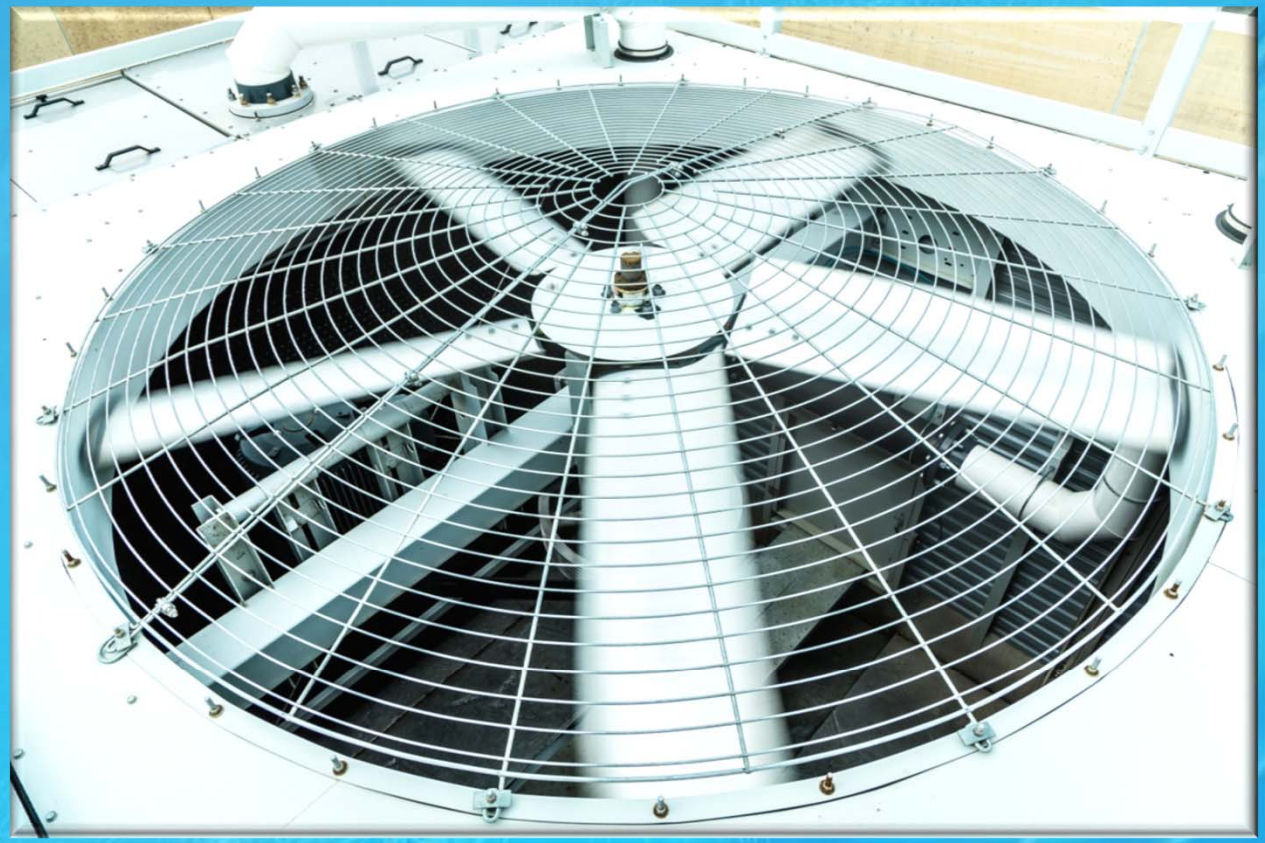
Wisconsin Healthcare Engineering Association
Water Treatment Lunch and Learn



Scale and Deposition are Often the First Problem Associated With Tower and Refrigeration Systems

Scale and Deposition Occur Due to Chemical and Mechanical Reasons

- **Potential Causes**
  - Poor control of scale control and/or pH chemistry
  - Running Dissolved Solids Too High (High Conductivity)
  - Softener Malfunction
  - Bleed Valve Plugged
  - No Filtration/ Wrong Filtration
- **Operational Impact**
  - Decreased Cooling Capacity
  - Increased Energy Costs
  - Under Deposit Corrosion Risk Increased
  - Sludge Provides “Hide Out” for Pathogenic and System Destroying Bacteria

Myth # 1- Scale In My Condenser System Is My Biggest Concern

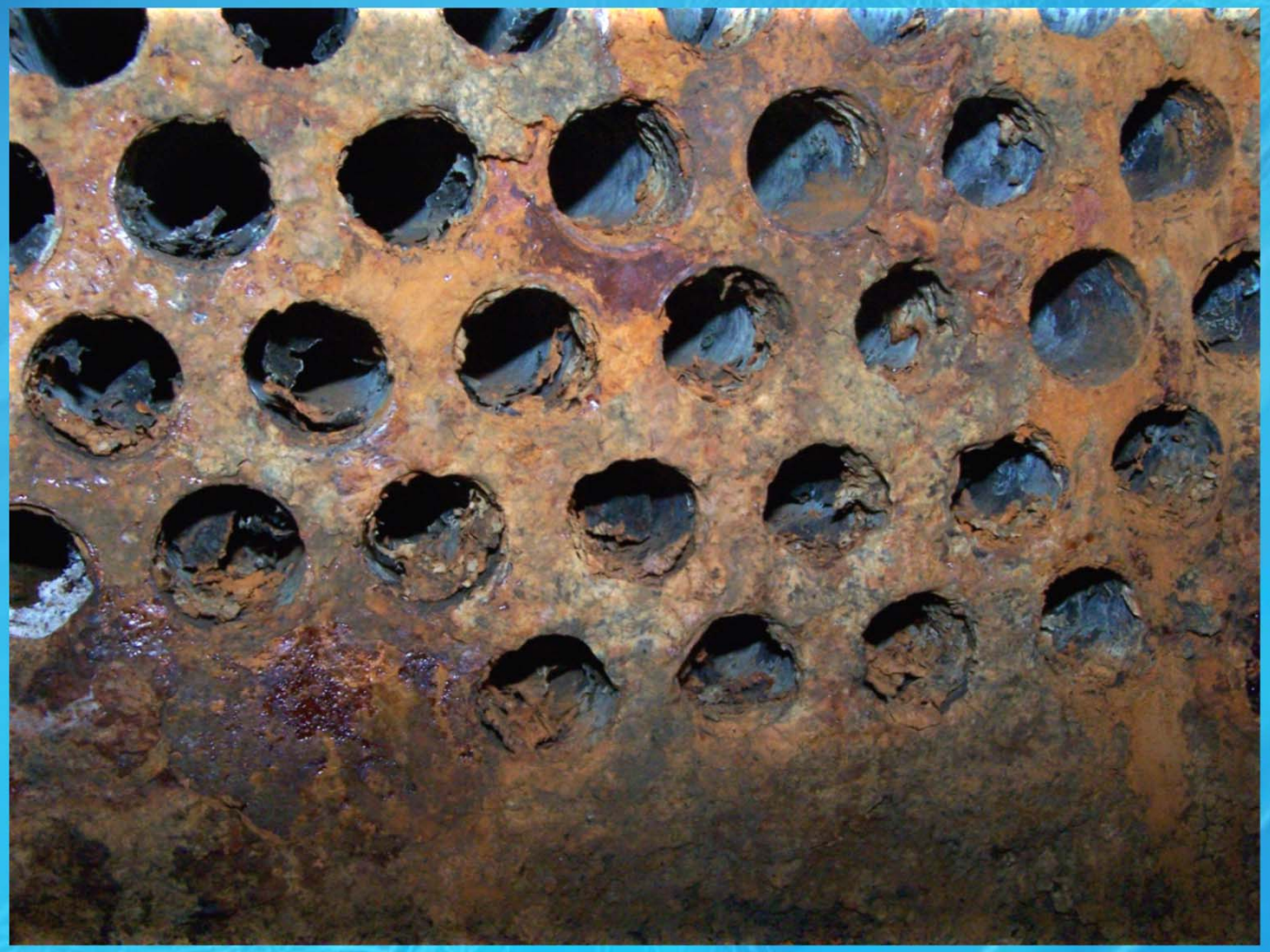
- Scale and Deposition is not the biggest water management problem you face. Why?
  - Existing scale and deposition is reversible
  - Risk of new scale and deposition can be minimized
    - Partner with a trustworthy water management company that will provide effective chemistries, expertise and education for you and your staff
    - Softeners will help control hardness scale
    - Effective filtration will control deposition

