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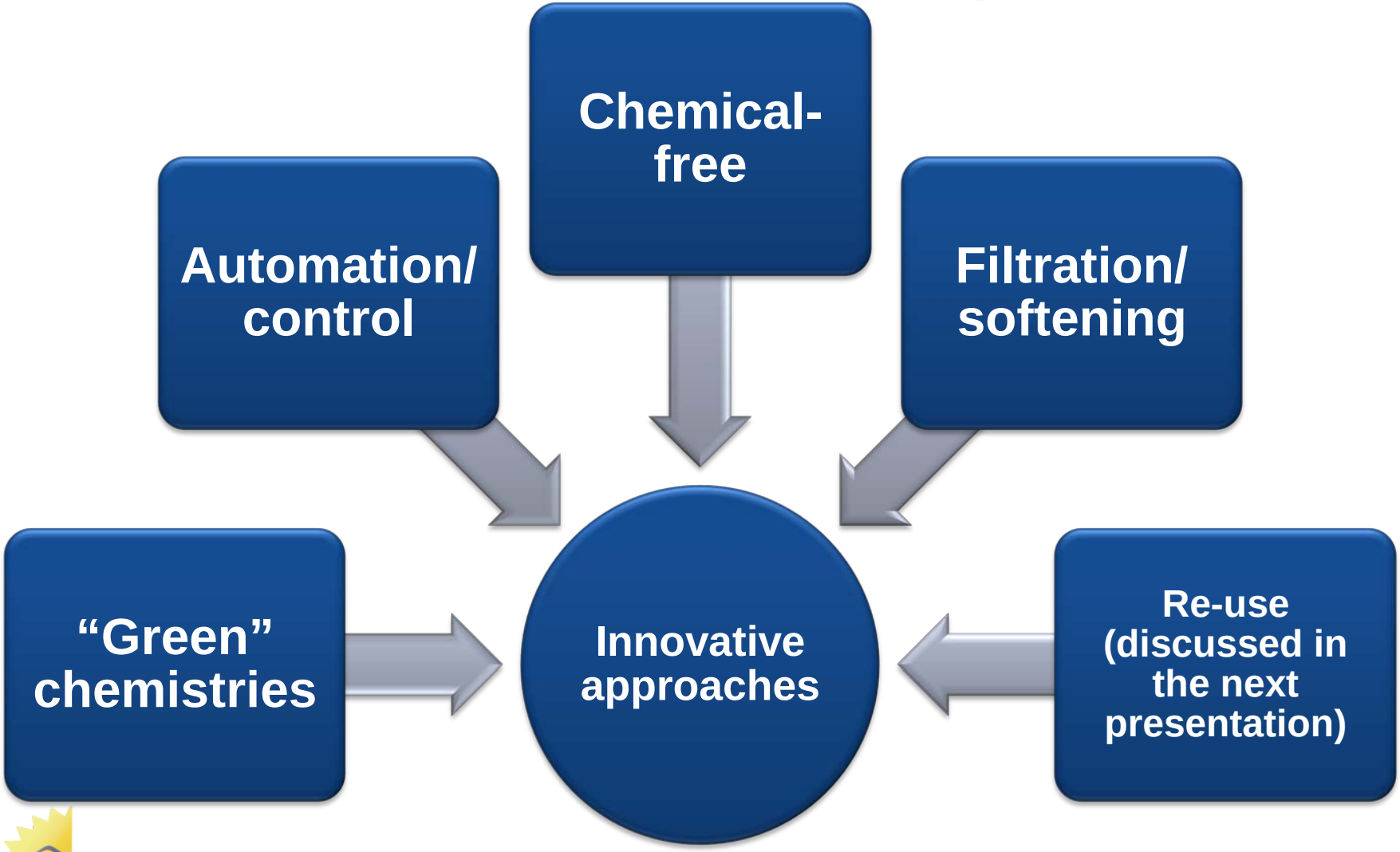
· August 15-18, 2010 · Dallas, Texas ·
· Dallas Convention Center ·

Innovative Approaches To Cooling Tower Water Management

Brian Boyd
Pacific Northwest National Laboratory

Tower Treatment Options



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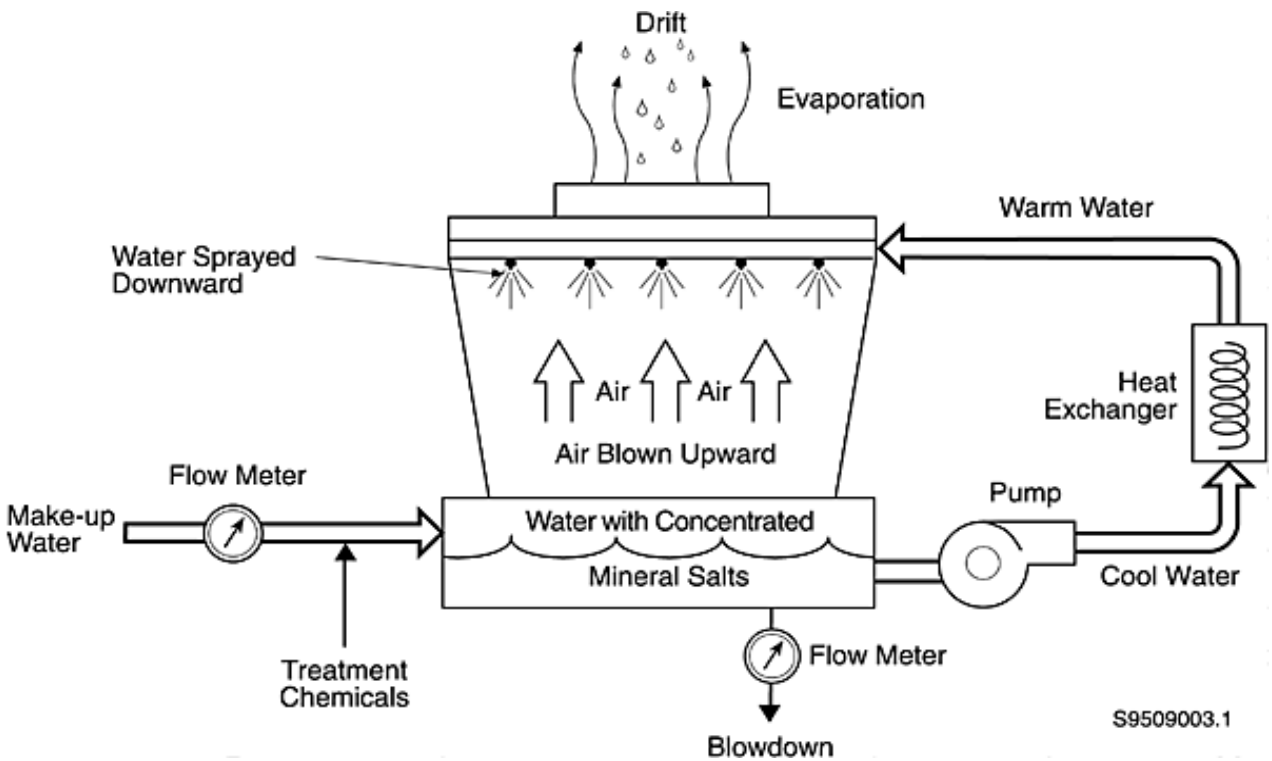
Cooling Tower Overview



