LEADER IN COMPLETE WATER TREATMENT SOLUTIONS

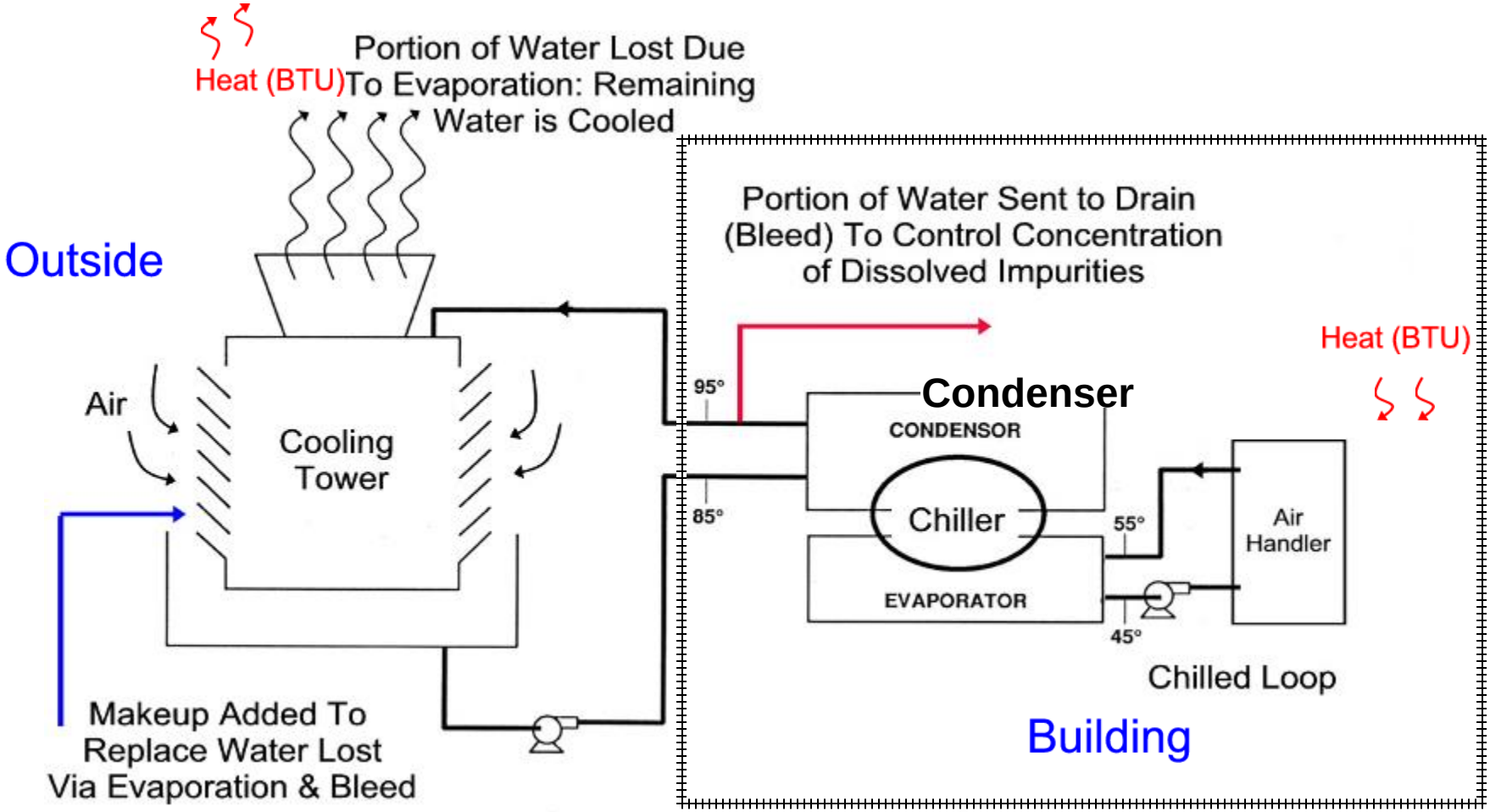
Waterside Problems
with
HVAC Systems

ASHRAE -Tennessee Valley Chapter
Chattanooga, TN

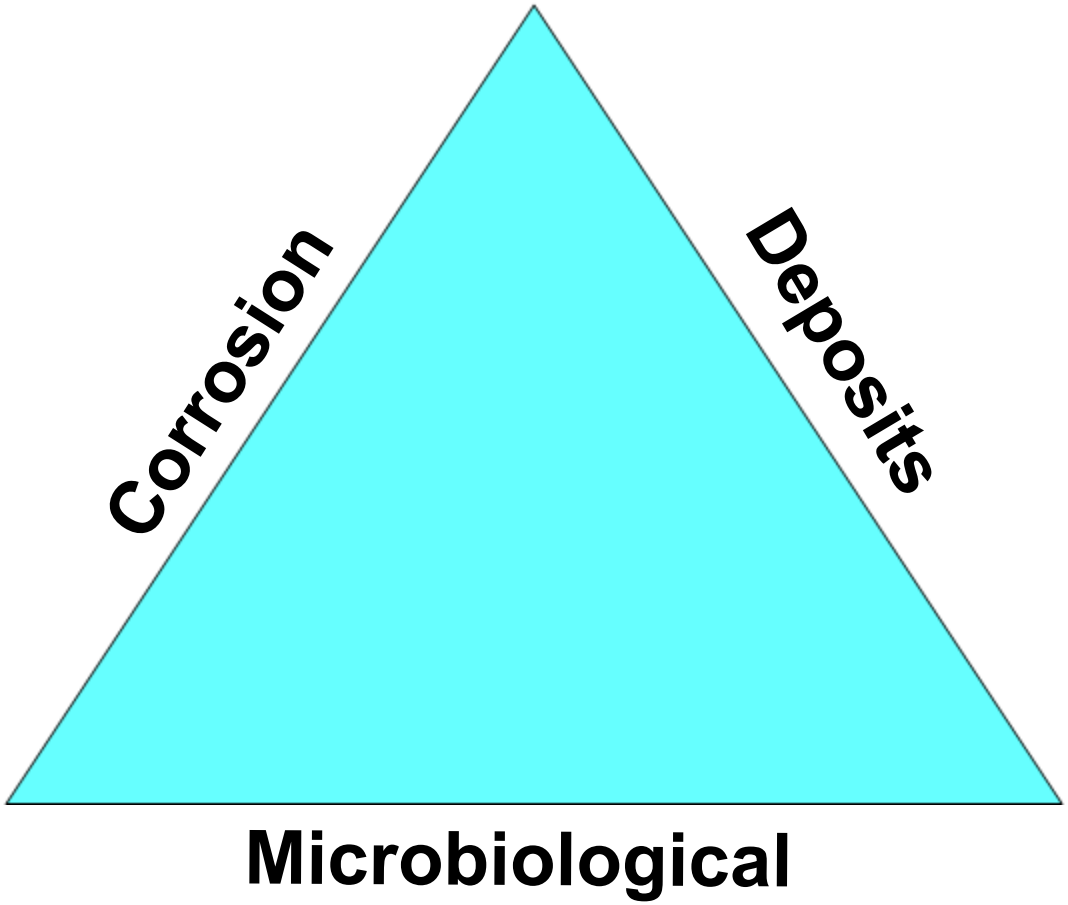
January 5, 2022

Dan Weimar
Senior Corporate Engineer

Typical Water Cooled A/C System

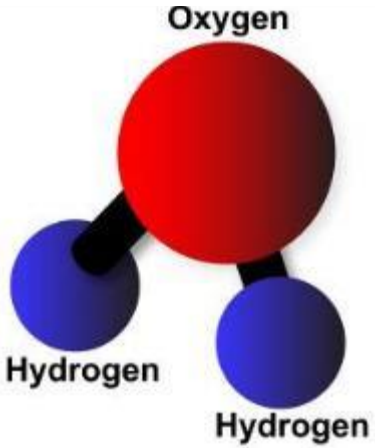


Challenges w/ Cooling Water Systems



Water

- Water has several properties that make it an excellent heat transfer medium
  - Safe
  - Relatively available and inexpensive
  - High heat capacity (can absorb or release more heat per °F than virtually any other common substance)