Corrosion and Erosion of System Components Occur Due to Chemical and Mechanical Reasons

- **Potential Causes**
  - Poor control of inhibitor chemistry
    - Under feed of Corrosion Inhibitor
    - Over feed of pH Control Chemistry
    - Uncontrolled feed of Oxidizer Biocide. Over feed is corrosive.
  - No Filtration/ Wrong Filtration
  - High Flow Rates
- **Operational Impact**
  - Decreased Cooling System Life
    - Increased Equipment Repair/Replacement Cost
    - Increased Risk of Ammonia Release
  - Under Feed of Oxidizer Can Promote Growth of System Destroying Bacteria; IRB and SRB

Active Corrosion Sites on Chiller Exchanger Head

Corrosion Byproducts Create Fouling



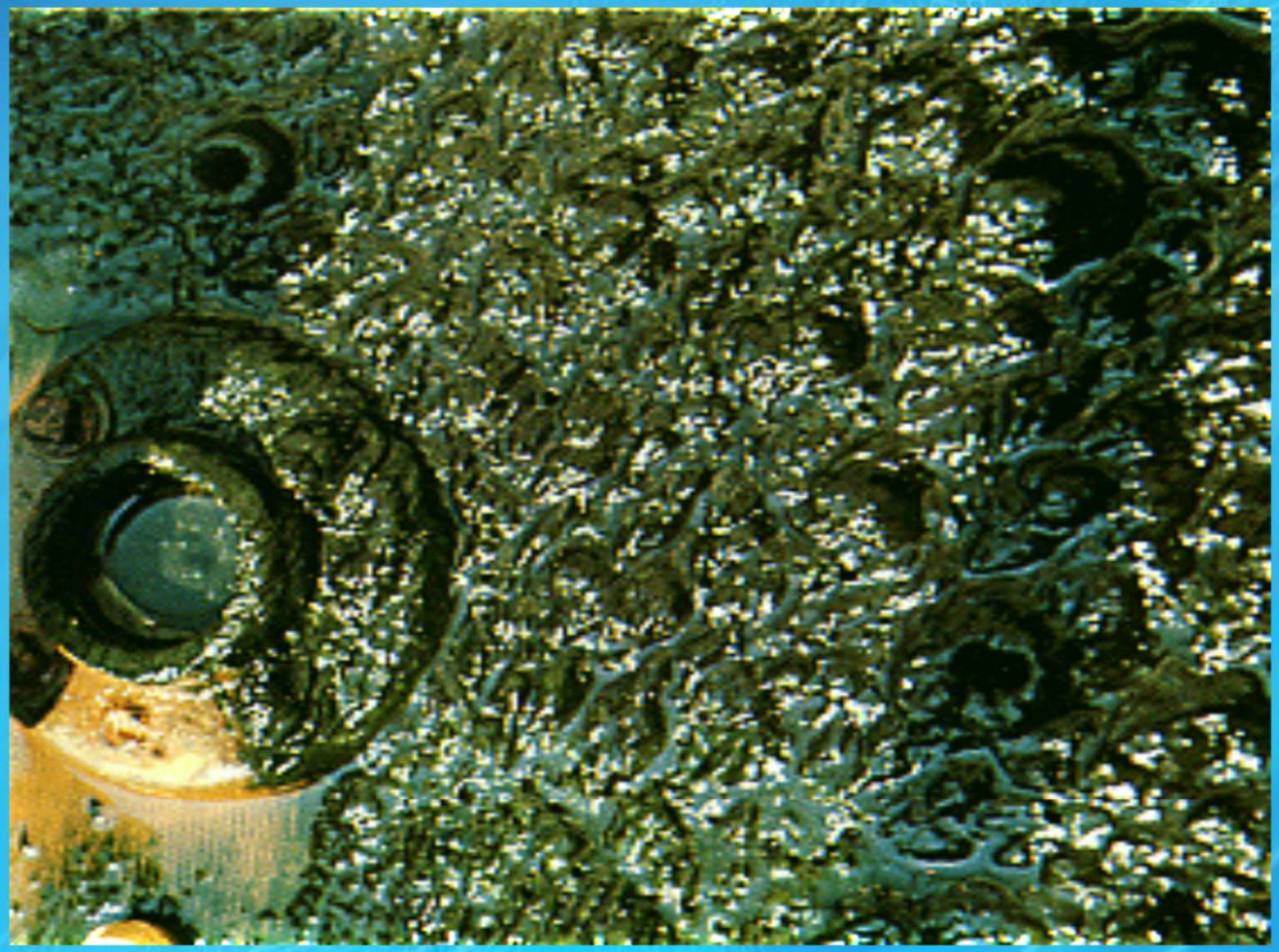
Myth # 2

- Despite being irreversible, risk of general corrosion isn't the greatest risk to the operation of your cooling systems. Why?
  - General corrosion in cooling towers and chilled water can be easily managed through;
    - Use of effective corrosion inhibitor chemistries
    - Regular testing
    - Reliable and consistent feed and control systems (Controllers, pumps and valves)
    - Monitoring corrosion control effectiveness is simple and easy through use of corrosion coupons
    - Education