Open recirculating systems are open to the atmosphere at the tower. As the 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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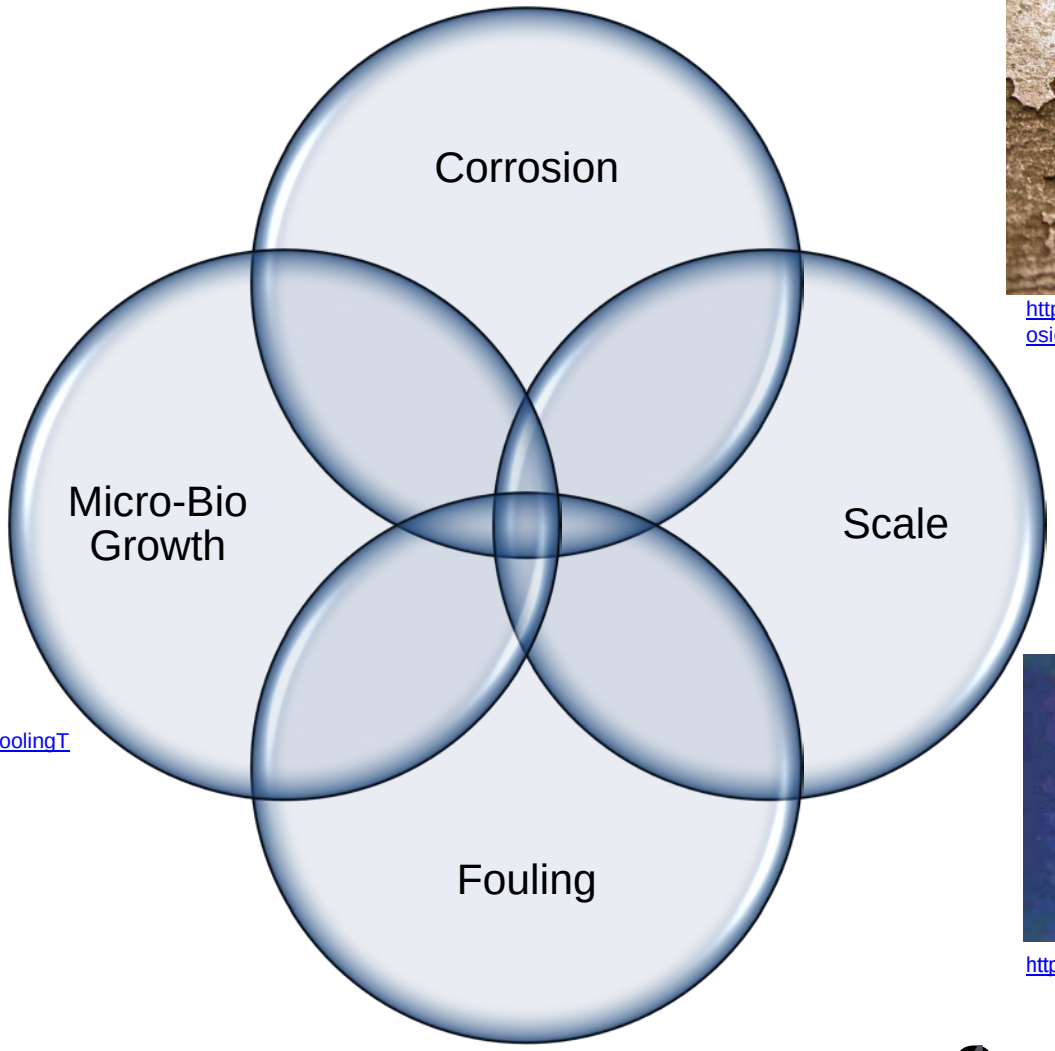
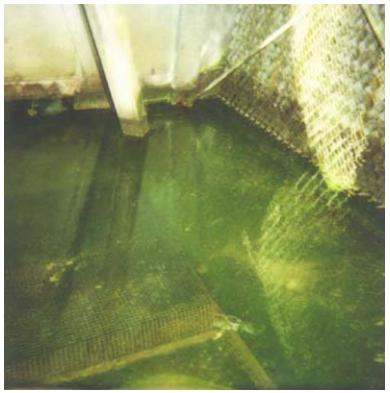
Cooling System Concerns

