



# Biofilm Control in HVAC & Cooling Systems

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Ionic Nano Copper kills bacteria ,prevent  
algae and reduces corrosion



A product of  
Advance  
Greentech  
Solutions

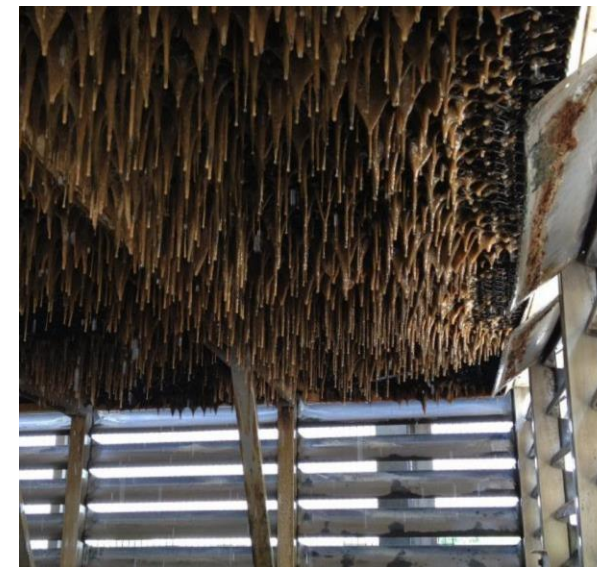
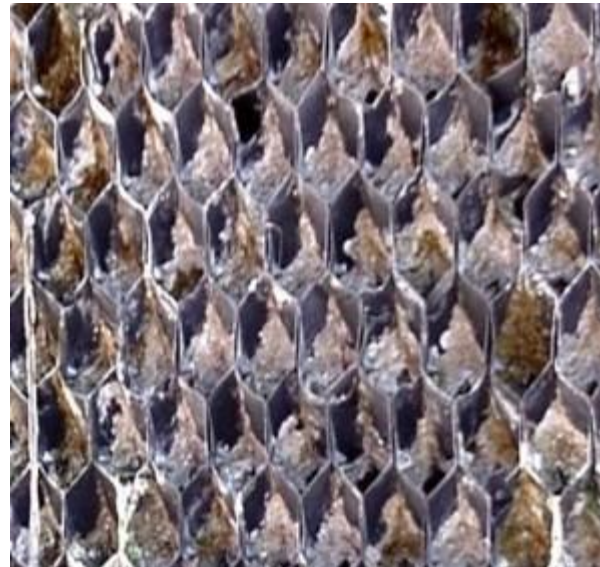
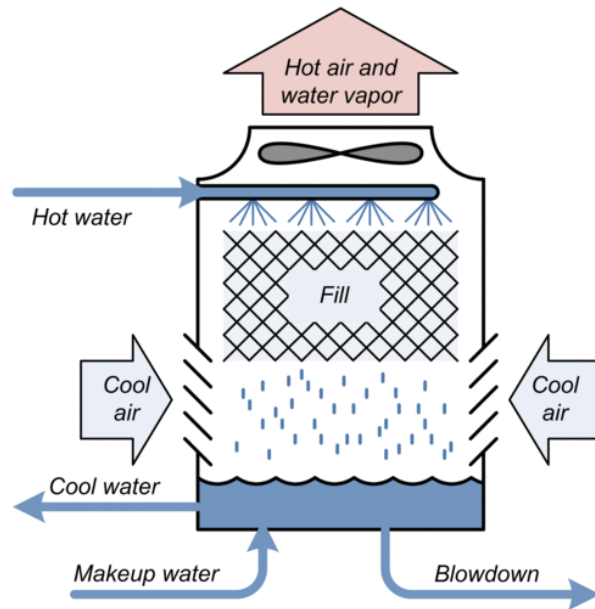
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Ionic Nano Copper