Reality

- The most significant water related threat to the safe and efficient operation of your cooling systems is from microscopic creatures
  - Fungus will rot wood
  - Algae can plug cooling tower distribution systems
  - Bacteria will
    - Promote deposition
    - Produce severe corrosion
    - Can cause life threatening diseases
  - General corrosion can be accelerated of up to 1000X due to MIC

Algae on Cooling Tower Deck



Algae

- Simple Plants Containing Chlorophyll
- Require Light for Growth
- Present in Surface Waters and Soils
- May Form Thick, Rubber-Like Green/Brown Mats

Algae

Fouls Strainers, Distribution Deck Ports, Heat Exchanger Tubes

Provides Matrix for Further Foulant Accumulation

Provides Environment (Food & Shelter) for Bacterial Populations

Bacteria

Single Cell Organisms
Two General Types

Aerobic

Anaerobic

Aerobic Bacteria

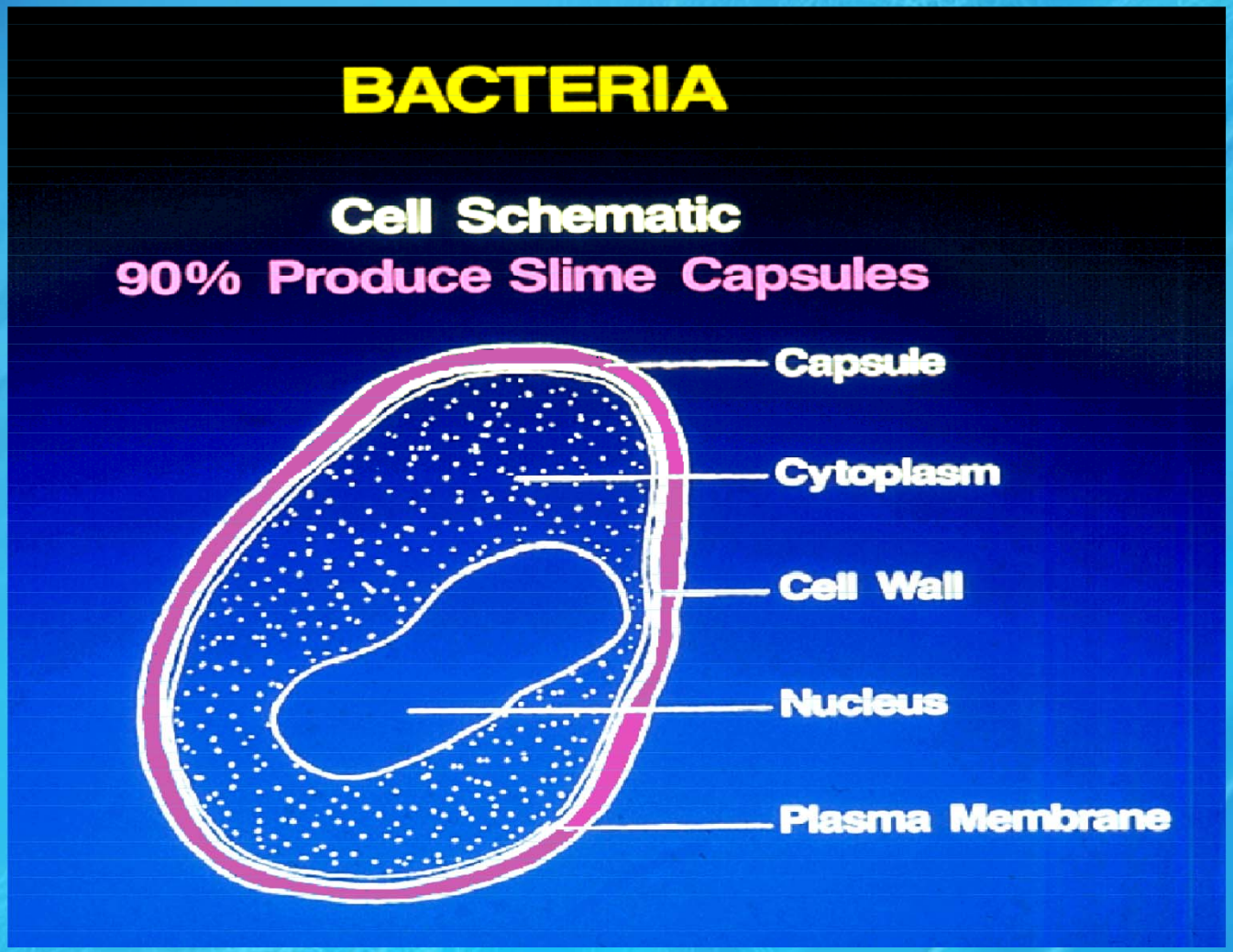
- Require Oxygen to Live
- Sunlight Not Required to Live
- Can Degrade Chemical Inhibitors
- Most Species in Cooling Towers are Prolific Biofilm Slime Formers
- Slime Interferes with Heat Transfer More Than Common Scale

