Secondary Disinfection for Potable Water

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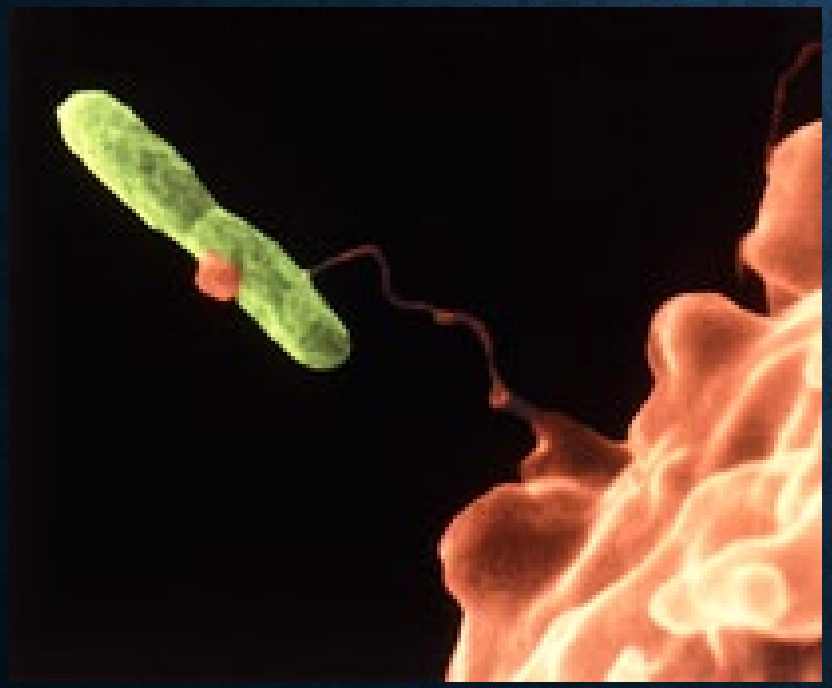
Discussion Topics