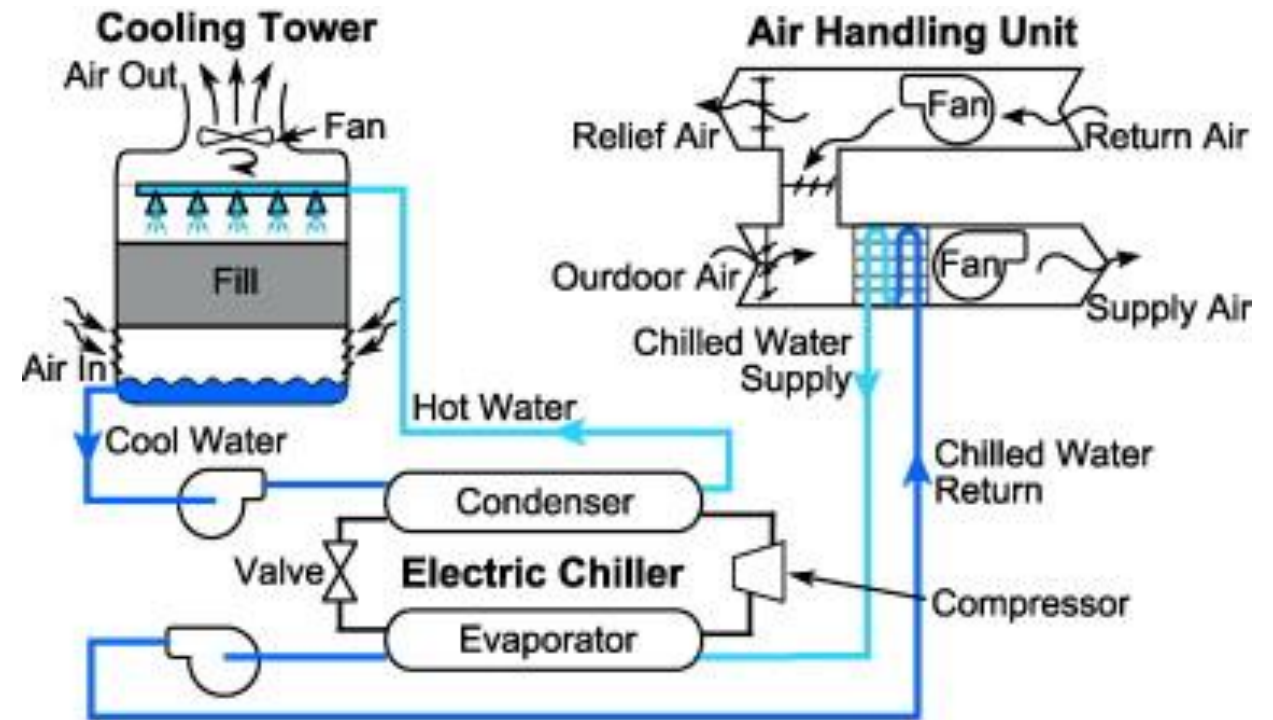
# Indication of Biofouling – How to detect

- Visual and tactile observations: colored or slippery slime deposits
- Diagnostics: Bacterial counts (plates, dipslides), indicating cultures (e.g., SRB), ATP, on-line biofilm monitors, deposit sample analysis by loss on ignition
- System performance: inefficient cooling, reduced heat transfer, electrical load



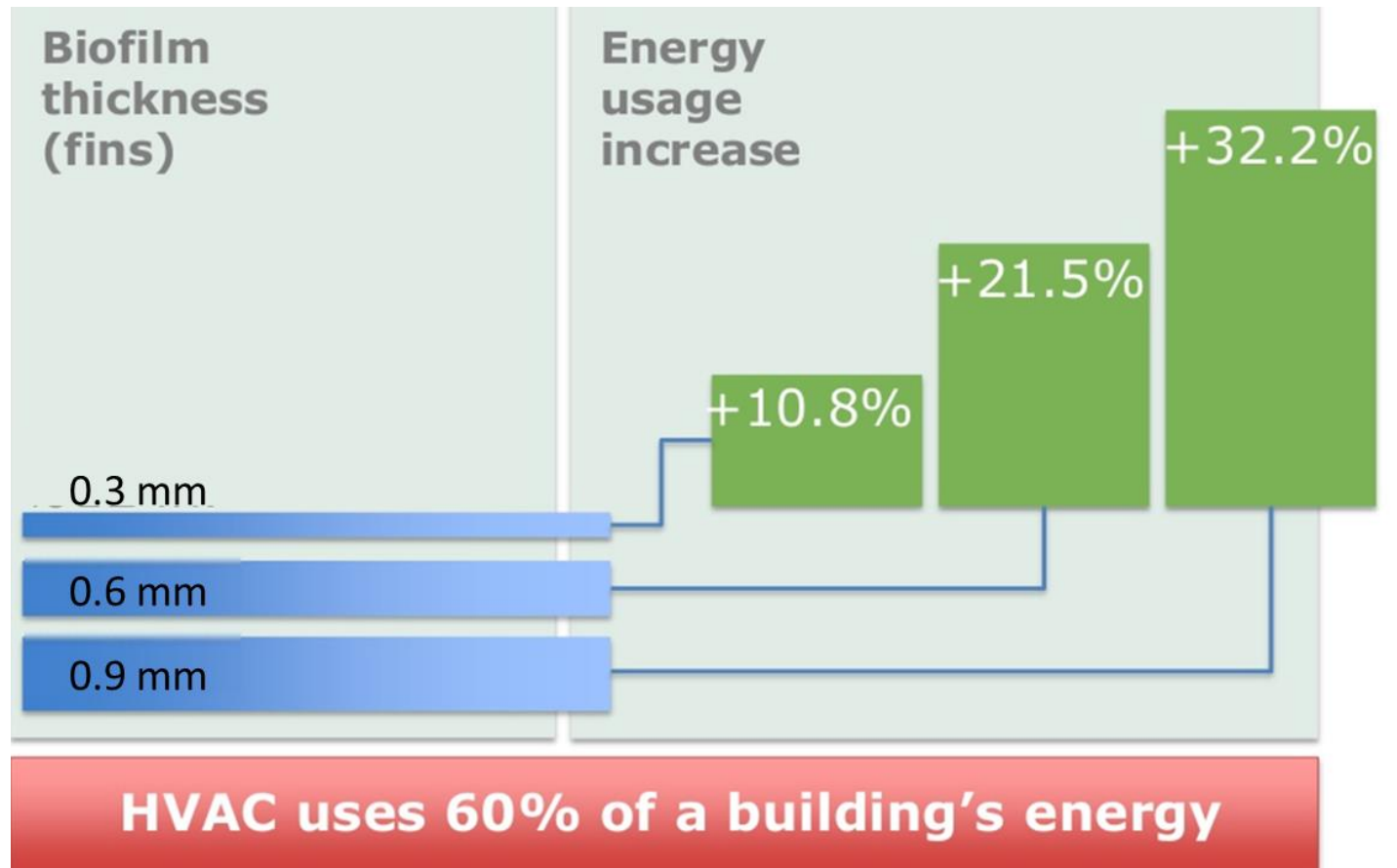
# What biofilm could cause at HVAC System