Anaerobic Bacteria

Thrive in Areas of Little or No Oxygen Within Tower System

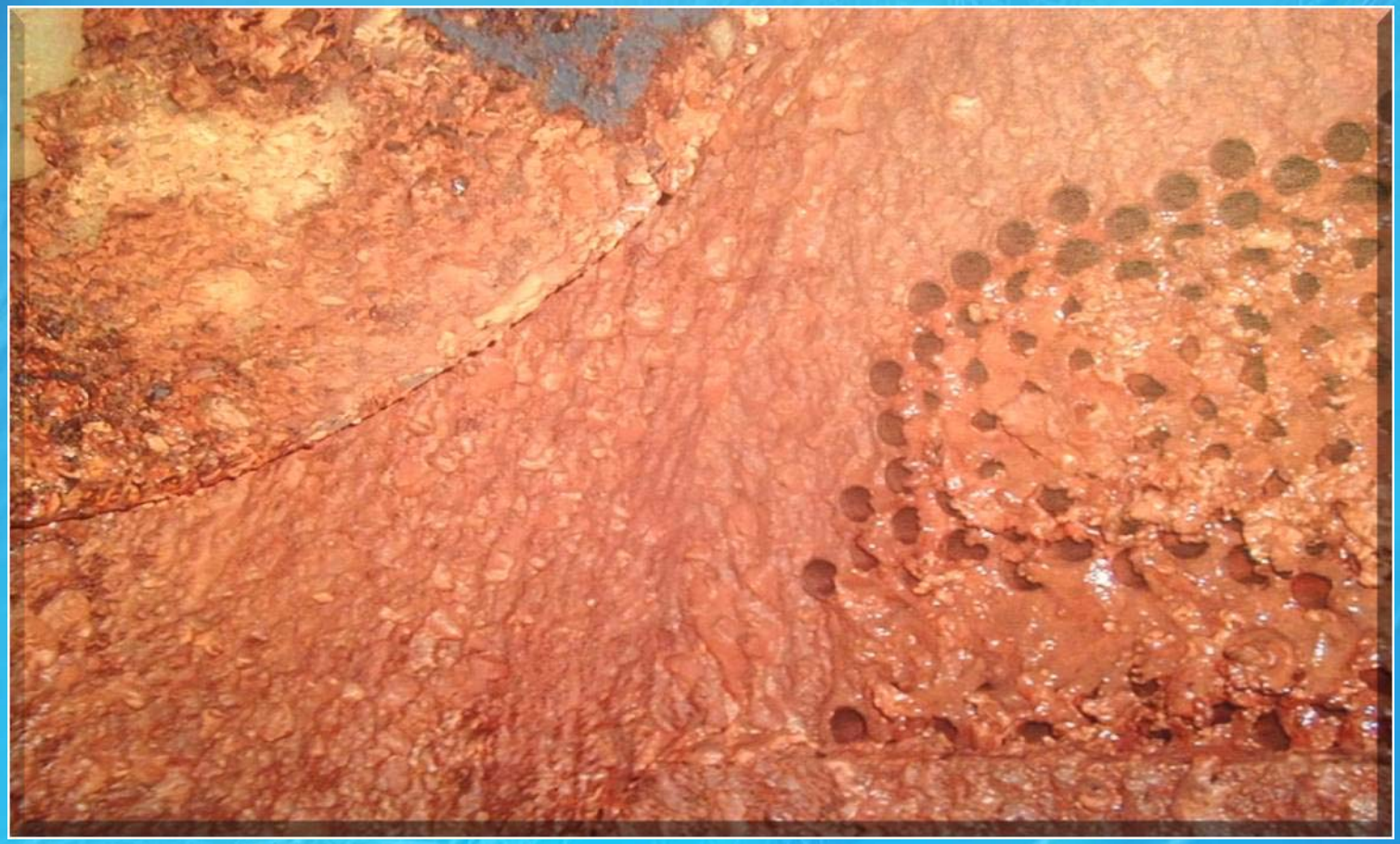
- Under Deposits and Sludge
- Beneath Algal Mats
- Beneath Bacterial Slime Masses

Typical Bacteria- What Kind of Problems Can This Little Guy Cause?

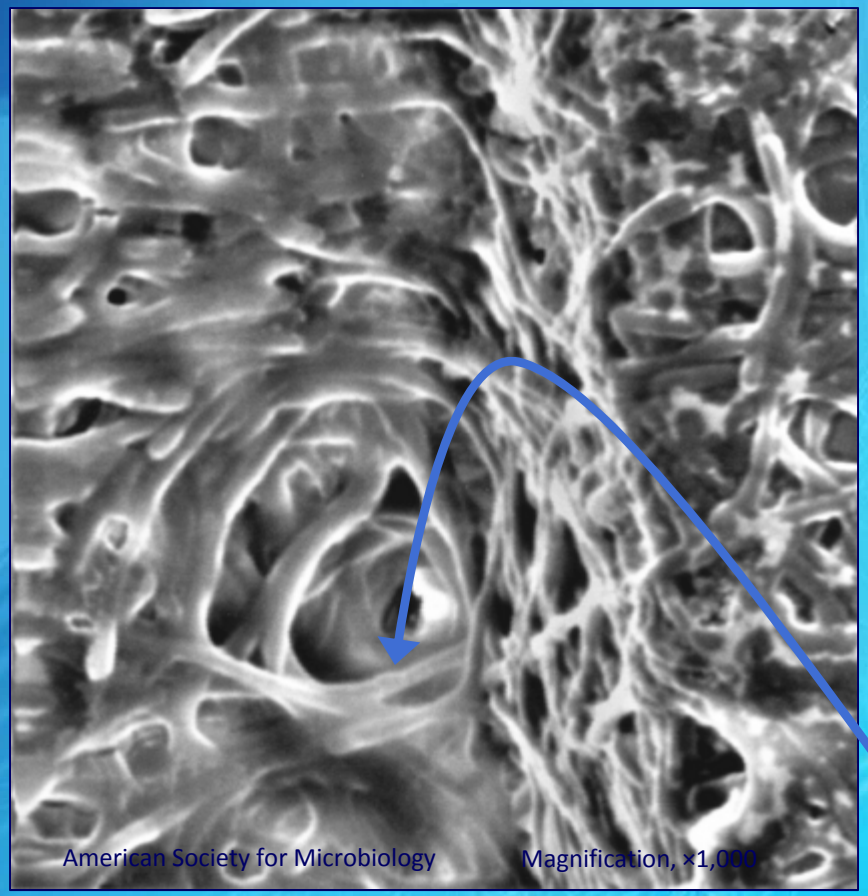


Biological/Organic Mat in a Cooling System Storage Tank

Microbiologically Induced Corrosion on a Chiller Tube Sheet



Biofilm



50 to 90% of biofilm is a non-uniform hydrated polysaccharide matrix composed of microcolonies of different bacteria. Example is The gram-negative facultative anaerobic pathogen Pseudomonas aeruginosa. Anionic properties are conferred to the biofilm by the bacteria allowing Divalent cations to cross-link strengthening the film.

A water channel is seen in the biofilm matrix.