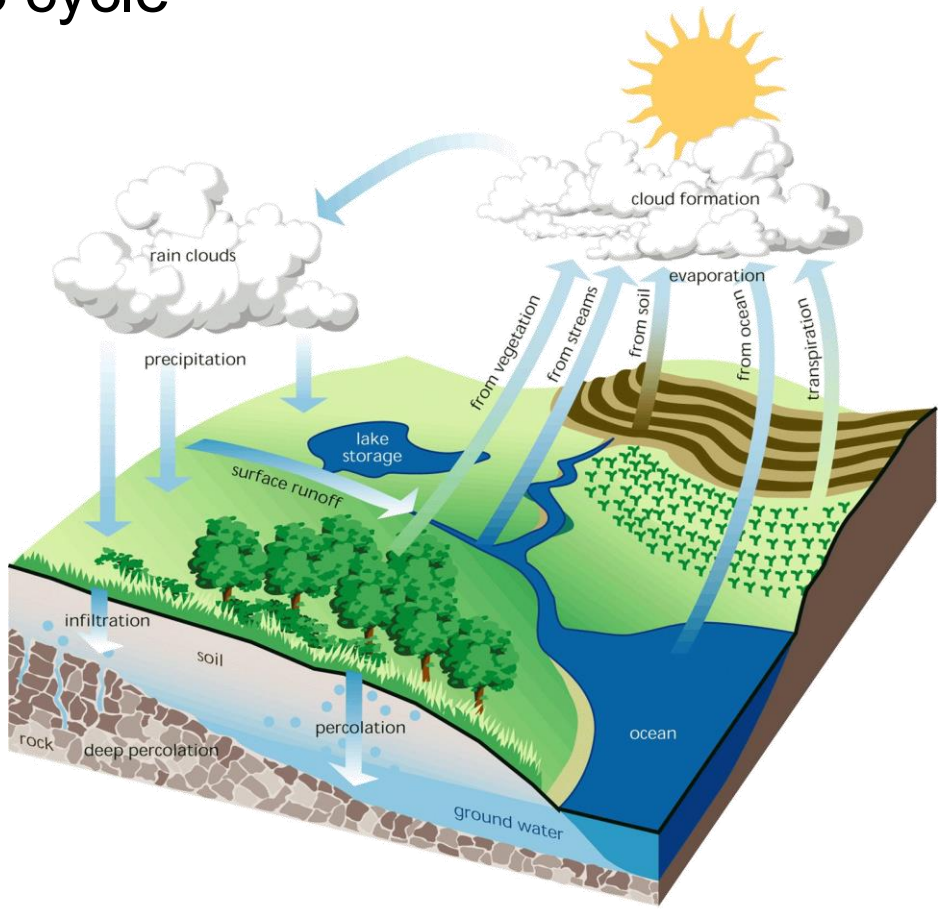


The Universal Solvent

- Water is known as a “universal solvent”
- Water has the ability to dissolve to a certain extent almost every substance found in nature
- It’s the impurities in water that cause corrosion, deposits, and related problems
- Rain water is water in its purest form
  - It’s condensed water vapor (no impurities)
  - But rain water doesn’t stay pure for very long

The Hydrologic Cycle

- The problem causing impurities in water are picked up as it goes through the “hydrologic cycle”
  - Dissolved gases
  - Dissolved solids
  - Suspended solids
- Water quality varies widely depending on geography
- Water quality can change
- over time



Effective Water Treatment Helps

- Maximize cooling system
  - Life
  - Efficiency
  - Reliability
  - Safety

- Minimize total operating costs
  - Energy, water, chemical, maintenance, and labor

*****Water Treatment is an important part of your preventative maintenance program**

An Effective Water Treatment Program Must Address All Three!

- Corrosion
  - Destroys system metals
  - Contributes to deposits

- Deposits
  - Reduce heat transfer efficiency
  - Increase energy costs
  - Causes under-deposit corrosion

- Poor Microbiological Control
  - Causes corrosion, deposits and increases potential for disease