- Energy cost increase
- Hard Maintenance work
- Electrical overload of pump (trip off)
- Health danger(Legionella)
- Equipment life time(Corrosion)





# Cost Impact of Microbial Fouling



On Condenser  
Biofilm forms an  
insulating layer  
1 mm biofilm  
thickness >  
13 % energy loss



Chiller Condenser

# Potential Health Danger

Legionella Bacteria



# THE KILLERS IN THE MIST

**July 12** First South Bronx Legionnaires' case is diagnosed.

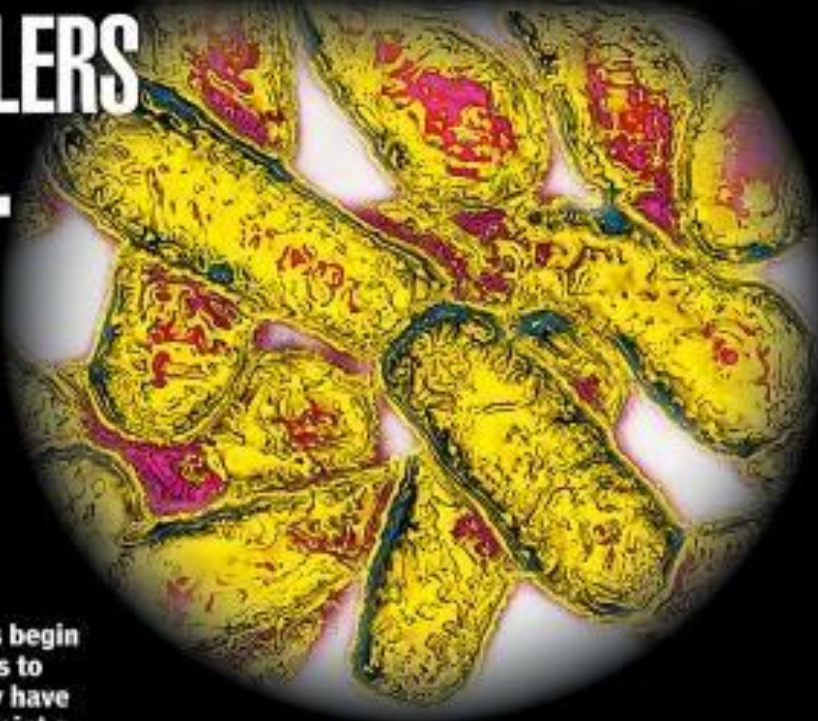
**July 18** The number of diagnosed cases grows to 12.

**July 20** City officials begin interviewing patients to determine what they have in common and pinpoint a source of the outbreak.

**July 27** The number of diagnosed cases grows to 40.

**July 28** City begins to sample and test water from cooling towers in the South Bronx.

**July 29** The city tells the public about the outbreak and discloses that two patients have died. The first towers to test positive for Legionella bacteria are cleaned.



**July 30** The number of new cases peaks, as 13 are diagnosed in a single day.

**July 31** City gets test results for all 17 cooling towers in the outbreak area. Five cooling towers test positive: at Lincoln Hospital, Concourse Plaza mall, the Opera House Hotel, Streamline Plastics Co. and a Verizon building.

**Aug. 1** City reveals a fourth Legionnaires' patient has died and that reported cases have risen to 65. Cleaning is completed in all five contaminated buildings.

**Aug. 3** City announces that the outbreak's death toll has climbed to seven.

**Aug. 4** The number of reported cases grows to 86.

# WHAT YOU NEED TO KNOW

**Q** What is Legionnaires' disease?

**A** It's a severe form of pneumonia caused by a bacteria grown in warm water – for instance, in hot water tanks and cooling towers.

**Q** How do you get Legionnaires' disease?

**A** When you breathe in a mist containing the bacteria. You do not catch it from another infected person.

**Q** What are the symptoms?

**A** Victims suffer shortness of breath, high fever, muscle aches, headaches and coughing.

**Q** What are treatment options?

**A** The disease can be treated with antibiotics.



**Gram-positive** | Ex. *Streptococcus*  
Thick peptidoglycan layer absorbs surrounding materials, even toxins. Easier to kill, develops resistance slower.