Corrosion Induced by Biofilm

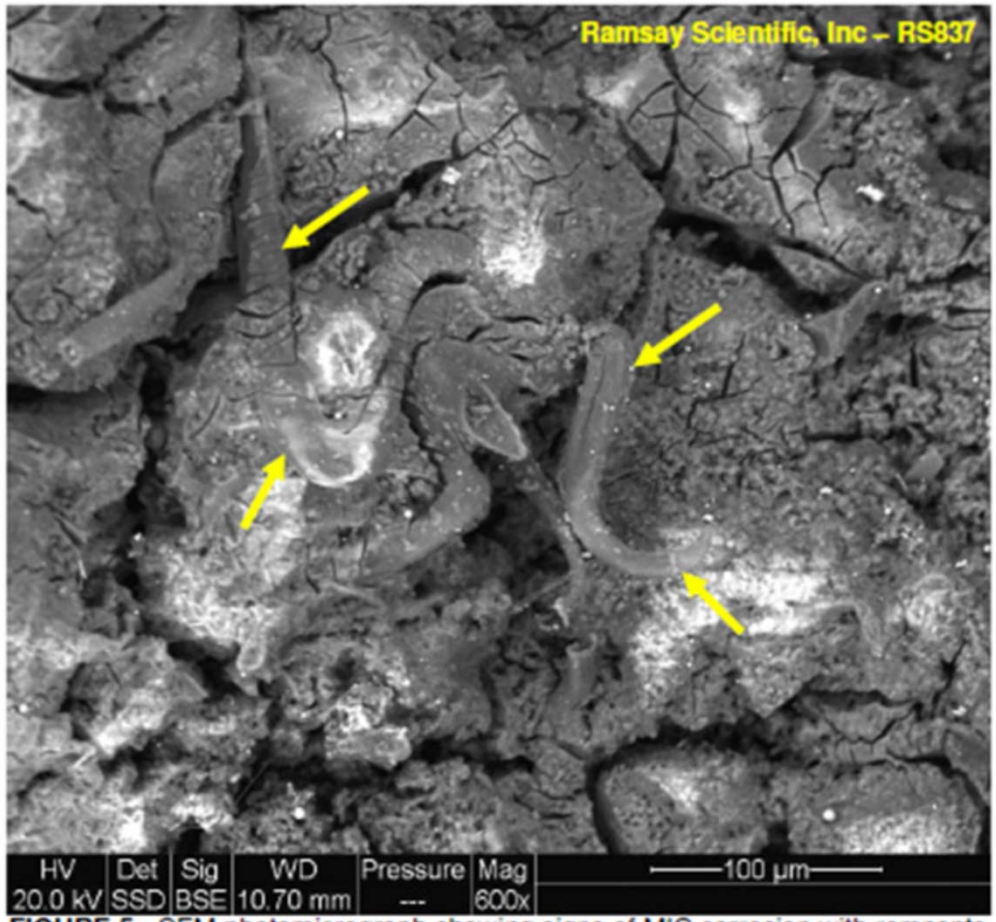


FIGURE 5: SEM photomicrograph showing signs of MIC corrosion with remnants of hemispherical tubercles (bacterial cells).

Legionella Pneumophila Bacteria

Responsible for Legionnaires Disease

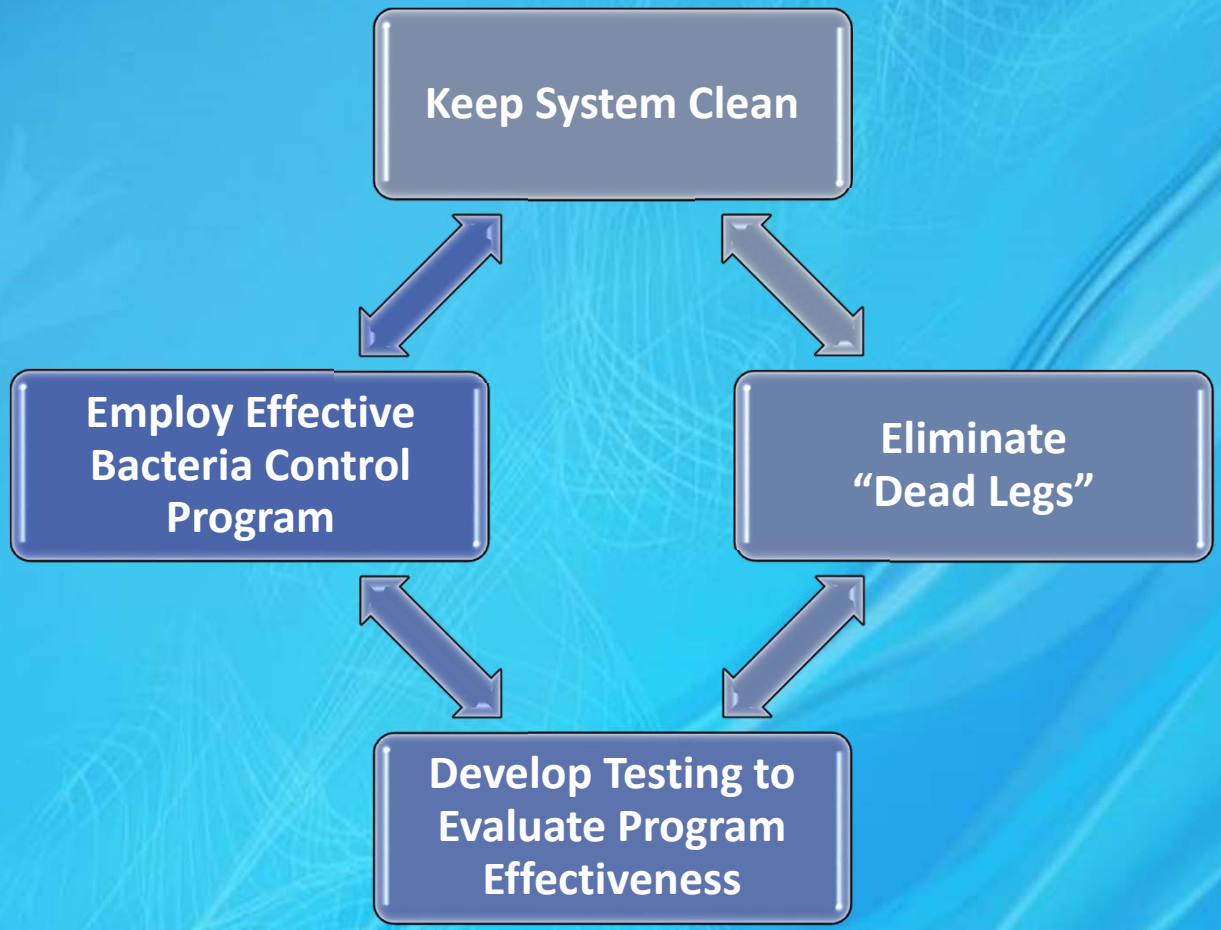
Microbial Fouling Problems

- Restriction of Heat Transfer
- Flow Restriction
- Matrix for Additional Foulants
- Potential Under-Deposit Corrosion
- Propagation of Diseases to Humans

