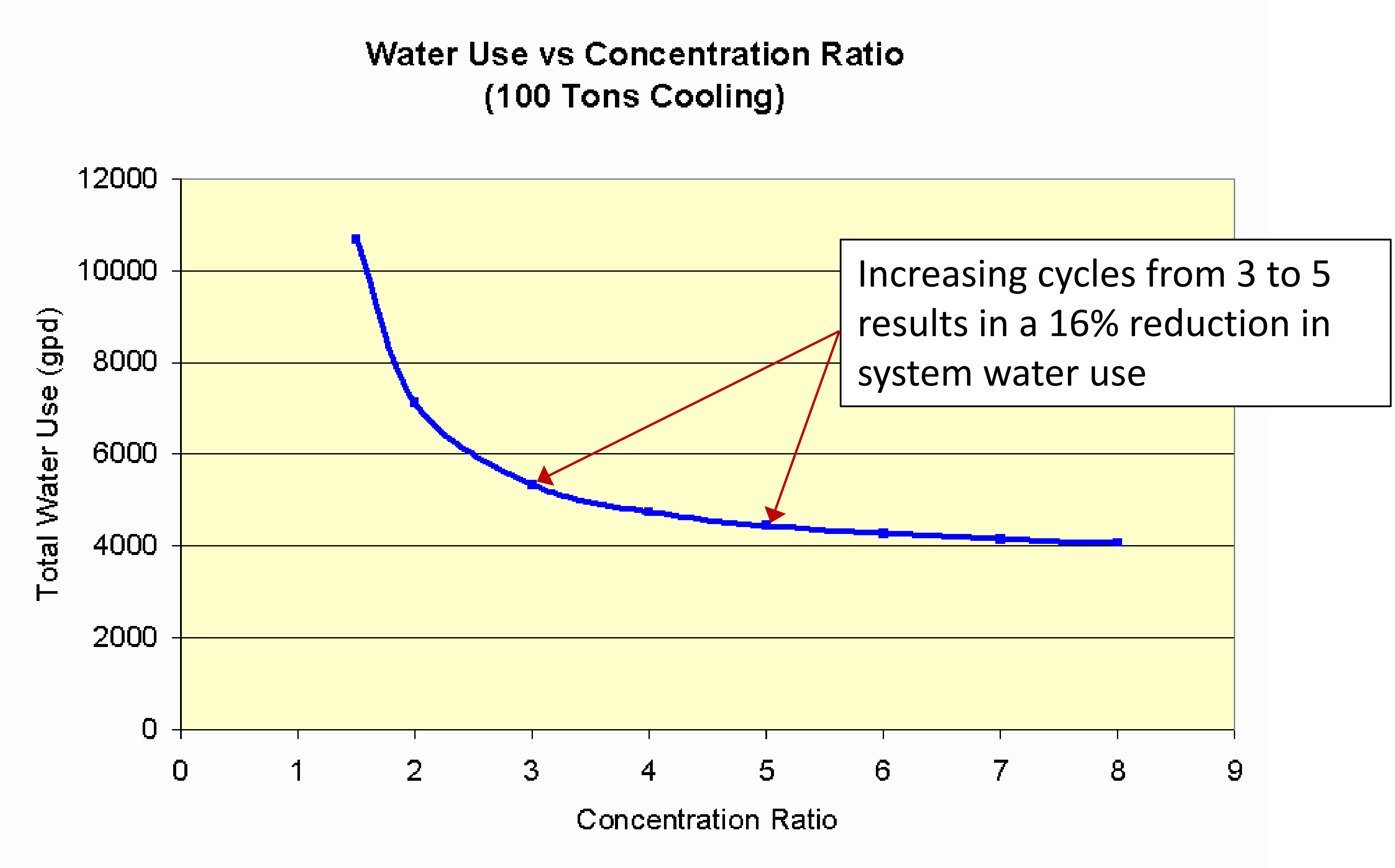


Cycles of Concentration

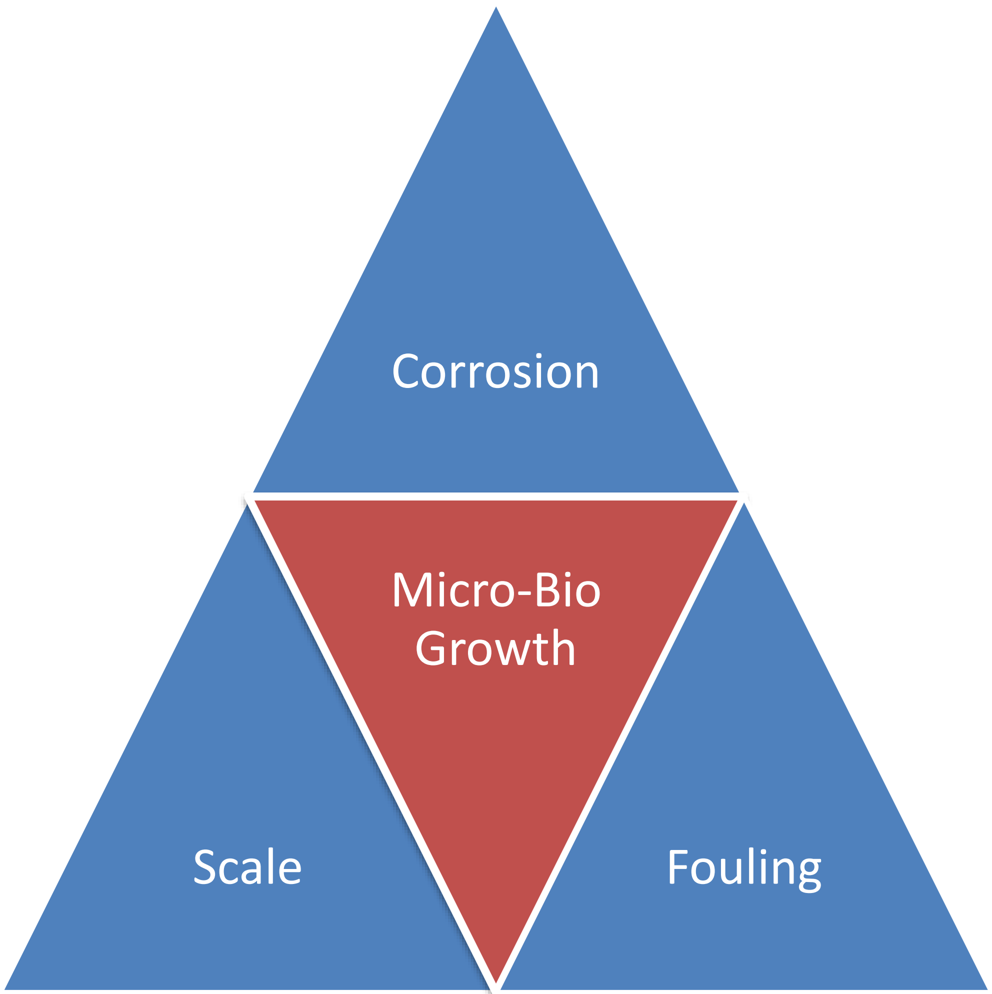
The ratio of the concentration of dissolved solids in the blowdown water compared to the makeup water

- A key parameter used to evaluate cooling tower operation
- Also referred to as “concentration ratio”
- Because dissolved solids enter the system in the makeup water and exit the system in the blowdown water, the cycles of concentration are also approximately equal to the ratio of volume of makeup to blowdown water
- From a water efficiency standpoint, maximize cycles of concentration is critical
- This can only be done within the constraints of your makeup water and cooling tower water chemistry