1. ASHRAE 188
2. Legionella Basics
3. Secondary Disinfection
4. Options for Secondary Disinfection
5. Questions



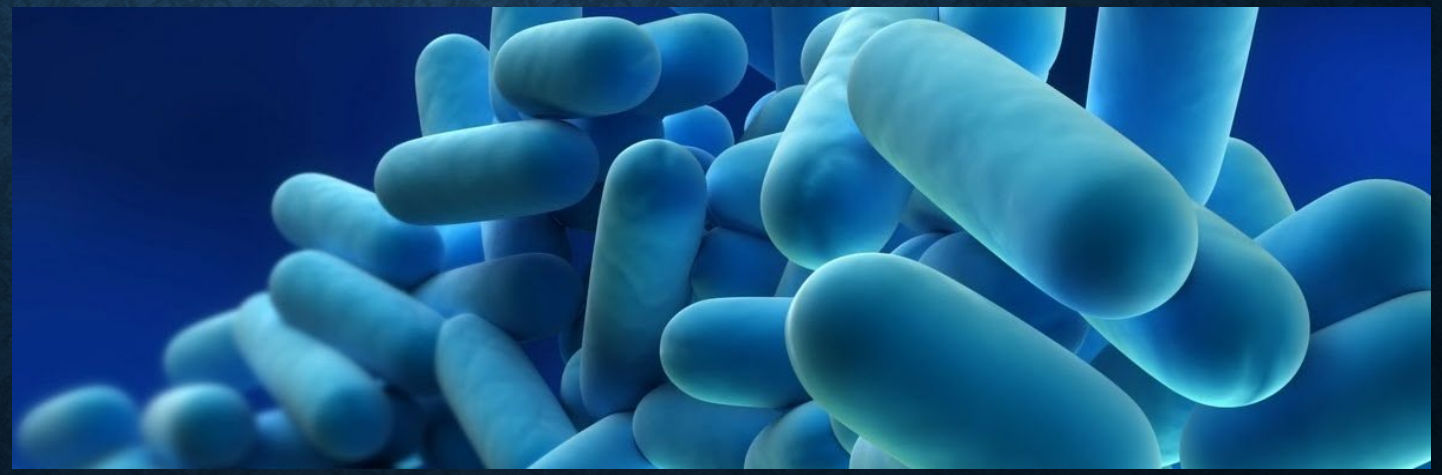
ASHRAE Standard 188

Legionellosis: Risk Management for Building Water Systems

- Published in June 2015, updated in 2018
- Applies to “human-occupied commercial, institutional, multi-unit residential, and industrial buildings, excluding single-family residential buildings.”
- Calls for the development of a water management plan for buildings that fit the criteria laid out in the standard
- Criteria include:
    - Healthcare facilities and assisted living/nursing homes
    - Buildings more than 10 stories (including below grade)
    - Has onsite: cooling towers, hot tubs, ornamental fountains, misters
    - Multiple housing units with one or more centralized potable water heating systems
- Water management plan focuses on monitoring, corrective actions, and documentation
- Does not require testing
- CMS & Joint Commission require healthcare facilities to have a water management plan

Legionella Fundamentals

- Legionella bacteria is commonly found in water supplies throughout the world
- There is no requirement for municipal water systems to treat specifically for Legionella
- Once Legionella enter a building piping system, there are multiple sites throughout the piping system that allow ample opportunity for the Legionella to colonize and multiply
- Legionella grow best in warm water areas with little or no flow that provide for the collection of nutrients
- Legionella thrive in biofilm

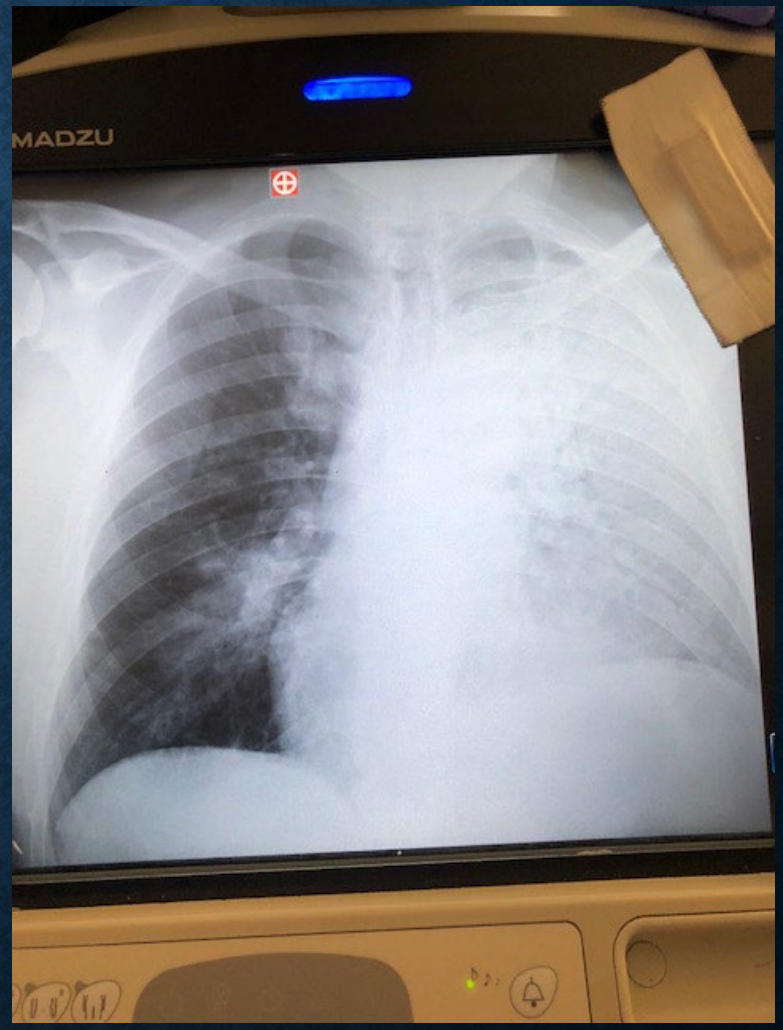


Legionella Fundamentals

- There are 50+ named species of Legionella
  - Further classification into serogroups