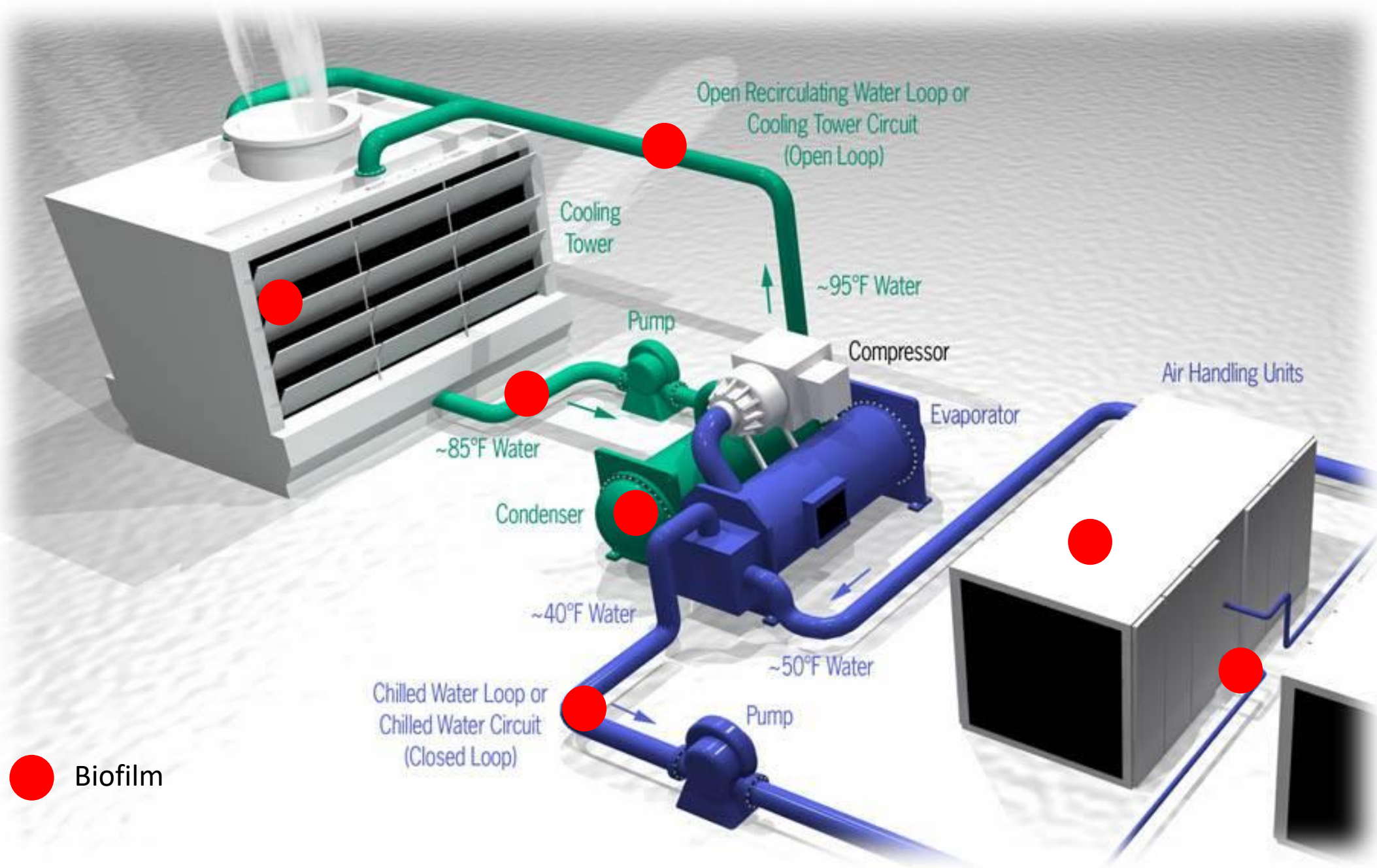
**Gram-negative** | Ex. *E. coli*  
Thin peptidoglycan layer covered by multiple thin layers of membrane which eject toxins. Harder to kill, quick to develop resistance.