Number One Cause of Corrosion

Bacteria

Waterside Corrosion

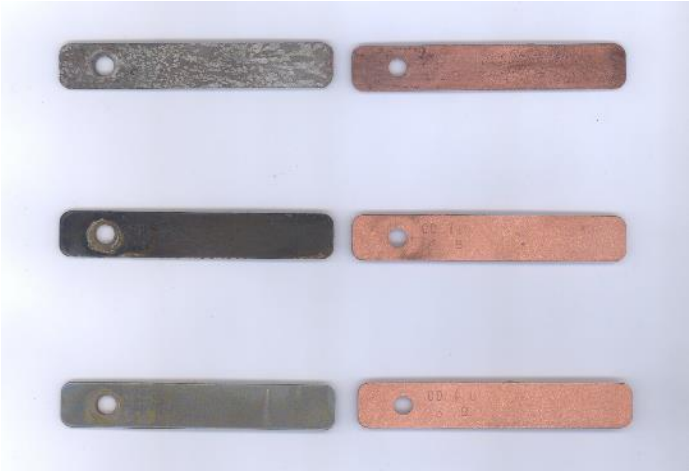








Monitoring Corrosion



Corrosion Coupons

Corrosion Coupons Racks

Monitoring Corrosion

Testing for iron levels in the cooling tower water is easy, quick and inexpensive

Ways To Control Corrosion

- Corrosion resistant materials of construction
  - Expensive up front, but equipment lasts much longer
- Balancing corrosive/scale forming tendencies by maintaining proper cycles (bleed)
- Good deposit and microbiological control
- Use of corrosion inhibitors
  - Proper inhibitors for conditions
  - Maintain inhibitor levels in desired range

Scale Deposits

- Mineral scale
  - Calcium carbonate
  - Other impurities
  - Watch for low flow!
  - Usually forms on heat exchange surfaces

- Most deposits are mixtures
  - Mud, silt, rust, slime, etc.
  - All can be termed “fouling”
  - Some deposits more insulating than others

Calcium Carbonate and Slime Deposit in Condenser Tubes

Why Scale Is Bad

- Fouled condenser surfaces do not cool the hot refrigerant gas as efficiently as clean surfaces
  - Refrigerant temperature will be higher than design
  - Refrigerant pressure must be increased so that it will condense at the higher temperature
  - Requires compressor to work harder
- The compressor is designed to work at a certain condensing temperature and pressure for a given load
  - Condensing pressure is also called head pressure
  - If the temperature is high, the head pressure will be high

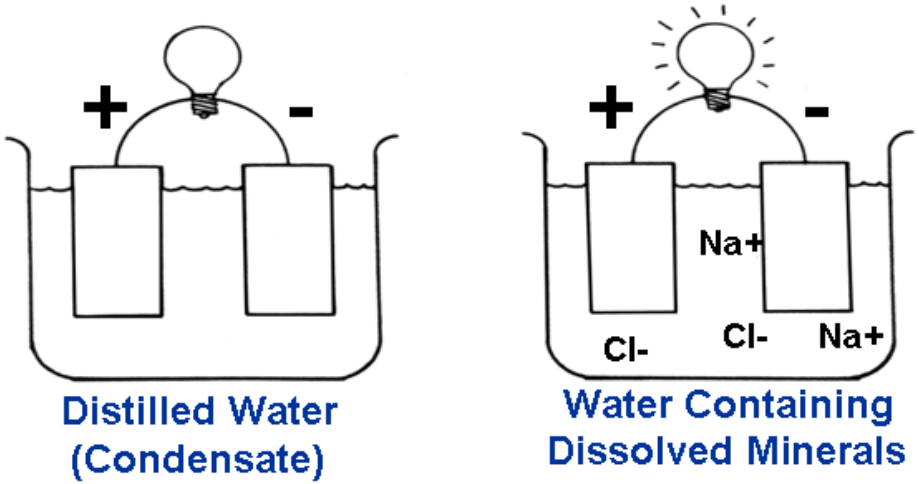
Scale Deposits

Factors That Influence Scale Formation

- High dissolved mineral concentration due to insufficient bleed
- Low flow
- High temperatures
- Low inhibitor level
- Suspended solids

Conductivity

- Measures ability of water to “conduct” an electrical current
- Used to estimate total dissolved solids (TDS) content
- Higher the conductivity, greater the dissolved solids content
- Conductivity increases as the dissolved minerals “concentrate” inside a chiller/cooling tower



Scale Control Methods

- Limit the concentration of the scale forming minerals through good bleed control
- Make changes to the system design to modify flow and/or temperatures
- Keep the system clean
- Apply chemical scale inhibitors
  - Extend the solubility of problem impurities
  - Keep solids from forming adherent deposits