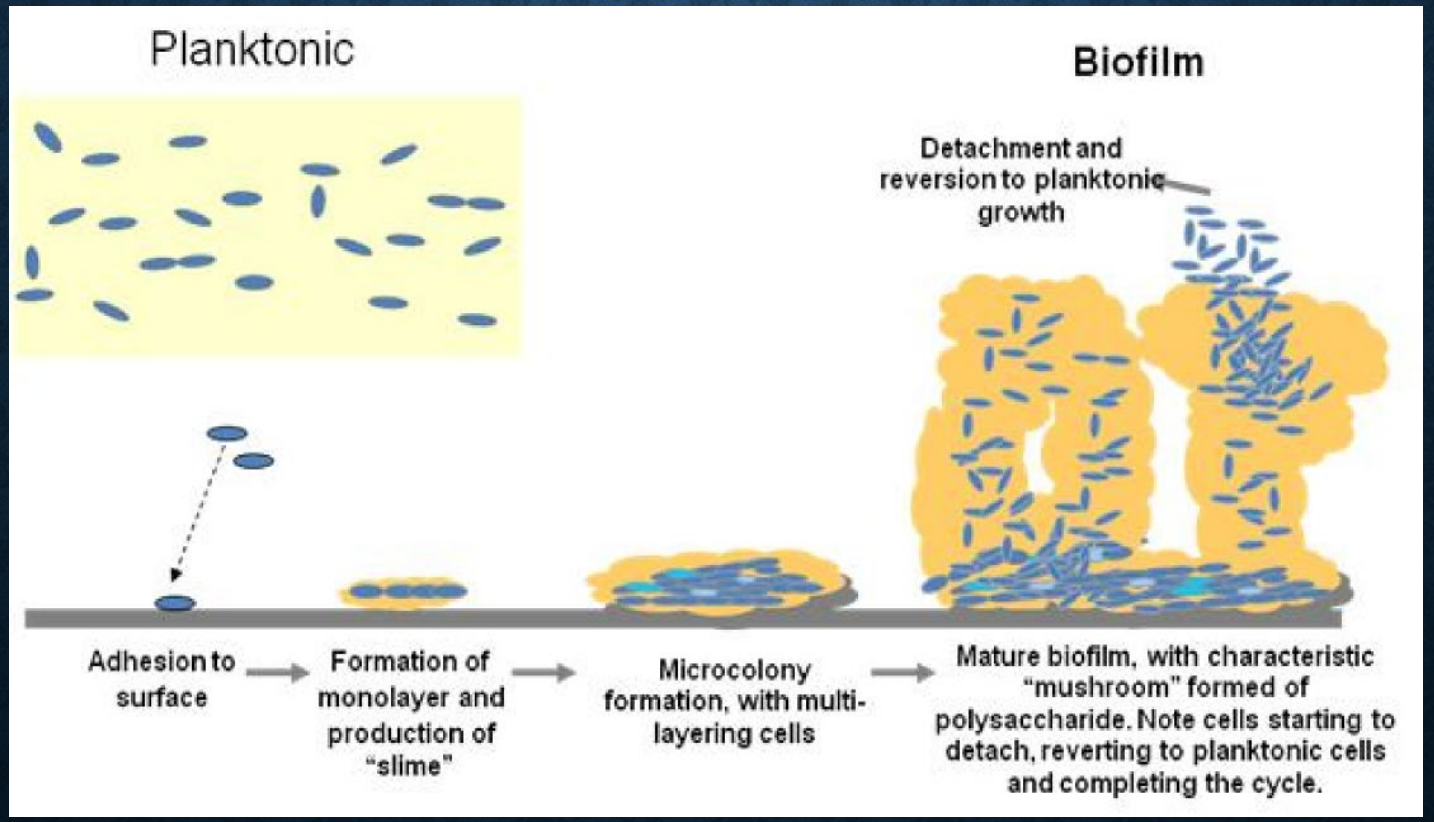
- There are at least 25 pathogenic Legionella species
  - Legionella pneumophila (90%+ of all cases)
  - Legionella longbeachae
  - Legionella bozmanae
  - Legionella anisa

- Legionella pneumophila has 15 serogroups
  - Serogroup 1 causes 70-80% of all cases of Legionellosis
  - Serogroups 3, 4, and 6 are relatively common causative agents