http://www.bushman.cc/photos/MIC_Corrosion_on_Heating_Oil_Tank.jpg

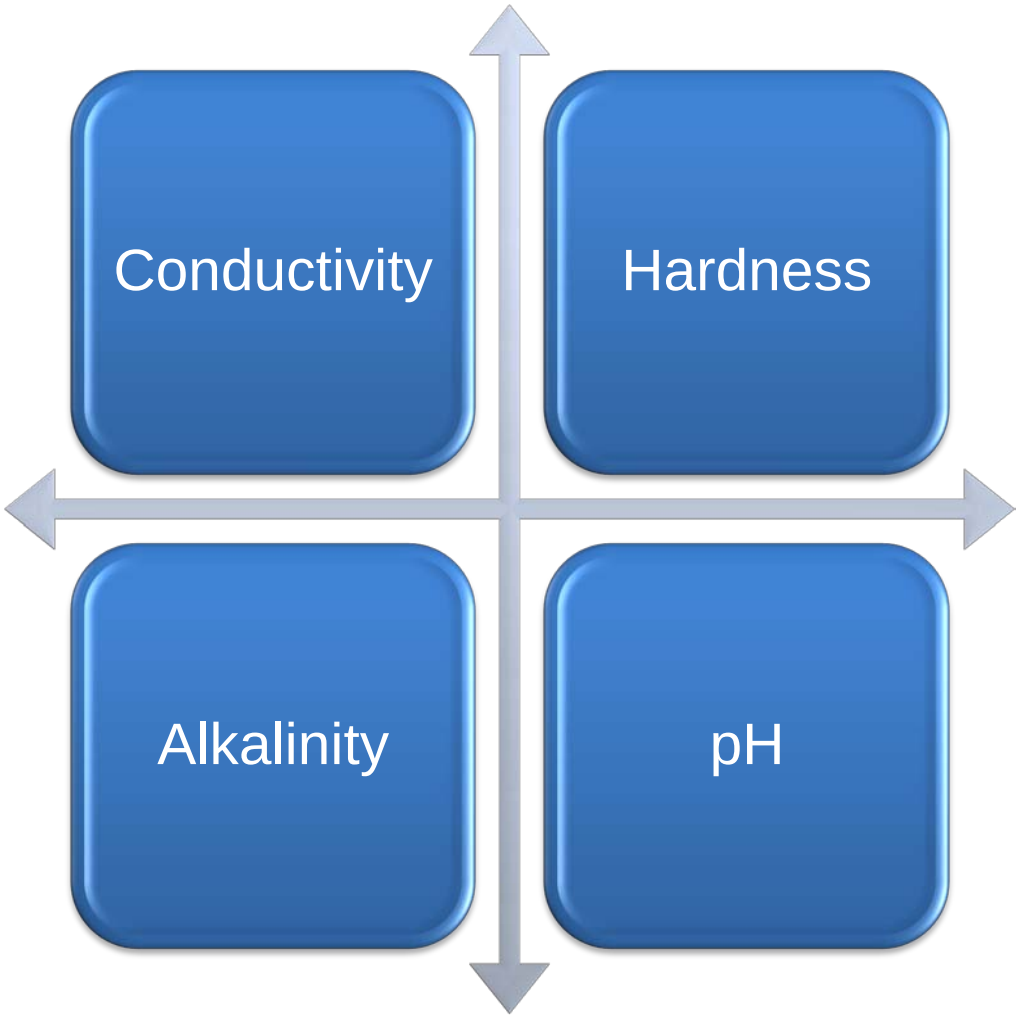




http://www.cascadewater.com/images/CoolingTowerAlgae.jpg

http://petroleumsoft.no/ESW/Images/scale.jpg

Important Properties of Water



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Hardness

Amount of Calcium & Magnesium Present

- Hardness reacts with other minerals such as carbonate alkalinity, phosphate, & sulfate
- Tendency to come out of solution & form hard deposits in heat exchangers
- Ca/Mg inversely soluble with temperature
- Potential for hardness deposition affected by alkalinity levels

http://petroleumsoft.no/ESW/Images/scale.jpg

Alkalinity

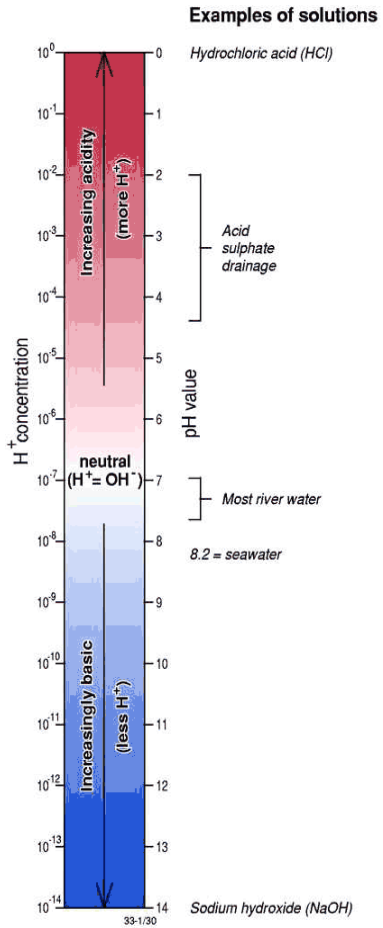
Carbonate & Bicarbonate

- 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 critical to cooling system operation