Keys To Effective Microbial Control

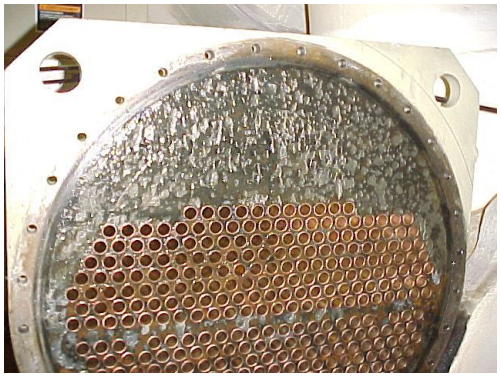
System Design
and Operation

Cleaning and
Disinfection

Biocide
Additions

Biomonitoring

Microbiologically Influence Corrosion (MIC)



Poor Microbiological Control

- Corrosion and metal failure
- Fouled heat exchanger surfaces energy costs
- Legionnaires' disease
- System downtime
- High maintenance costs

Millions of dollars due to reduced life, efficiency, reliability, and safety

Biofilm and Biofouling

- Bacteria produces a gelatinous substance called a biofilm
  - “Slick” feel
  - Highly insulating
  - May not even be visible
- Protects microorganisms from biocide additions
- Biofouling occurs when biofilms trap dirt, sediment, fibers, bugs, corrosion by-products, etc.
- Biofilms or biofouling is normally called “slime”
- It is associated with *Legionella* bacteria

Enhanced Chiller Tubes

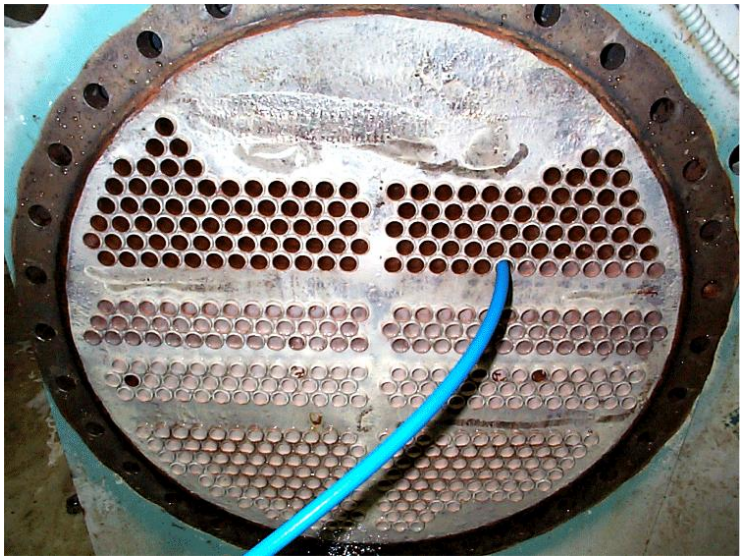
- Evaporator and condenser, a shell and tube HX
- Enhanced copper HX tubes typically used
- Also called rifled tubes
- Ridges and valleys
  - Increase turbulence
  - Increase surface area
  - Increase heat transfer
- Increase potential for corrosion & deposits
- Super enhanced – ridges very close together

Controlling MIC (Microbiological Influenced Corrosion)

- Every drop of water in the system should see a non-oxidizing biocide weekly – managed with your building's automation System
- An oxidizing biocide (i.e. chlorine) residual when in operation
- That may mean three times per week applications to comply with ASHRAE 188, a Standard that establishes minimum risk management requirement or building with complex water systems. (Legionaries' Disease)
- ASHRAE Guideline 12 is a Guideline, which can be viewed as voluntary guidance and supplementary material

Cost of Poor Water Treatment

- 500 ton cooling load
- Efficiency loss due to 0.01” biofilm in condenser tubes = $51,219 per year in increased electricity costs! *
- Fouling also increases
  - Potential for corrosion
  - Potential for Legionnaires’ disease
  - Maintenance costs
  - Potential for unexpected shutdown and failure



*** Based on a <u>average</u> chiller efficiency of 0.75 kW/ton & electricity cost of $0.06 kW-hr.**

Any Questions?

Thank you !

dan.weimar@chemaqua.com