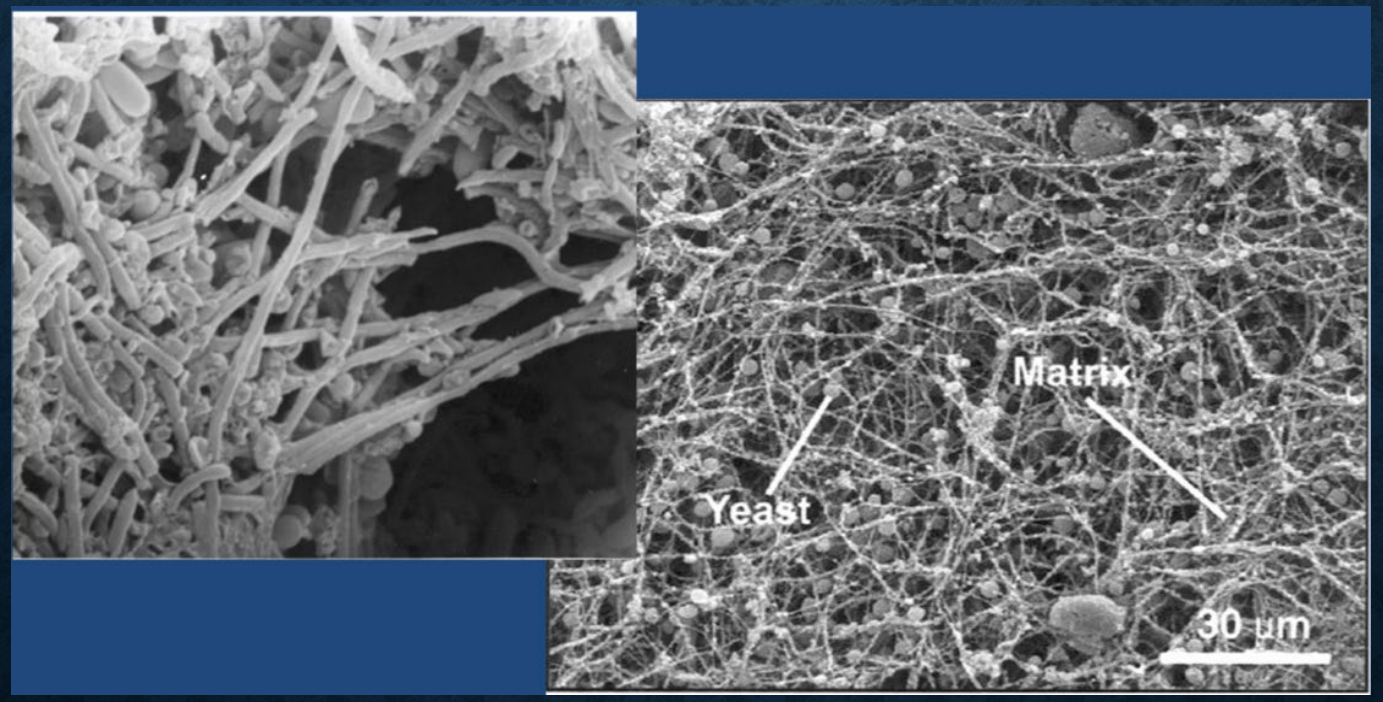
Biofilm

- Biofilm is a grouping of microbiological organisms that adhere to each other and attach to a solid surface
- In piping systems, the slime that typically coats the inside of the pipe is actually biofilm



Biofilm

- Biofilm provides an ideal environment for Legionella to grow and multiply
- The web-like matrix traps nutrients and shields the bacteria from exposure to disinfectants like chlorine



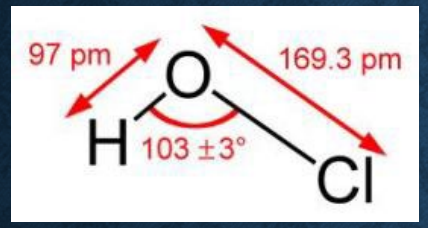
Secondary Disinfection

- Primary disinfection of potable water occurs at municipal water treatment plants
- With the exception of some groundwater sources, the U.S. EPA requires municipalities to maintain a minimum of 0.2 parts per million of disinfectant throughout the distribution system. The most commonly recognized disinfectant used by municipalities is chlorine
- Some bacteria can survive the levels of chlorine typically found in municipal water supplies
- Secondary disinfection involves the injection of an additional disinfectant at some point in the water distribution system