Low pH: Corrosion

High pH: Scale

http://www.bbc.co.uk/schools/gcsebitesize/science/images/sci_dia_39.gif

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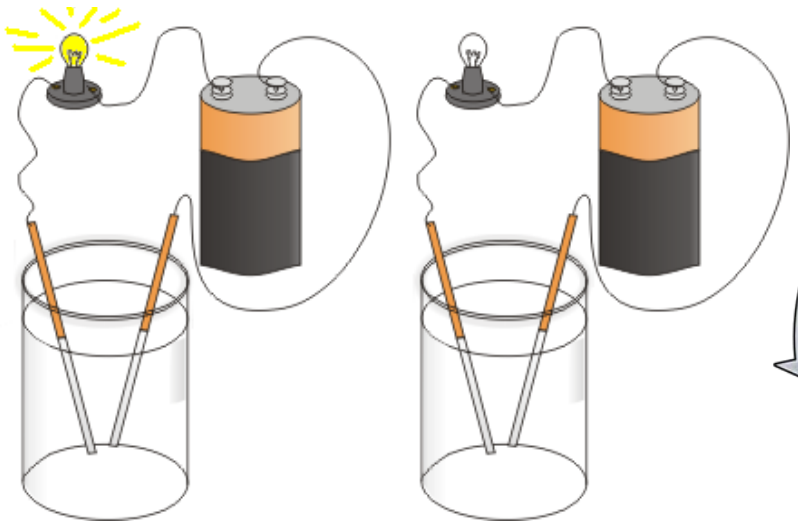
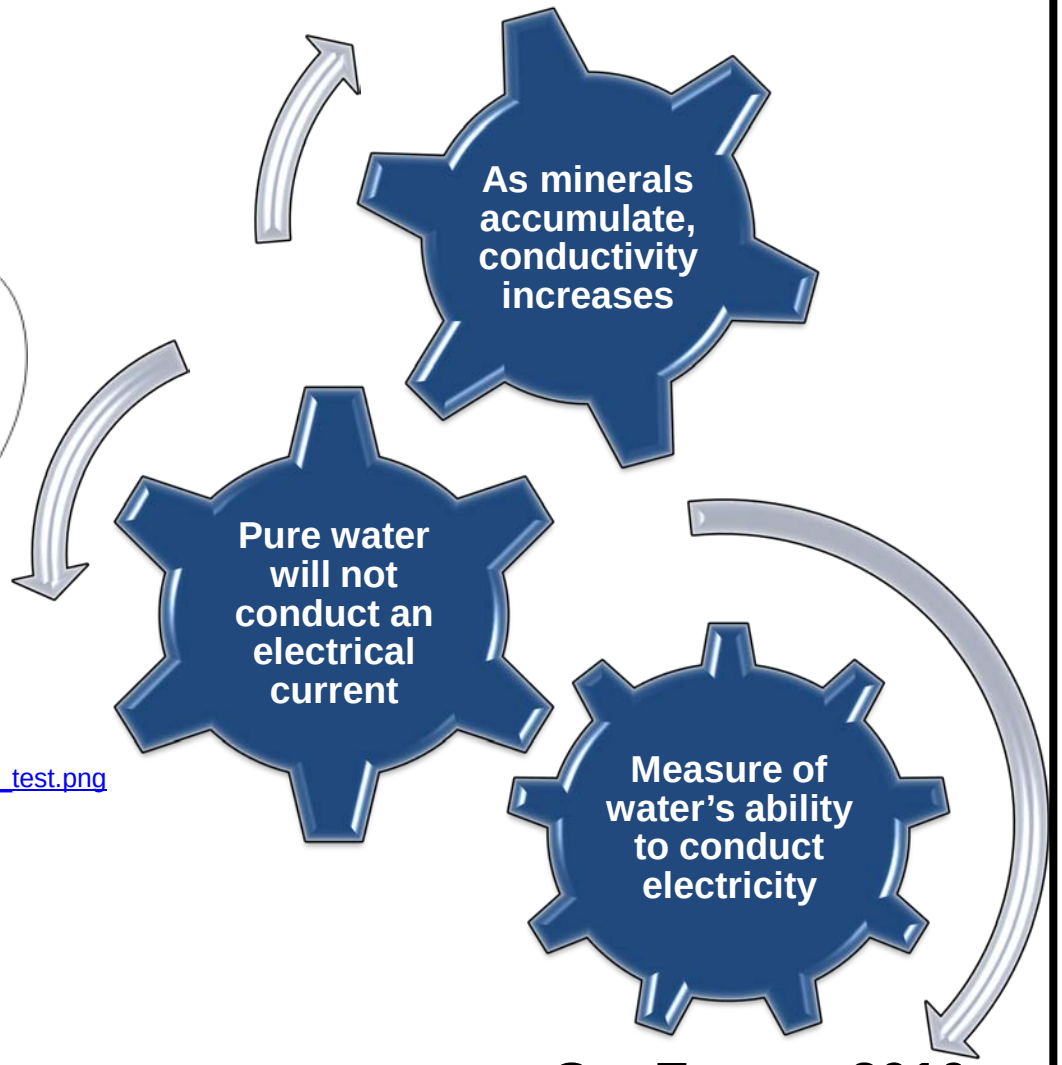
Conductivity

Distilled water with salt

Pure distilled water



http://www.cdli.ca/courses/sci1206/unit03_org02_ilo06/conductivity_test.png



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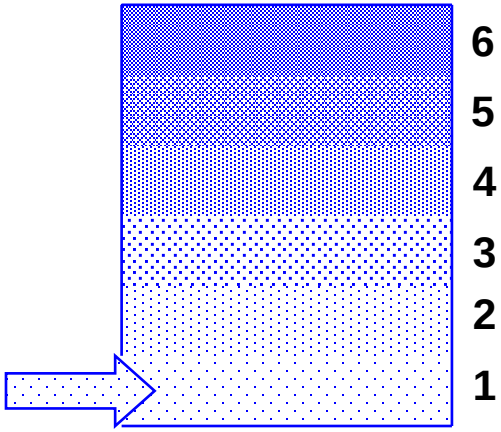
Concentration of Dissolved Solids



Only pure water can evaporate

No dissolved solids leave the liquid water

Dissolved solids build up in recirculating water

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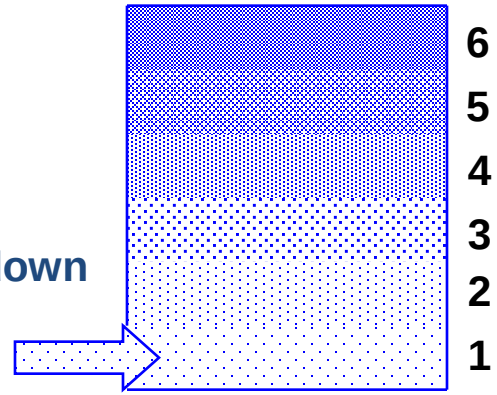
Impact of Blowdown on Cycles of Concentration

Constant Evaporation

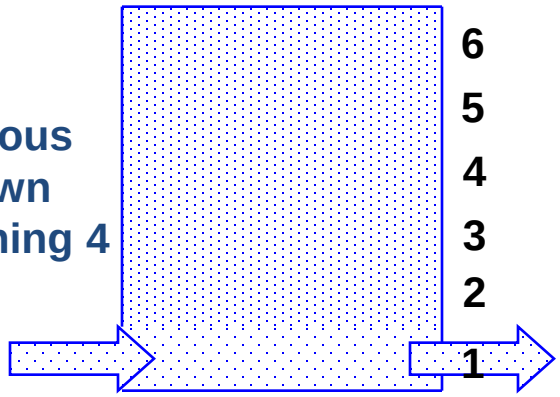
With Zero Blowdown



Mineral scale will form if the dissolved solids concentration in the cooling water becomes too high