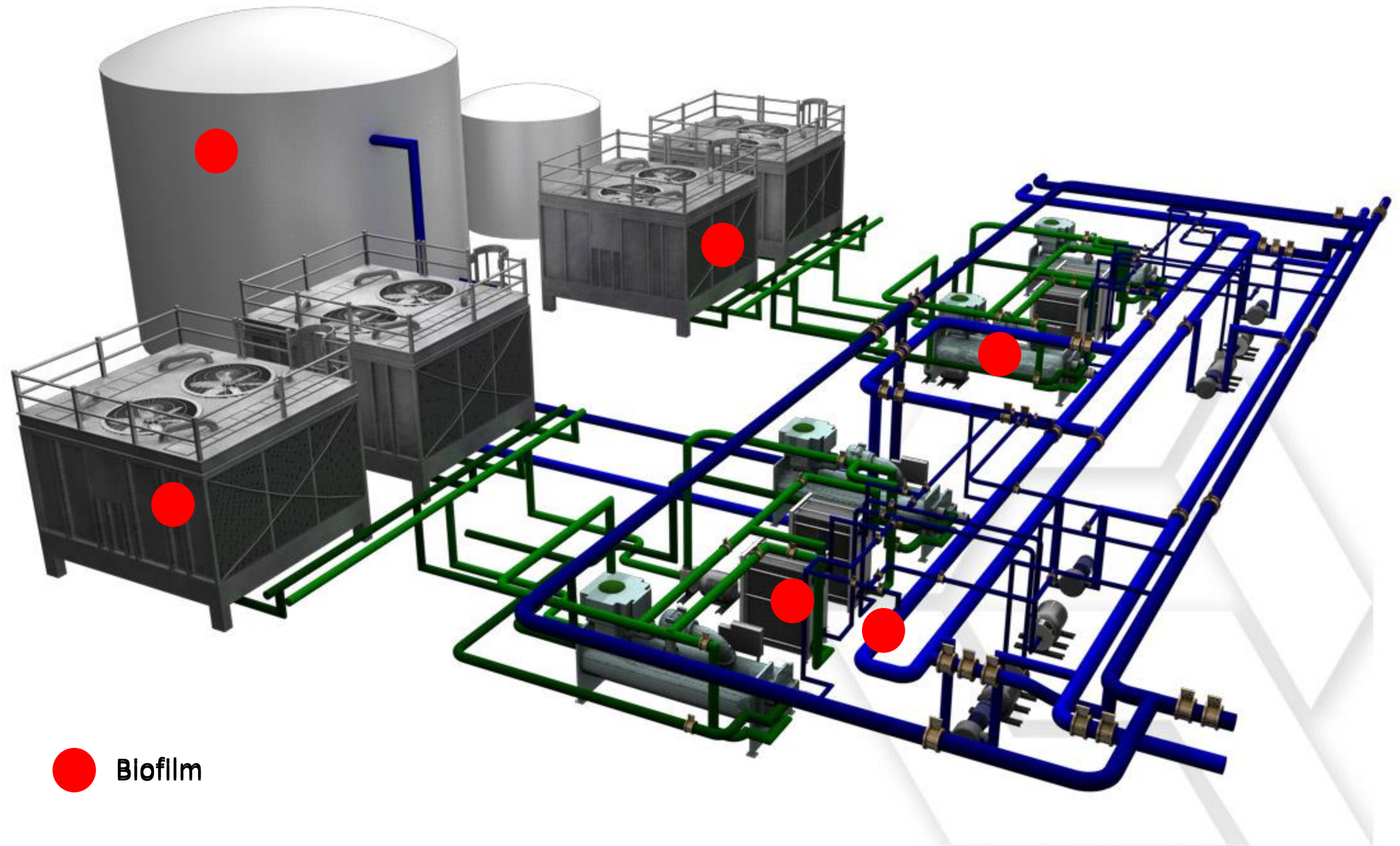




Cooling Tower – Chiller  
Condenser Water Tank  
Pump

# Biofilm in the water system

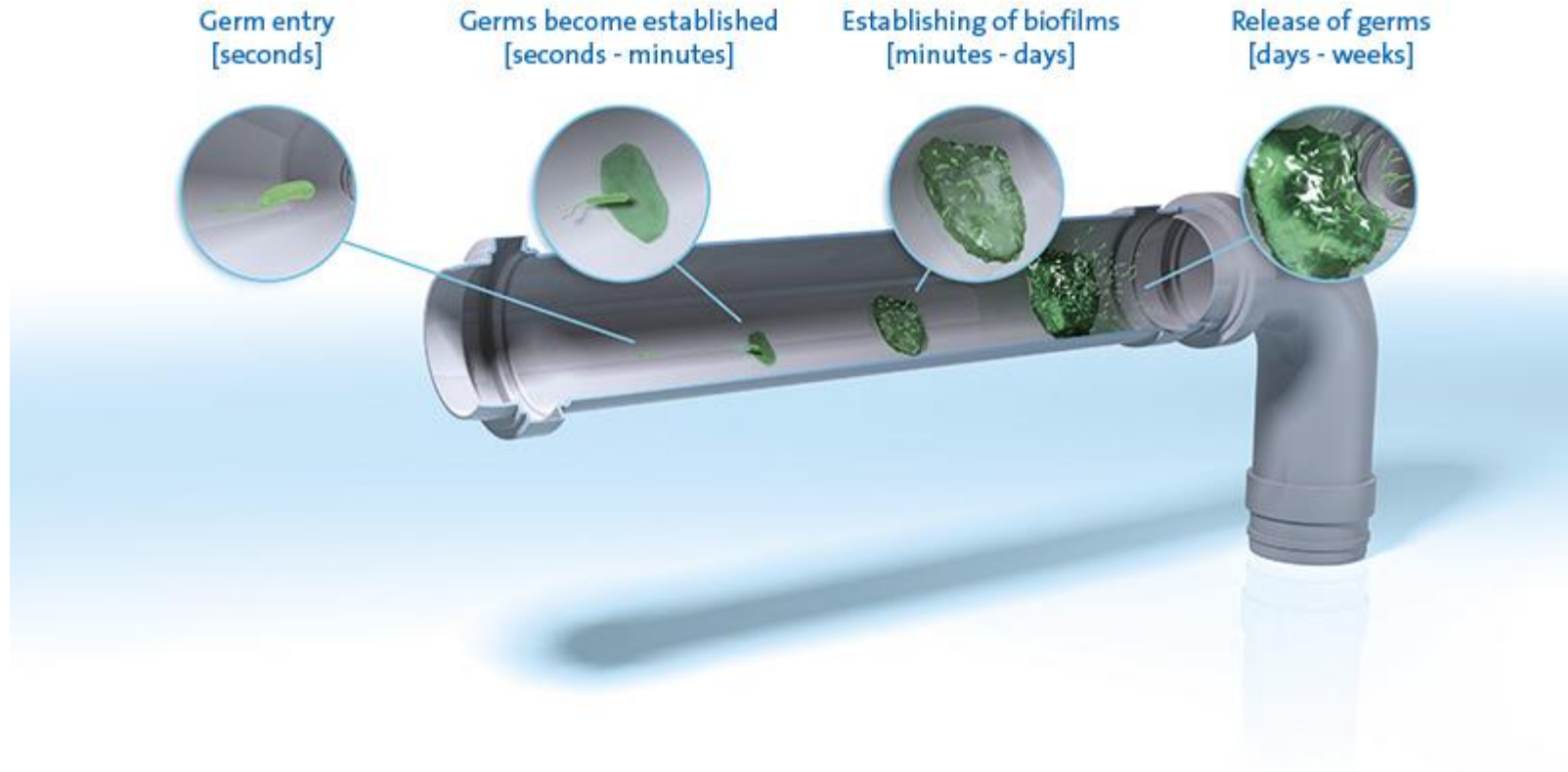




● Biofilm

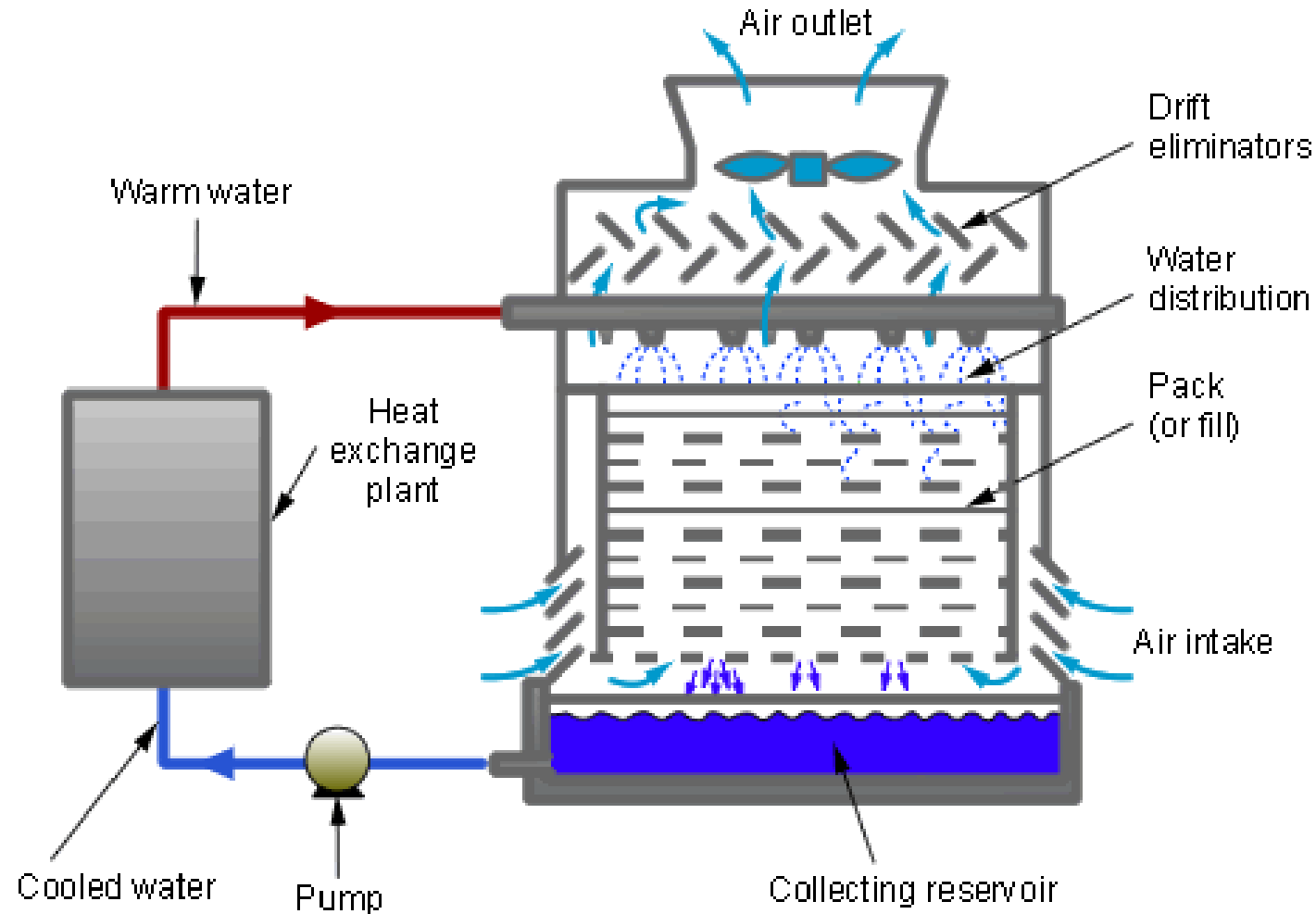


# Biofilm in the piping system



Microorganisms settle on wet surfaces and over time form a biofilm there. After several days, a biofilm can have already reached its stationary phase when continuous release of germs takes place.