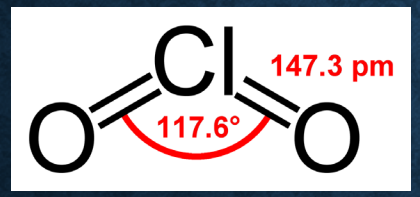
Secondary Disinfection Considerations

- The majority of Legionnaires' Disease cases occur in hospitals and nursing homes
- In recent years, there have been several high profile outbreaks associated with hospitals and hotels across the U.S.
- Outbreaks are frequently linked to the domestic water systems
- As a result, facilities started to explore prevention strategies including secondary disinfection of the incoming water
- The most common secondary disinfectants in use in the U.S. are: chlorine, chlorine dioxide, copper/silver, and monochloramine

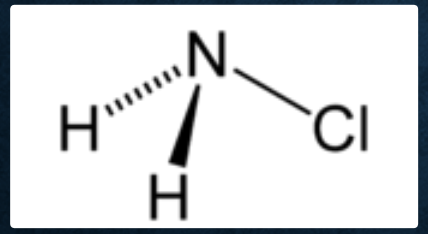
EPA Listed Disinfectants



Hypochlorous acid - cheap, simple to use, less effective, disinfection by-products, high residuals required, pH-dependent



Chlorine dioxide - very good disinfectant, dissolved gas, used for Legionella remediation with success



Monochloramine - very good disinfectant, used in drinking water, used for Legionella remediation with success

Copper / Silver Ionization

- Operates by passing an electrical current though copper and silver electrodes which releases copper and silver ions into the water
- Copper and silver are both antibacterial
- **Copper/silver ionization systems are EPA registered pesticide devices**
- There is no field test for silver which makes it extremely difficult to adjust/control the silver residual
- Studies have shown that bacteria (specifically Legionella) can develop resistance to copper and silver
- Copper is a regulated contaminant in drinking water
- Silver can plate out on copper piping and copper can plate out on mild steel piping. This results in galvanic corrosion cells that cause in pinhole leaks throughout the piping system

Why NOT Chlorination?

- Chlorine may not kill Legionella, it may only suppress Legionella bacteria growth in bulk water
- If Chlorination system fails, bacteria can experience rapid growth and recolonization in the system
- Chlorine may not penetrate biofilm. It is a strong oxidizer that may only burn the surface of the biofilm
- Chlorine use may result in taste and/or odor complaints
- Difficultly maintaining chlorine in a recirculated hot water system
- Disinfection byproducts formed
  - Trihalomethane (TTHM)- Known Carcinogen
  - Haloacetic Acids (HAA5) – Suspected Carcinogen

Chlorination

Chlorine may attack piping resulting in leaks and failures due to corrosion

Chlorine Dioxide

- Advantages
  - Proven to be effective
  - Eliminates biofilm
  - Does not form harmful byproducts
  - Effective regardless of pH
  - There is a safe method of onsite generation

- Disadvantages
  - Some chlorine dioxide generators are not appropriate for use due to safety concerns
  - Chlorine dioxide is more expensive than chlorine
  - **Difficult to maintain a residual concentration in low flow, hot water systems – such as hot water systems found in hospitals**

Monochloramine

- It is stable in cold and hot water temperatures normally encountered in building water systems
- Due to the stability of monochloramine, it is more difficult to remove from water
- For dialysis units, activated carbon filters should be replaced with catalytic carbon filters or ensure the existing carbon filters have a minimum empty bed contact time of 10 minutes
- Widespread use in American drinking water supplies