Constant Evaporation

With Continuous Blowdown Maintaining 4 Cycles



Blowdown: Deliberate discharge of water to prevent the dissolved solids from getting to high

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Cooling System Water Modeling

WaterCycle® version 7

Capabilities	Features
• Scale prediction • Corrosion modeling • Product input formulation • Dosage optimization	• High powered ion association model • Advanced saturation index • Outstanding visual aids • Presentation/report quality printouts

http://www.frenchcreeksoftware.com/watercycle/index.aspx

“Green” Chemistries

Corrosion Inhibitors

- Polysilicates – used for many years in potable water systems

Dispersants

- Polyaspartic Acid

Biocides

- Hydrogen Peroxide
- THPS - tetrakis(hydroxymethyl)phosphonium sulfate (1997 EPA Green Chemistry Award Winner)

Automation/Control

Blowdown controls

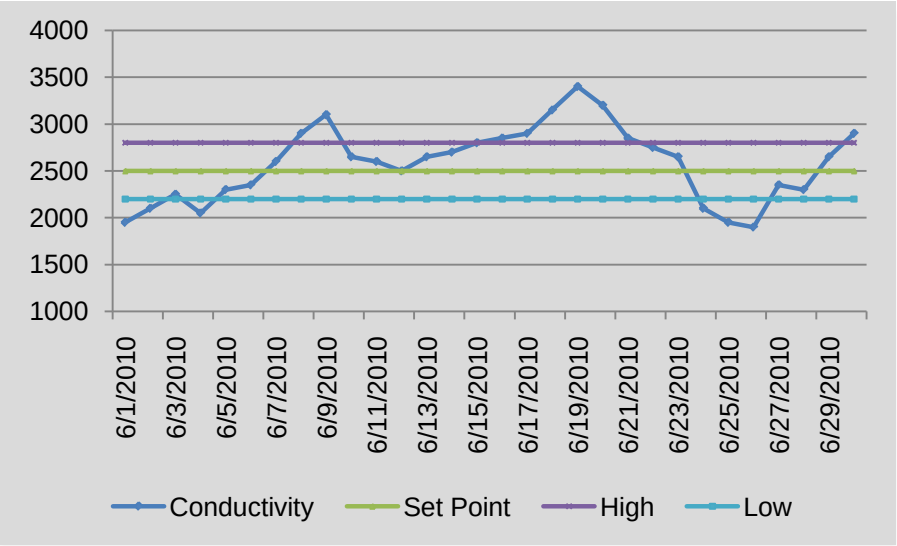
Conductivity control	Chemical dosing	Water meter inputs	Alarm relays

http://www.prominent.us/desktopdefault.aspx/tabid-2168/244_read-4486/

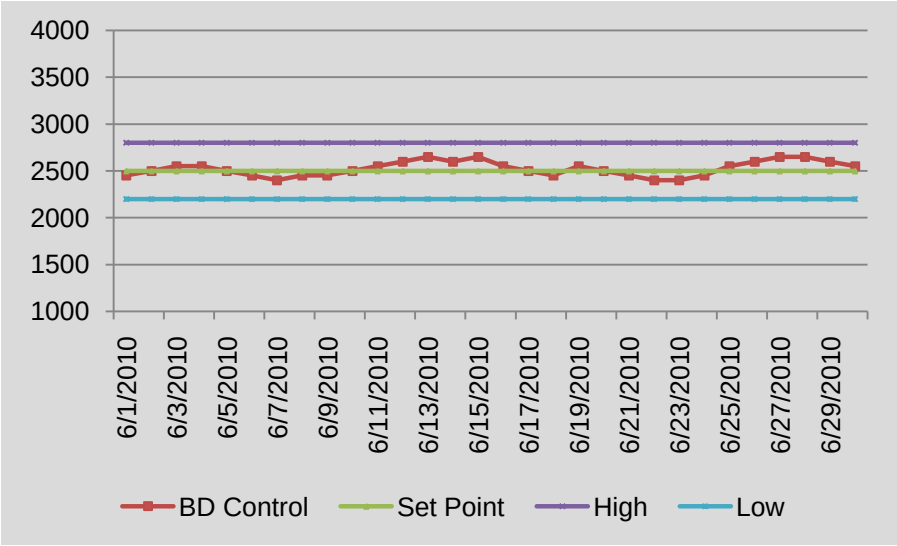
http://www.walchem.com/products/controllers/wct400.htm

Blowdown Control Benefits

Manual or Timed Blowdown



Conductivity Set-point Blowdown



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Blowdown Control Benefits

Advantages

- Optimizes cycles of concentration
- Reduces the likelihood of scaling and/or corrosive conditions
- Minimizes excessive blowdown

Disadvantages

- Requires calibration and occasional maintenance
- Doesn’t eliminate routine operator testing

Automation/Control

System-wide monitoring and dosing

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

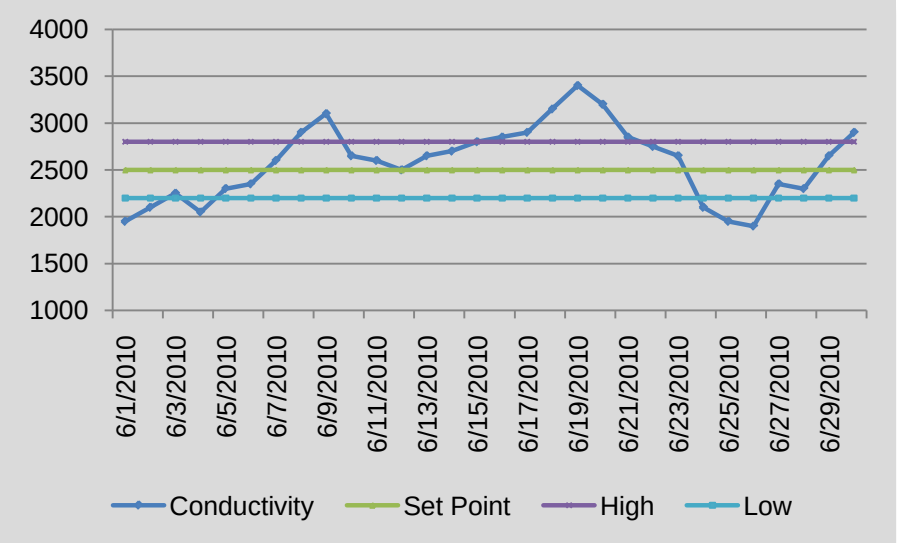
http://www.gewater.com/products/equipment/chemical_feed_equip/pacesetter_platinum.jsp