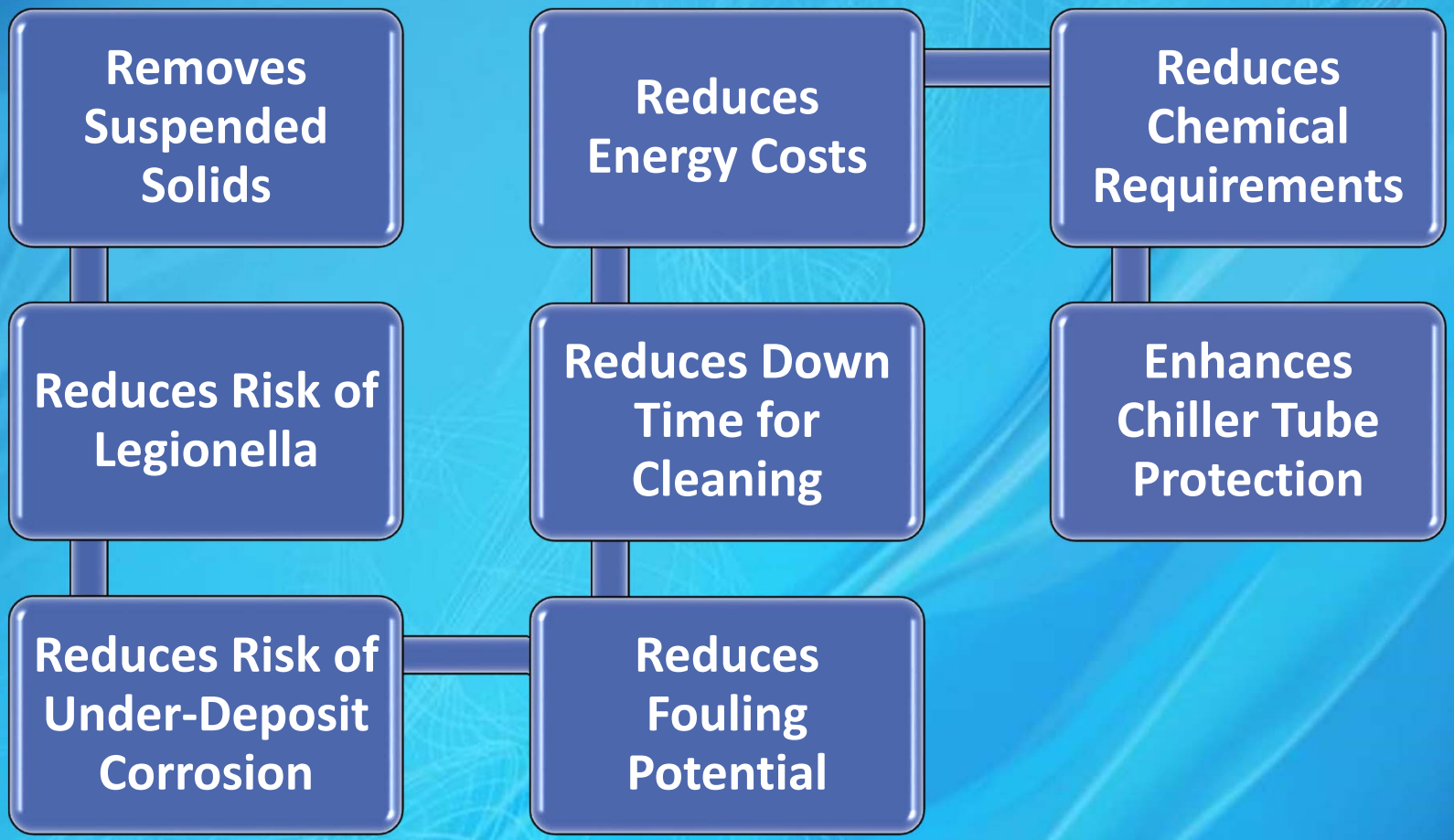
Fact- Any of These Problems Could Potentially Shut Down Your Cooling Systems

- Slime in cooling towers will reduce cooling effectiveness
- Bio-film will foul condenser and/or evaporator condenser tubes, reduce water flow, increase energy costs, promote pitting attack in coils, and potentially shut down your cooling system
- Anaerobic bacteria can excrete acid (SRB's) and metabolize steel piping (IRB's). If this sounds really bad, it is
- Legionella bacteria, commonly found in cooling system water, can cause a deadly form of pneumonia called Legionosis (Legionnaires disease) and has resulted in many very expensive lawsuits

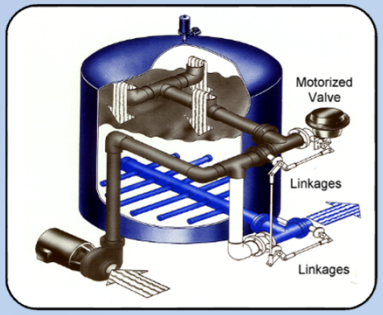
OK, This Sounds Bad. What Can Be Done to Minimize Risk of These Problems?