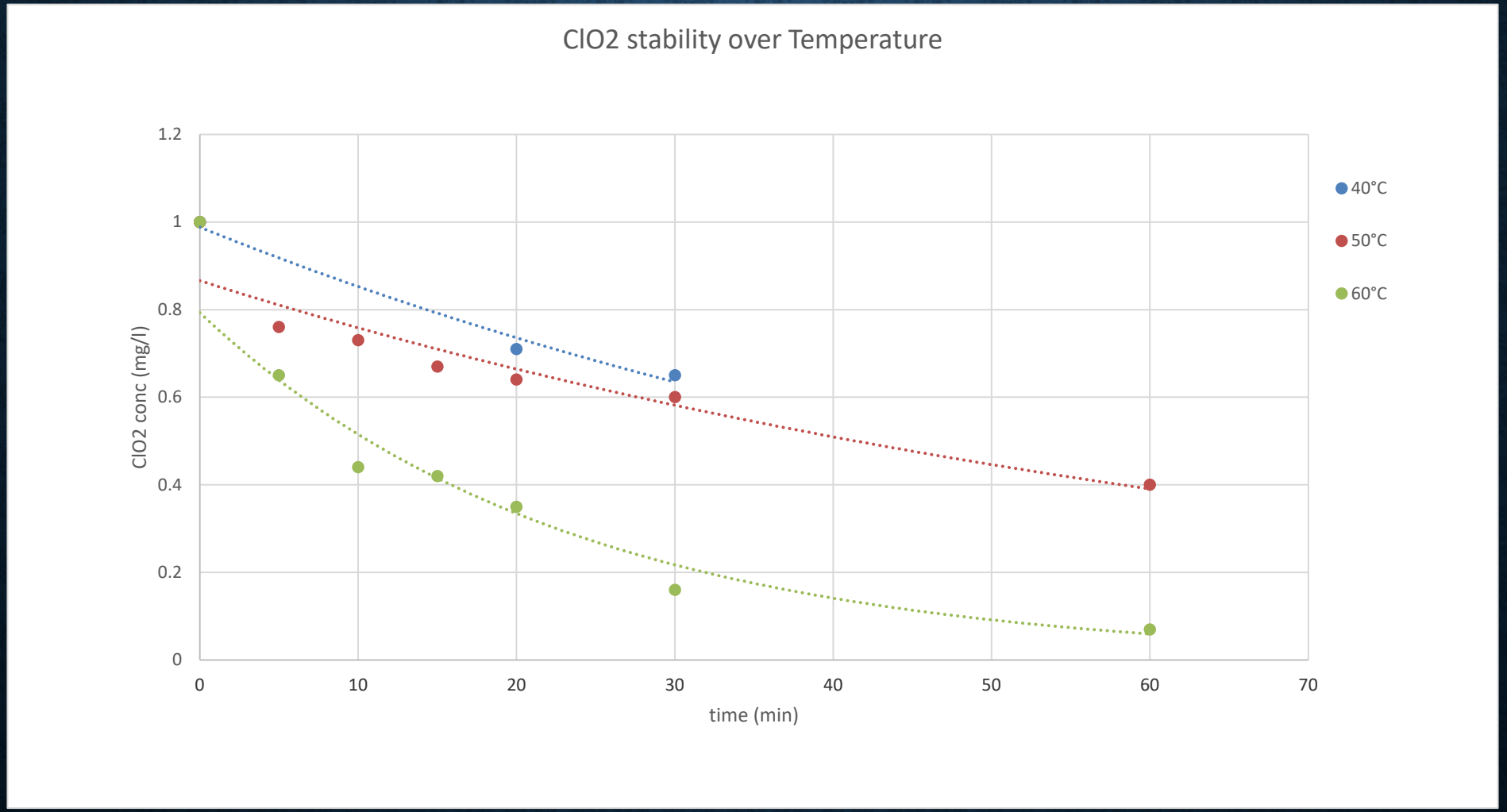
- Denver	- Los Angeles	- Dallas	- Houston
- Indianapolis	- San Francisco	- Boston	- Miami
- Philadelphia	- Honolulu	- San Diego	- Tampa
- Minneapolis	- Portland, OR	- Washington, DC	- Kansas City