Maximize Cycles of Concentration



Cooling System Concerns



Microbiological Breeding Grounds

Cooling towers present the perfect environment for microbiological activity

The moist, wet environment is typically at an ideal temperature for bacteria growth

Dust and debris collection provides a natural food source

Direct sunlight permits algae growth

Dead legs and stagnant areas may exist

Legionella Bacteria

- Common aquatic-born bacteria
- Can be found in many potable and utility water systems
- Cooling tower conditions are perfect for legionella bacteria growth and multiplication
- Inhalation of aerosolized water containing legionella bacteria can lead to Pontiac Fever and Legionnaire's Disease
- For individuals with weak immune systems, Legionnaire's Disease may be fatal

ASHRAE Guidance

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) approved ANSI ASHRAE 188-2015, "Legionellosis: Risk Management for Building Water Systems“ in May 2015

Detailed requirements for risk management of all building water systems	Building owner and new building designer are responsible for compliance	Annual review is minimum requirement	Provides specific methodology and steps that must be followed

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ASHRAE 188-2015 Compliance

Familiarization with ASHRAE and Cooling Technology Institute guidelines for controlling Legionella

Regular microbiological testing and strict control of halogen residuals for cooling water systems

Documentation of due diligence demonstrating evidence of system control

Managing Microbiological Risks

Inspect systems for algae and biofilms, and proper flow through the tower fill

Cover open distribution decks

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Managing Microbiological Risks

- Eliminate dead lags and stagnant locations
- Minimize potential for human contact
- Implement effective treatment programs
- Maintain consistent oxidizing biocide (free chlorine) residuals and supplement with routine bio-dispersants and non-oxidizing biocide treatments

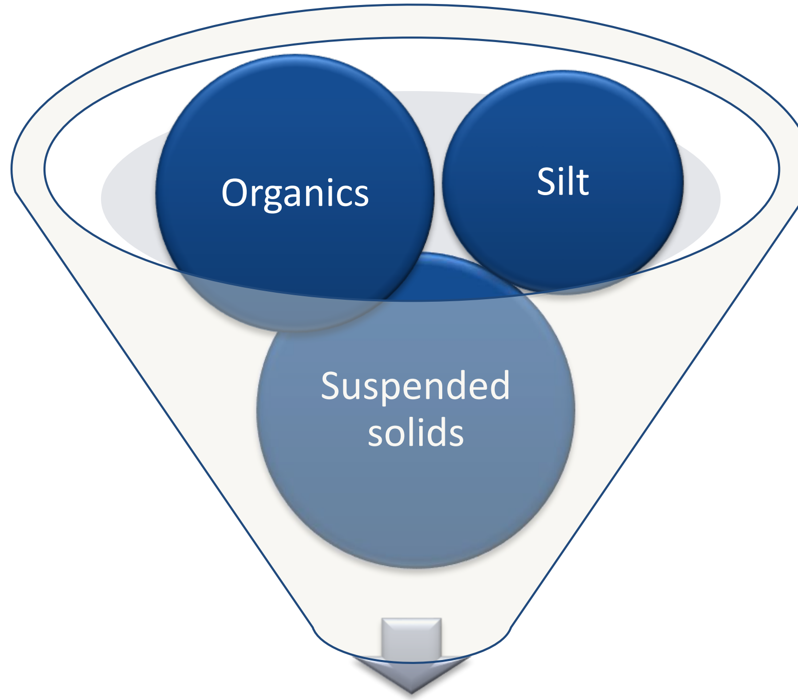
Softening

- Reduces scaling potential but increases need to manage corrosion rates
- Galvanic corrosion, or white rust, becomes very important to monitor as most systems have many different metallurgies (steel, copper, galvanized, etc.)
- Tight control of pH and alkalinity is necessary
- May enable higher cycles of concentration
- System should be modeled properly to determine ideal cycles of concentration based on potential salt concentrations

Side-Stream Filtration

Removes suspended solids and organics that contribute to fouling, and provides nutrients for bio-activity