# Biofilm in Industrial Process Cooling



# Microbial Influenced Corrosion

- APB – Acid Producing Bacteria
- IRB – Iron Depositing Bacteria
- Sulfate Reducing Bacteria







Remove existing  
biofouling deposits  
Prevent the formation  
of new deposits



Biofilm build up every  
where

Ionic Nano Copper  
stops biofilm build up

# Ionic Nano Copper

## Chemical Name & Properties

Common Name of Active Ingredient	Copper Sulphate Penta-Hydrate
Chemical Name of Active Ingredient (IUPAC I designation)	Present as Copper Sulphate Penta-Hydrate
Formula (empirical and structural)	CuSO <sub>4</sub> ·5H <sub>2</sub> O
Production Date	08/12/2016
Expiry Date	08/12/2026

- Copper Sulphate Penta-Hydrate CAS# 7758-98-7 5% to 5.3%
- Sulphuric Acid CAS # 7758-99-8 2.8% to 3.1
- Odor: Mild
- Appearance: (Physical state, & color) Clear, blue liquid
- Odor threshold concentration: (ppm) Not applicable
- Density/specific gravity: (H<sub>2</sub>O = 1) 1.19
- Vapor pressure at 200 C: (mmHg) 0.1
- Vapor density: (Air = 1) 1
- Evaporation rate: N/A
- Boiling point: (C/F) 104°C
- Freezing point: (C/F) 00°C
- pH: 1.2 (buffered)
- Lead (as Pb) ND
- Cadmium (as Cd) ND
- Arsenic (as As) ND





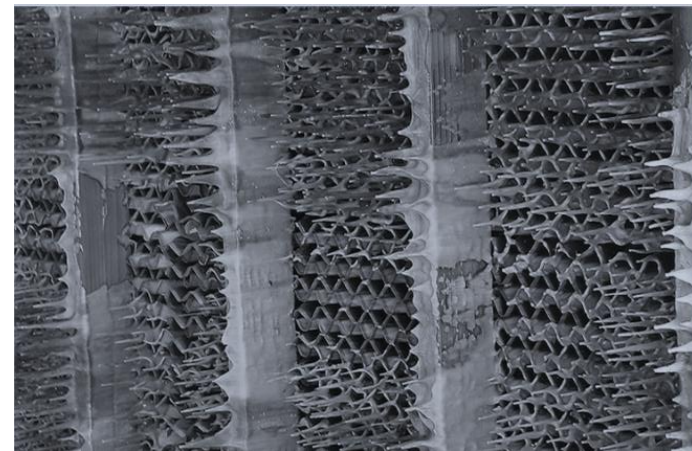
# Objective of Ionic Nano Copper

- Improved Biofouling Control
- Cost effective biofouling control
- Enhanced Corrosion Control
- Enhanced Scale Control

The evidence from decades of scientific research is very clear. *Legionella pneumophila* resides primarily in biofilms in building and industrial water systems.