Chemistry Behind the Technology

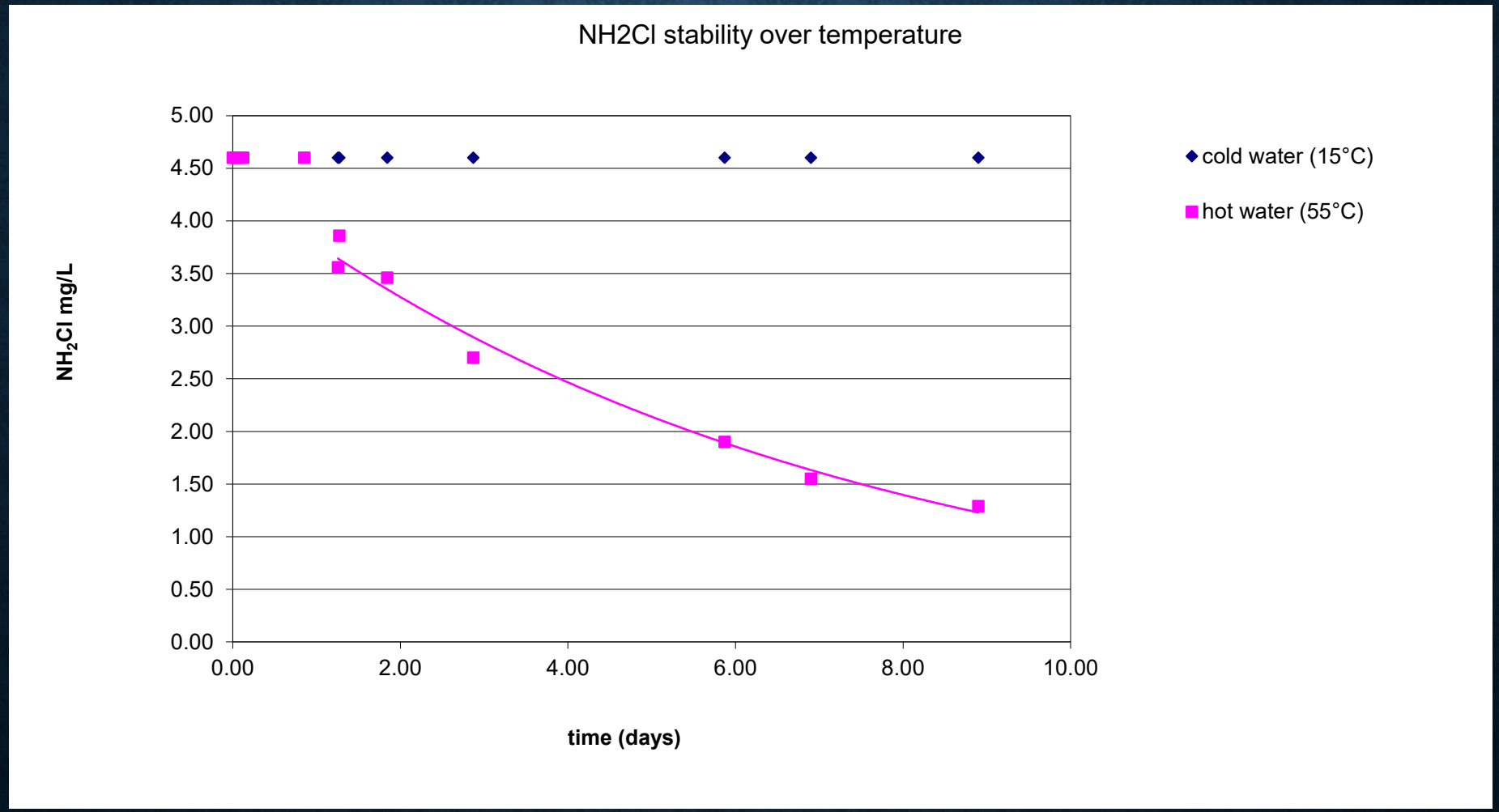
$$NH_3\ (aq) + HOCl > NH_2Cl + H_2O$$

- Ammonia source is ammonium chloride or ammonium sulfate solution
- Chlorine source is a stabilized hypochlorite solution
- The only theoretical by-product of this reaction is water
- Di- and tri- chloramines are not produced due to precise control and alkaline pH environments
- No disinfection by-product (THM, HAA) production
- Penetrates and destroys biofilm
- No DBP formed
- Rapid reduction of distal site positivity