Considered a best practice by many cooling system treatment specialists



Filtration down to 0.45 microns

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Automation/Control

System-wide monitoring and dosing

- Conductivity/ blowdown control
- pH
- Oxidation-reduction potential
- Real-time chemical monitoring and dosing
- Continuous corrosion monitoring
- Web-enabled reporting
- Alarm relays

System-Wide Monitoring and Dosing

Advantages	Disadvantages
• Chemical feed based on continual system monitoring of residuals • Remote access and web reporting • Scalable and programmable depending on location needs • Eliminates over-feed/under-feed conditions for treatment chemicals • Corrosion rates, scaling potential, and bio-activity can all be monitored • Alarm capability • Maximizes system cycles of concentration	• Capital cost • Doesn't eliminate routine operator testing requirements • Maintenance and calibration required • Some probes require routine replacement

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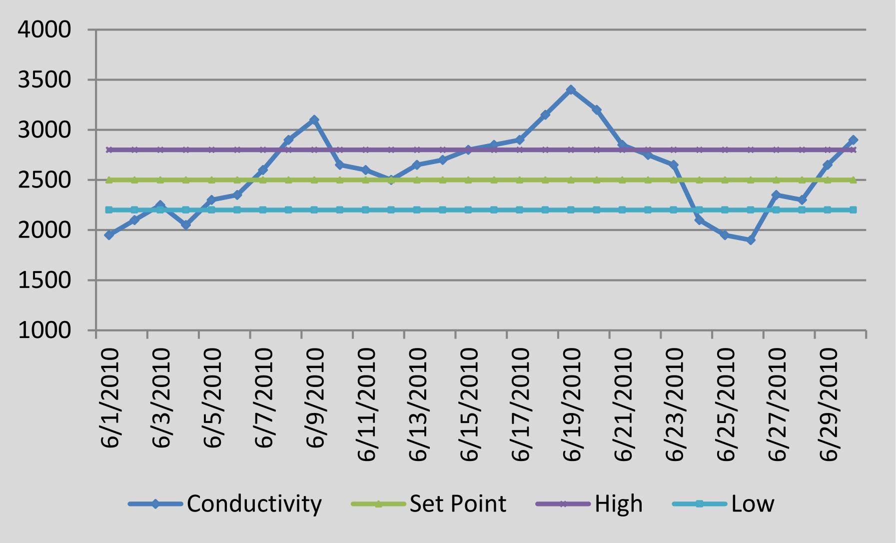
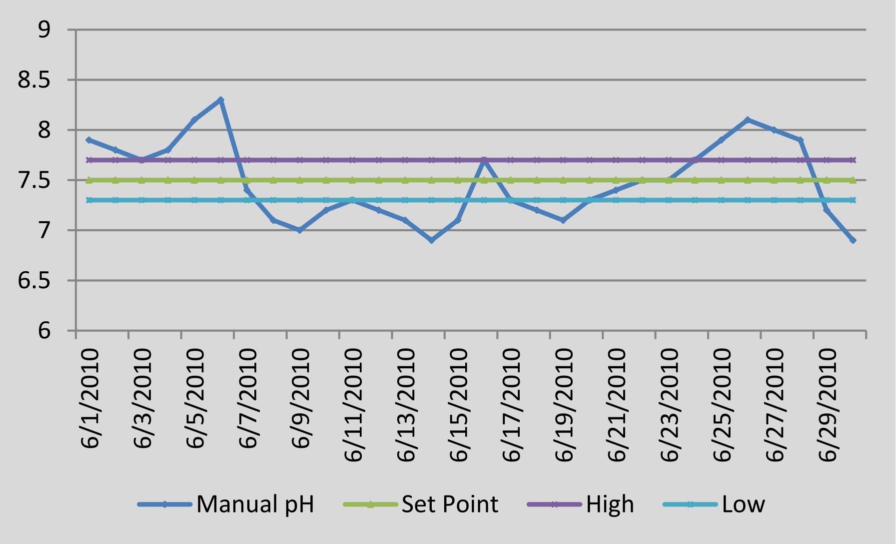
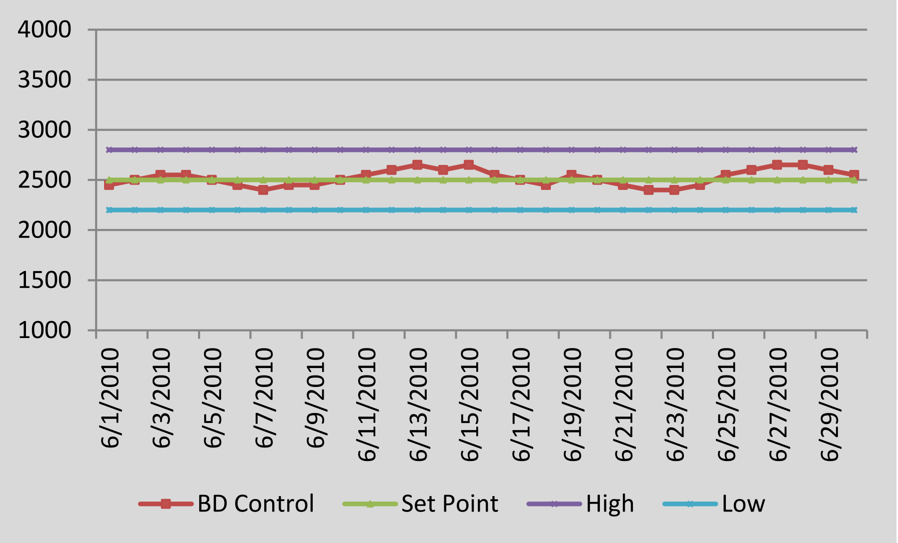
System-Wide Control Benefits