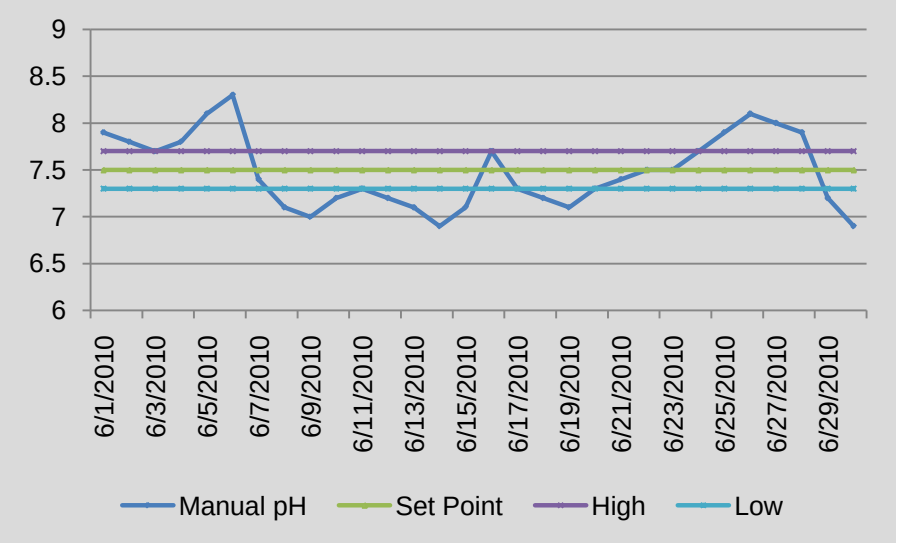
http://extranet.nalco.com/asp/services/applied/trasar/Trasar_Cooling.asp