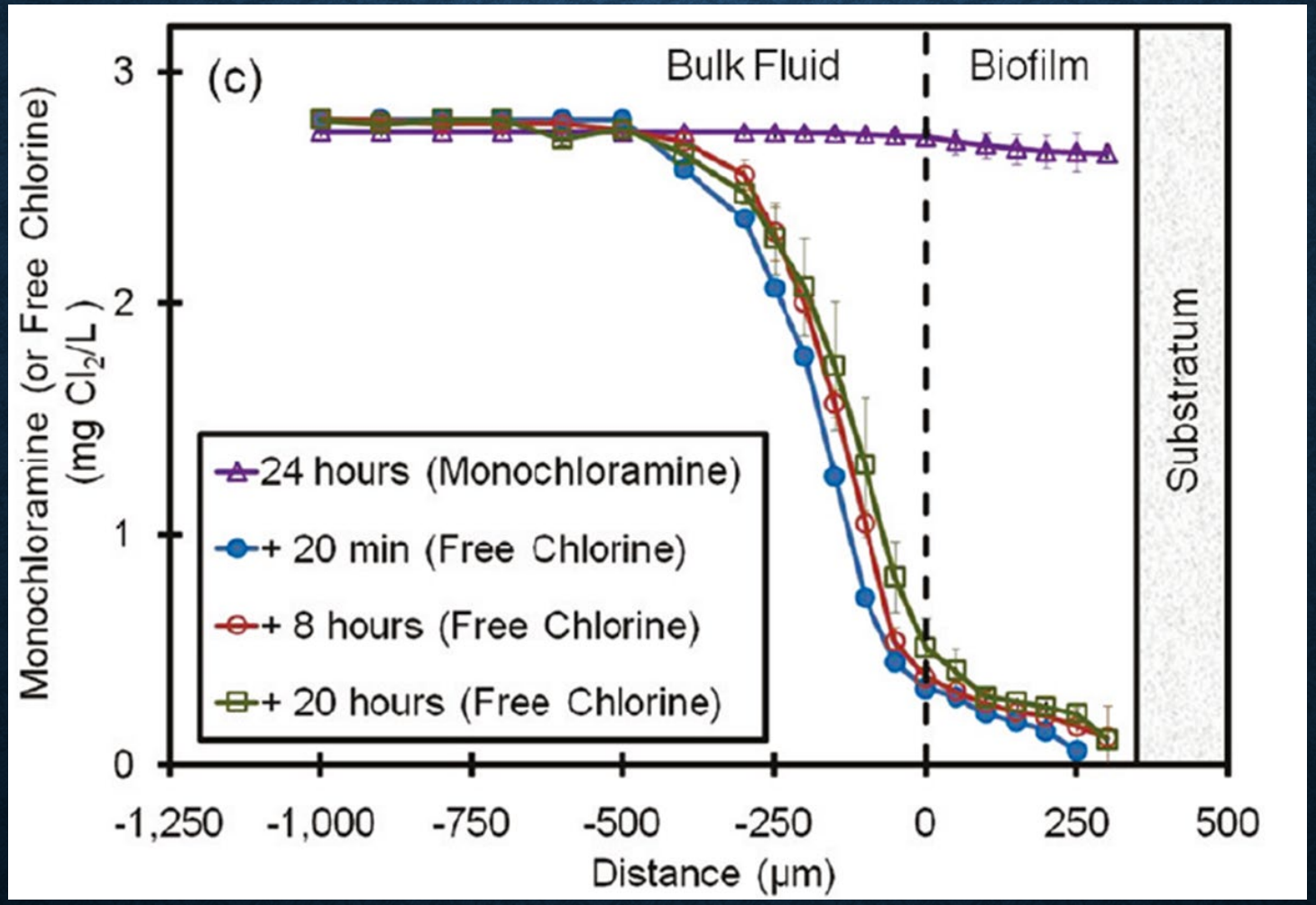
ClO_2 Stability Over Temperature



MCl Stability Over Temperature



Biofilm Penetration



Point-of-Use Filters

- 0.15 micron filter
- Available in 30, 60, 90, and 120 day maximum lifespan
- Excellent first response to a Legionellosis outbreak
- Typically stocked by vendors
- Can easily be shipped overnight
- Will provide protection until a more permanent solution is installed

Thank You!
Questions?

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