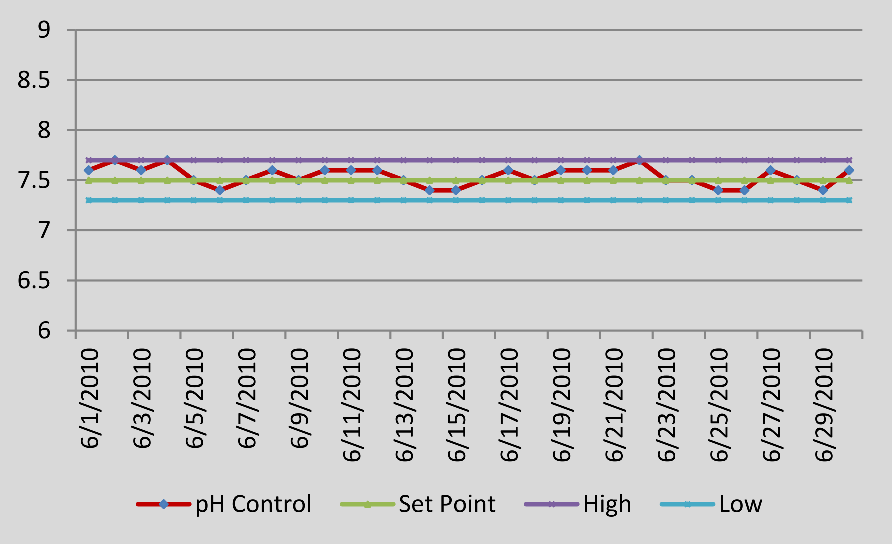
Manual Control





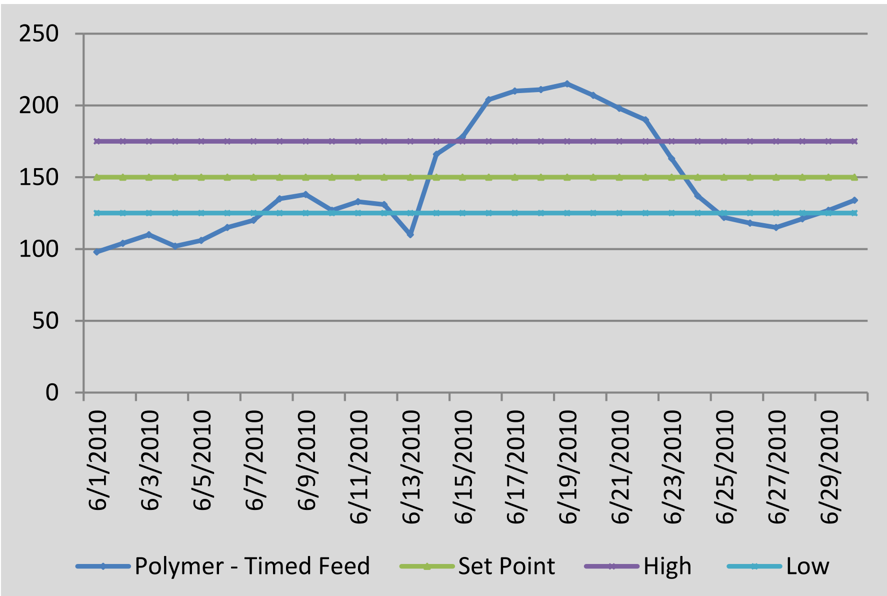
Automated Control





System-Wide Control Benefits

Manual Control



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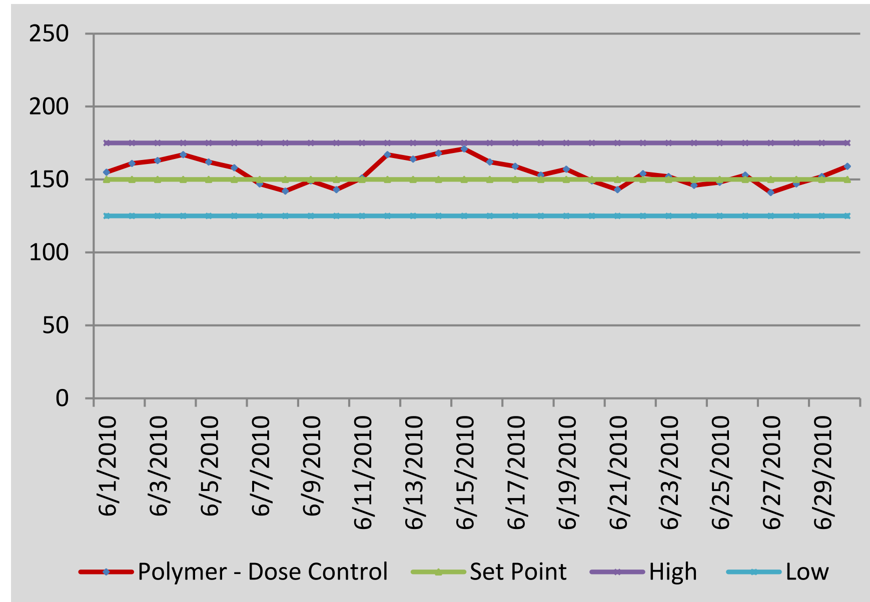

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Cooling System Control

Important questions to ask about the safety and operational conditions of your cooling tower system

- Do you have O&M and EH&S procedures in place?
- Is your system running efficiently?
- What are the limiting factors?
- What is your treatment program?
- What are the operational hazards?

Optimal operation of cooling water systems depends on three things

- **Mechanical** integrity of system components
- **Operational** control of system variabilities
- **Chemical** control of critical system parameters and treatment programs

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Conclusions

Cooling towers are dynamic systems

Operational and maintenance challenges include corrosion, fouling, scale, and microbiological growth

These challenges are inter-related

Understanding and managing these challenges is critical for efficient and safe operation

Questions?

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