2008 EPA Green Chemistry Award Winner

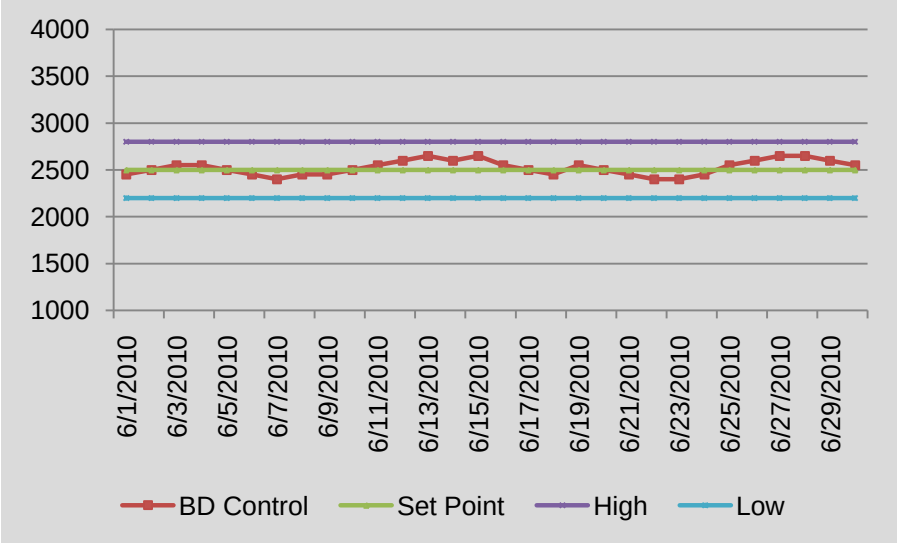
System-wide Control Benefits

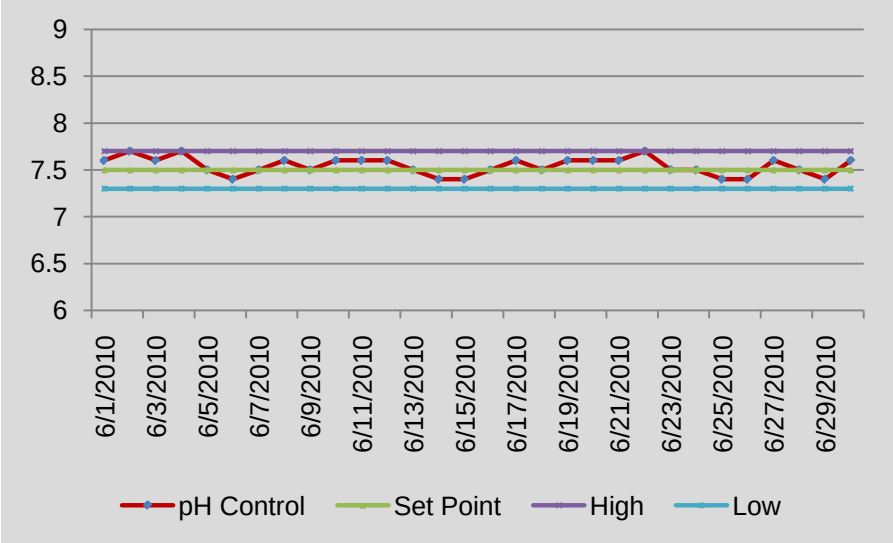
Manual Control





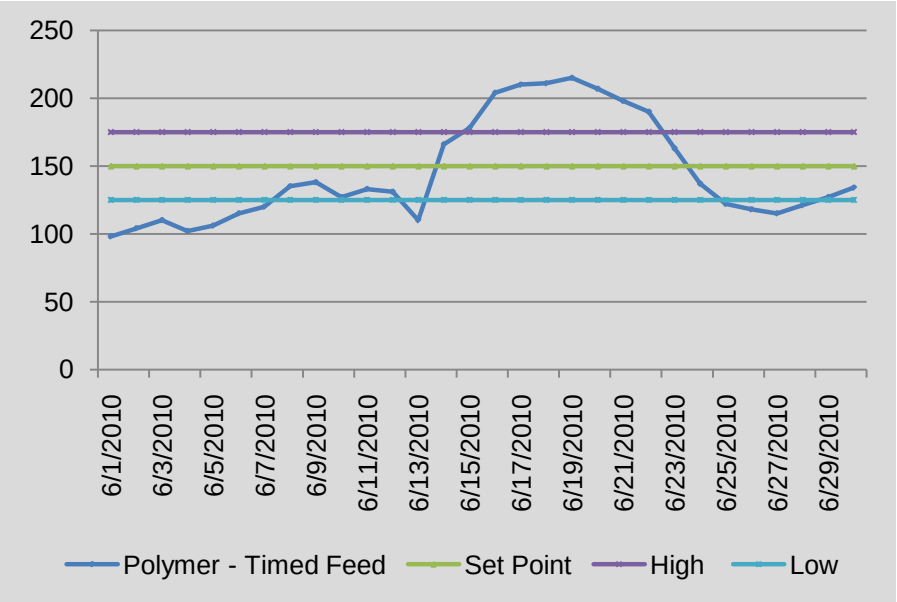
Automated Control



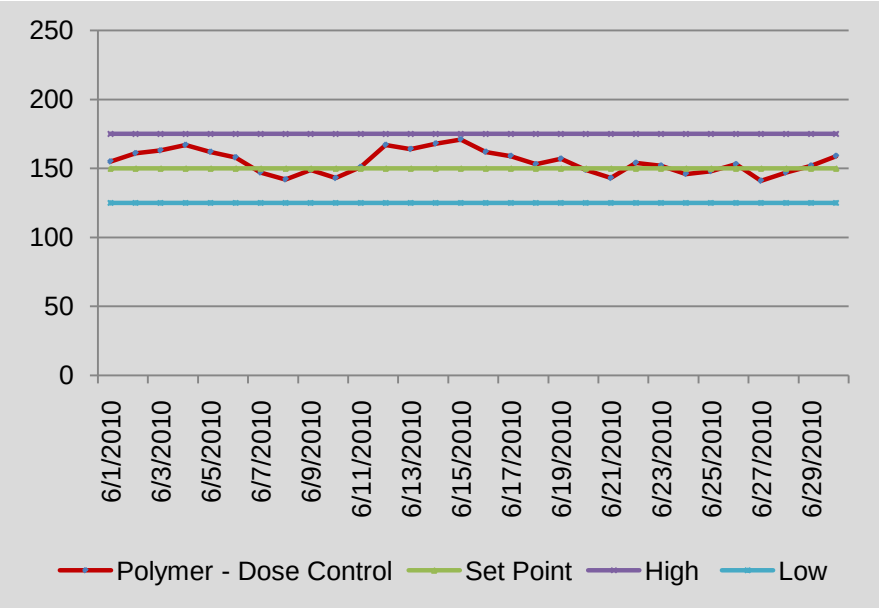


System-wide Control Benefits

Manual Control



Automated Control



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System-wide Monitoring and Dosing

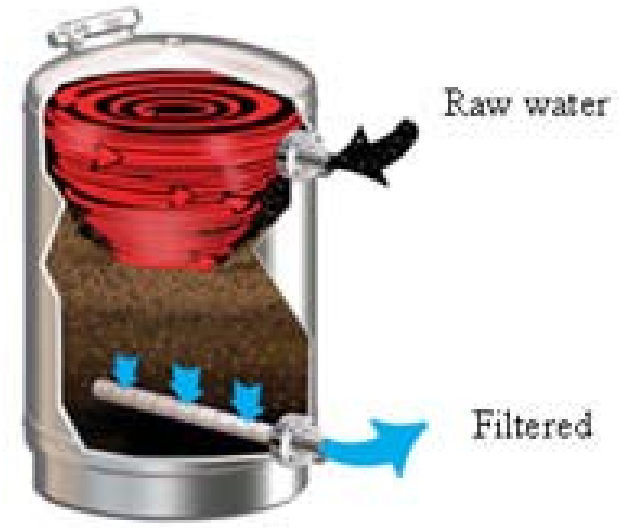
Advantages

- Chemical feed based on continual system monitoring of residuals
- Remote access and web reporting capabilities
- 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

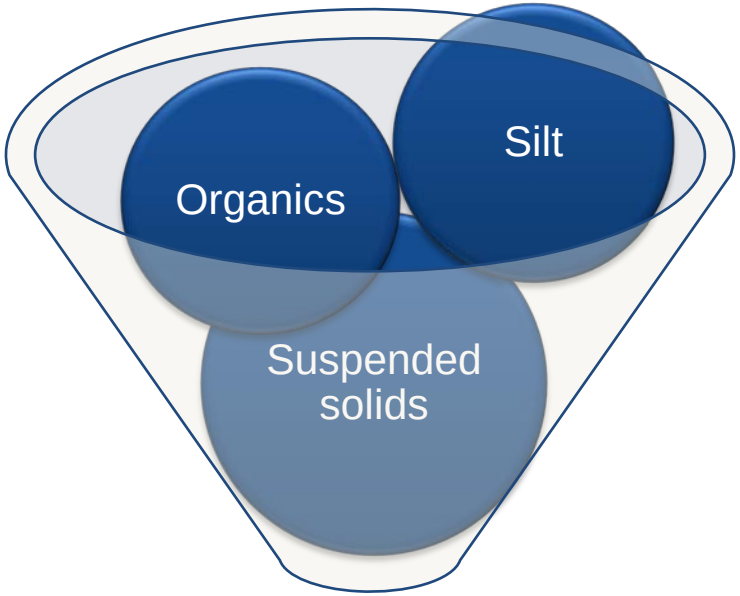
Disadvantages

- Capital cost
- Doesn't eliminate routine operator testing requirements
- Maintenance and calibration required
- Some probes require routine replacement