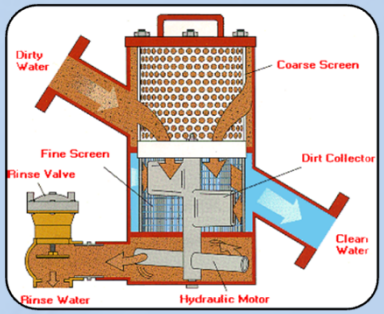


Filtration - Keeping Your Tower and Chilled Loop Systems Clean



Filter Types





Media Filters

Cartridge Filters

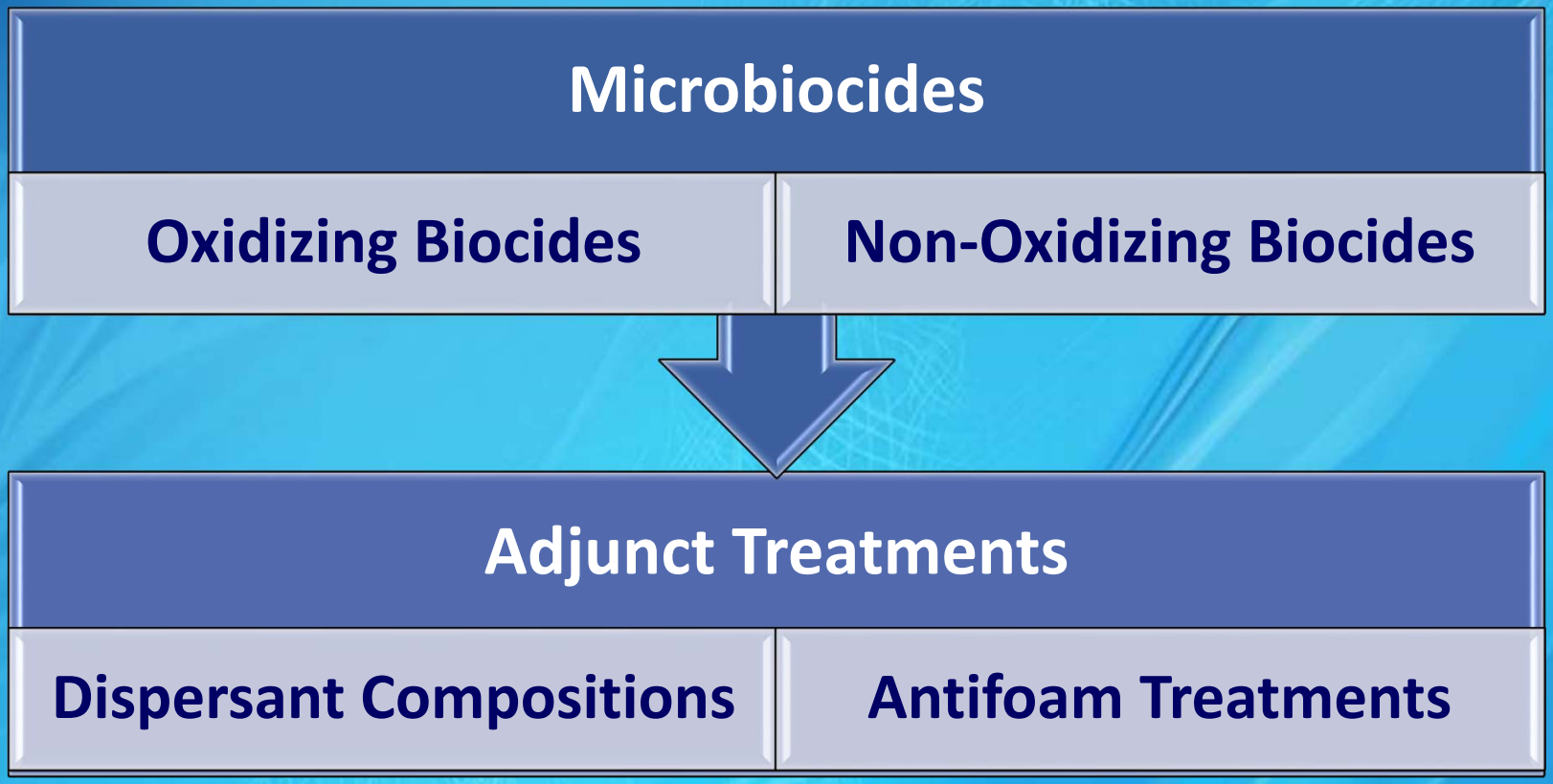
Bag Filters

Screen Filter

Eliminate Dead Legs

- Redundant Systems Create Problems
- Rotate Unused Towers Regularly
- Identify Unused Exchangers/Equipment/Piping
- Determine Strategies to Eliminate These

Effective Bacteria Control Chemistries



Oxidizing Biocides

Halogens (Bromine and Chlorine)

- Most Common Oxidizing Treatments
- Continuous Residual
  - > 1.0 ppm (OSHA)
  - 0.5 - 1.0 ppm (CTI)

Ozone (O_3)

- 0.1 - 0.2 Residual

Chlorine Dioxide (ClO_2)

- 0.25 - 1.0 ppm Residual

Oxidizing Biocides

Fed Continuously at Low Residuals

- **Continuous Bio-Population Control**
- **Reduces Corrosion Tendencies**

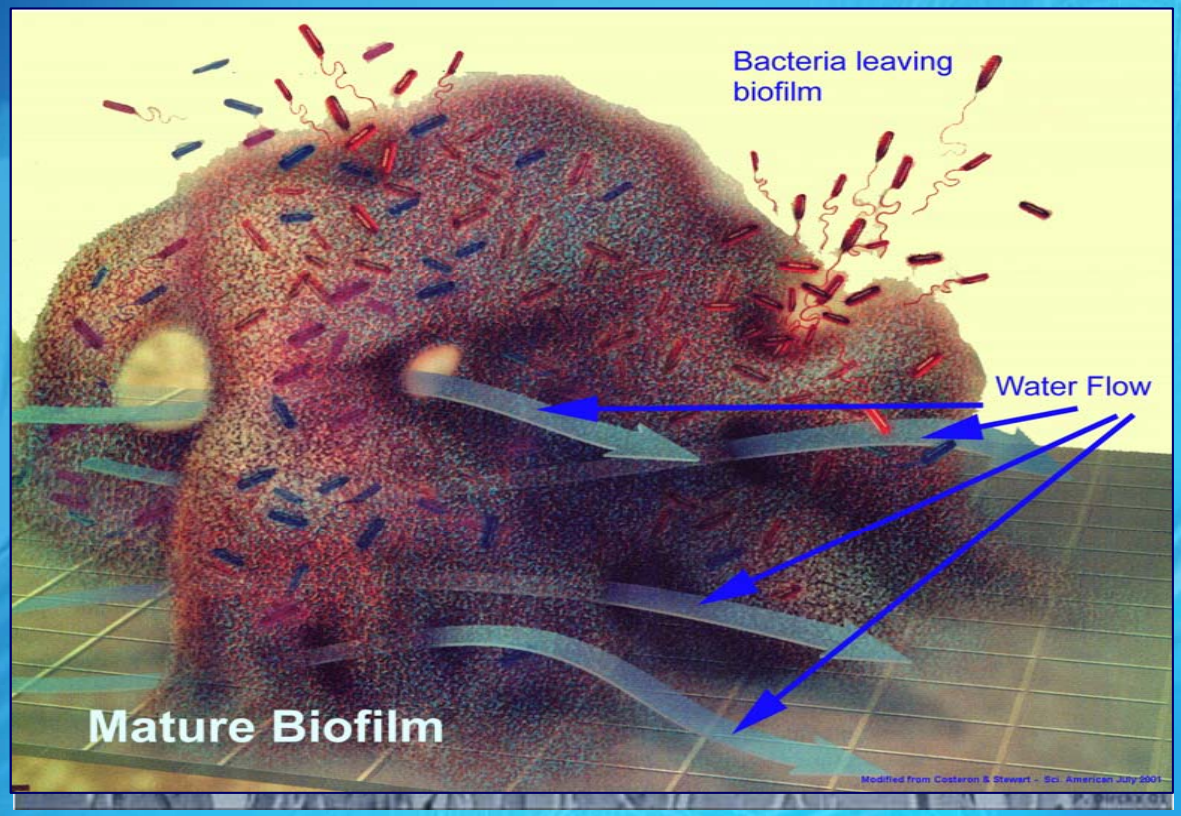
May Be Fed at Higher Slug Dose

- **Season Start-Up & Shut-Down**
- **Response to Microbial Upset**

Non-Oxidizing Biocides (Poisons)

- Glutaraldehyde
- Isothiazolinone
- Quaternary Ammonium Compounds
- Copper/Silver/Tin
- Thiones
- Carbamates
- Dibromo-Nitrilo-Propionamide (DBNPA)
- Methylene bis Thiocyanate (MBT)
- Tris (Hydroxymethyl) Nitromethane
- 2-(decylthio) Ethanamine (DTEA)