Side-Stream Filtration

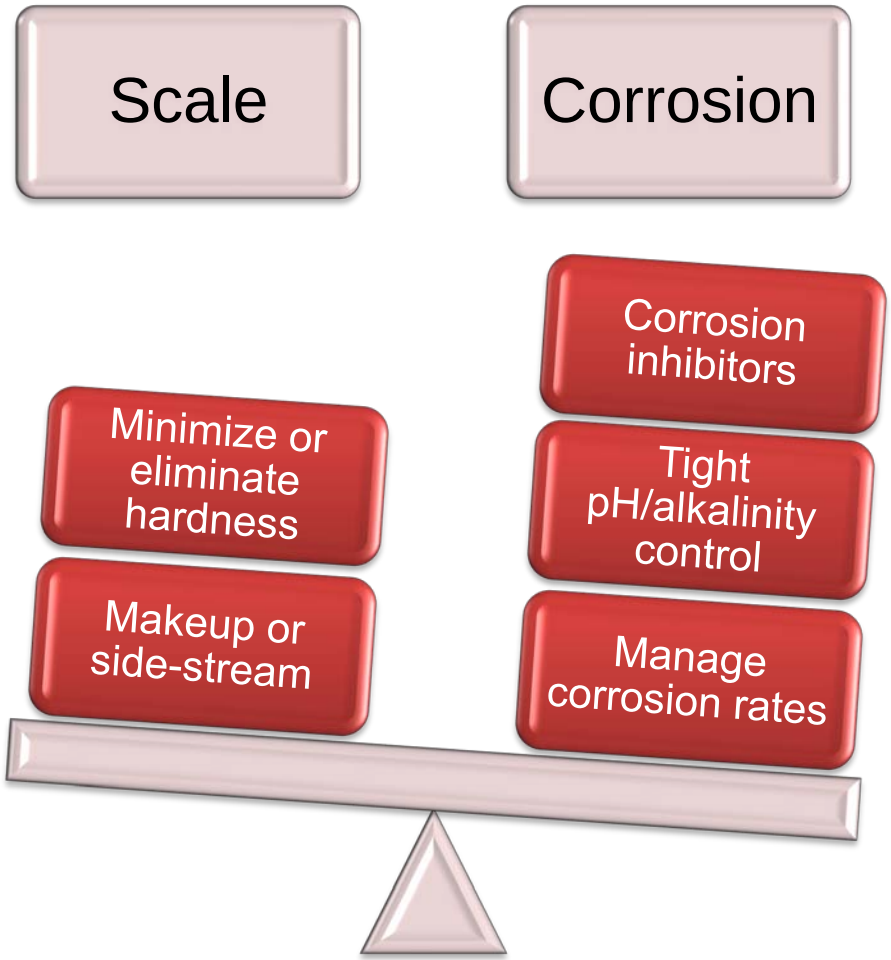


http://www.vortisand.com/en/sandfiltration/vortisand_features.php



Filtration down to 0.45 microns

Softening



http://www.culligandealer.com/nyc/sidestream.html

Chemical-free Treatments

Ozone

Advantages

- Flexible across a broad pH range
- Low operating costs
- No biological resistances
- No undesirable by-products
- On-line measurement capability

Disadvantages

- Short half-life
- Low solubility in water
- May not affect sessile bio-growth

http://www.prominent.us/desktopdefault.aspx/tabid-2102/156_read-2225/

Chemical-free Treatments

Ultraviolet Disinfection

Advantages

- Flexible across a broad pH range
- Low operating costs
- No undesirable by-products

Disadvantages

- “Point” disinfection, no residual
- No cell removal
- Specific flow requirements

http://www.veoliawaterst.com/processes/repository/2543,uvstarnew.jpg

Chemical-free Treatments

Electro-magnetic Platforms

Electric field passes through the flow of water

- Creates a “seeding” mechanism for dissolved minerals
- Microbe cell walls are damaged by pulsed currents
- Corrosion is maintained naturally

Pulse~Pure

NEW! P-14 & P-16 Models Included

http://www.dolphinwatercare.com/dolphinworks.aspx

http://www.evapco.com/whatsnew.asp?WN_ID=13

Chemical-free Treatments

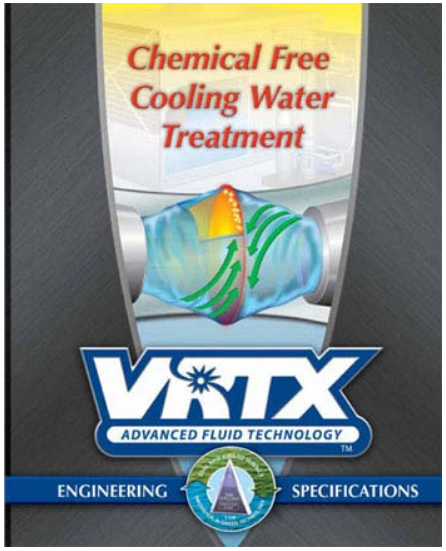
Hydrodynamic Cavitation

Mechanical collision and pressure variation applied to opposing streams of system water

Creates a "seeding" mechanism for calcium carbonate (calcite)

Microbe cell walls are ruptured in the cavitation process

Low pressure zone strips the water of CO2, maintaining alkaline conditions and elevated pH to control corrosion



http://www.vrtxtech.com/pages/specs.html

Chemical-free Treatments

Advantages

- Eliminates or reduces the need for treatment chemicals
- Many platforms have been available for some time and had successful trials/case studies
- Promise single-platform control over all cooling system parameters
- Perception

Disadvantages

- Capital cost
- Doesn't eliminate routine operator testing requirements
- Some concerns surrounding certain water quality and operational limitations
- "Point" treatment, rather than system-wide residuals

Questions?

Brian Boyd

Pacific Northwest National Lab

Brian.Boyd@pnl.gov