Bio-film Chemistry



Biocide applications typically kill only surface bacteria

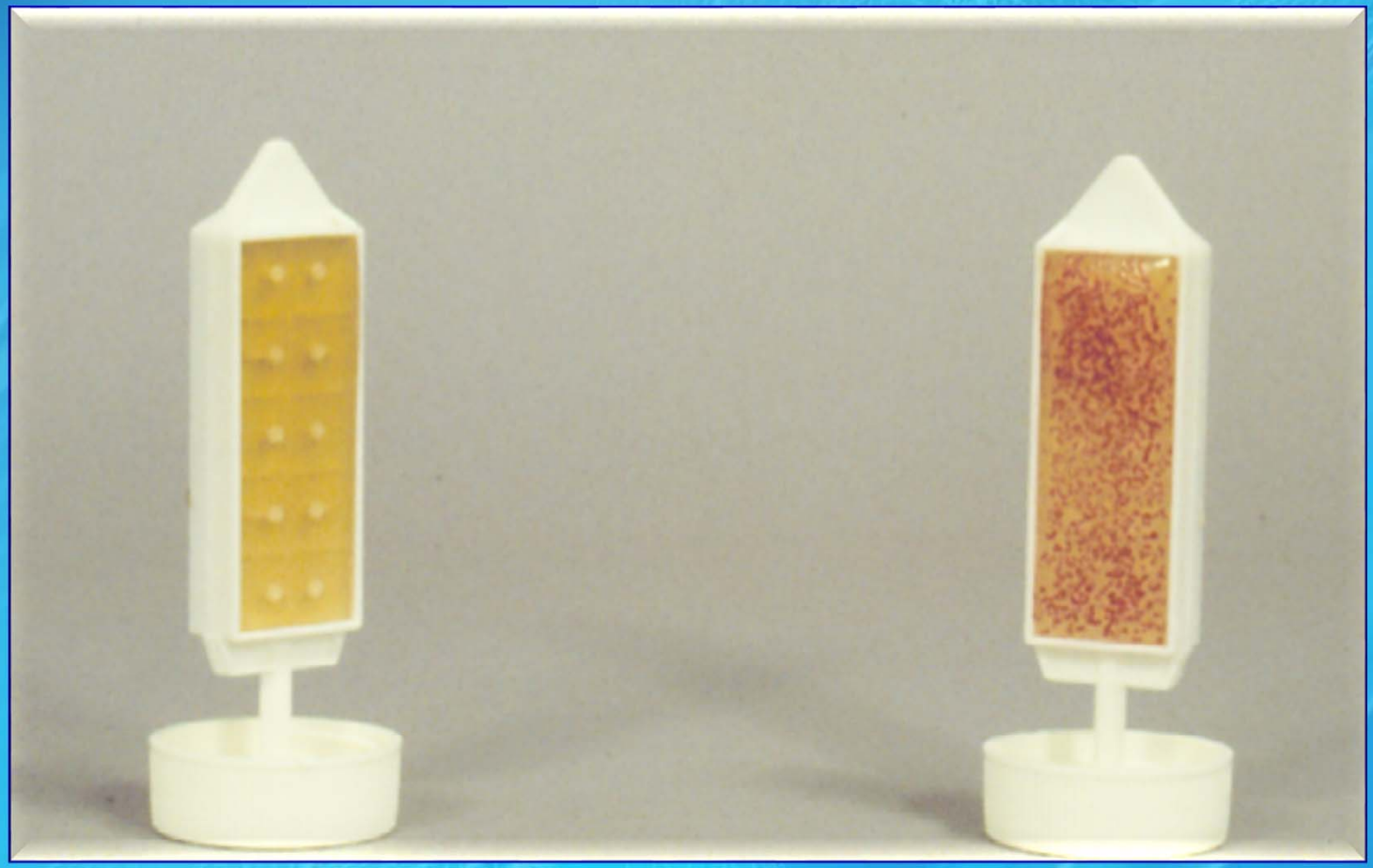
Remaining bacteria react by creating more biofilm

Microbiological Monitoring

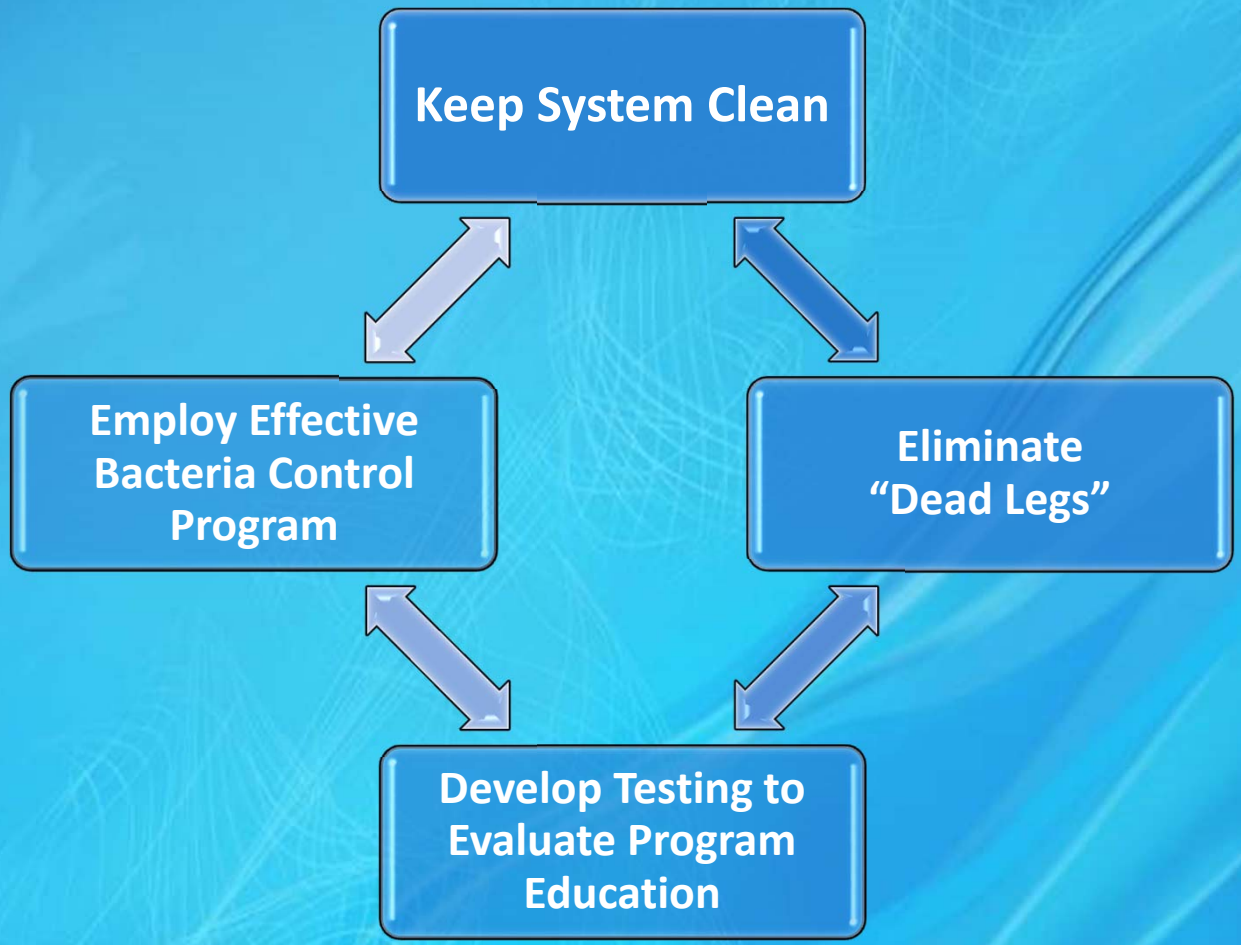
- Visual Inspection
- Monitoring Heat Exchanger ΔP and ΔT
- Bacteria/Fungi Testing of Tower Water

Microbiological Testing

Total Aerobic Bacterial Culturing



In Closing- Find a Water Treatment Professional Who Will Partner With You To Help You…



Thank You

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