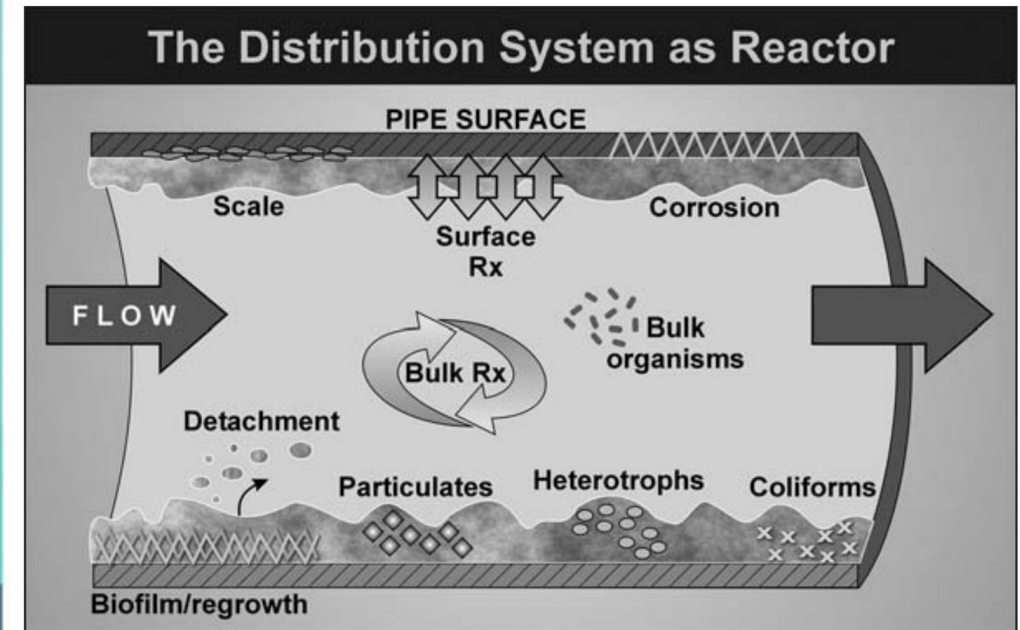
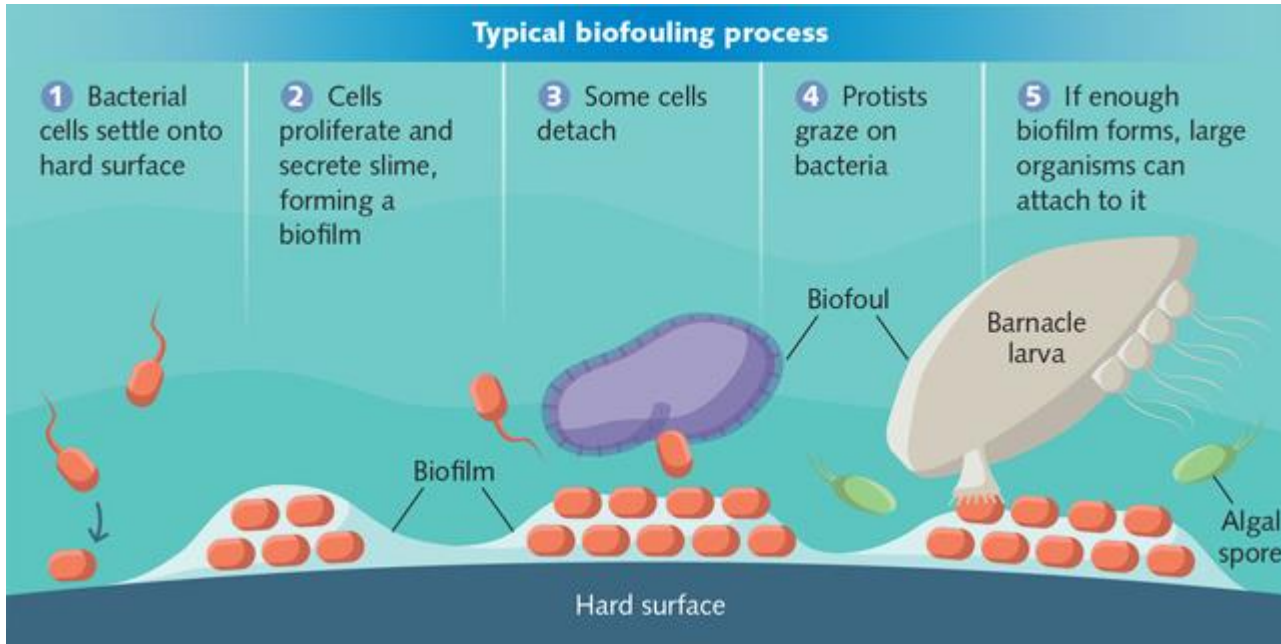


Clean cooling tower



Biofouled cooling tower

# 90% of bacteria lives in biofilm



Source: Center for Biofilm Engineering 1996

- Biofilms protect the pathogenic bacteria, making them hard to kill.
- Hiding in biofilms, bacteria can spread throughout the body.
- Large, sticky biofilms resist the attack of the immune system and antibiotics

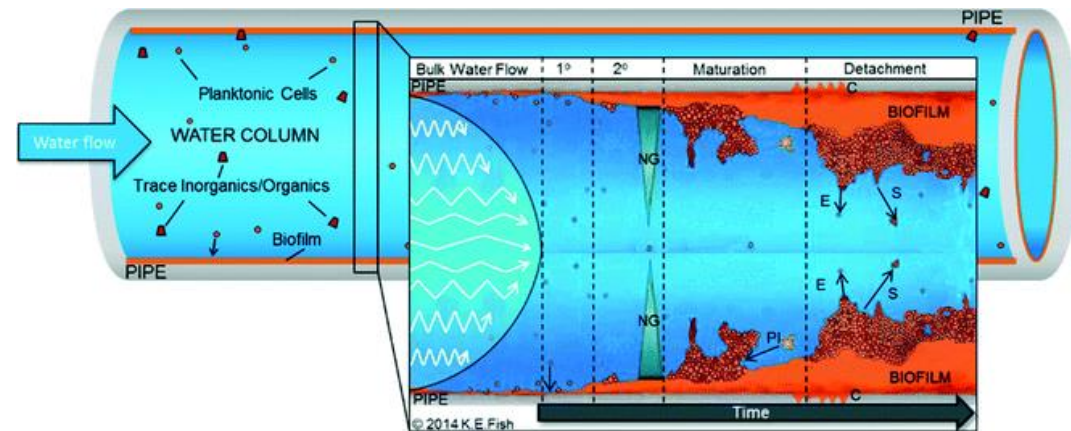
# Ionic Nano Copper stops biofilm formation

## Clean Water and Biofilm Contamination

What happens inside a water pipe?



A dirty pipe puts your drinking water quality at risk of contamination





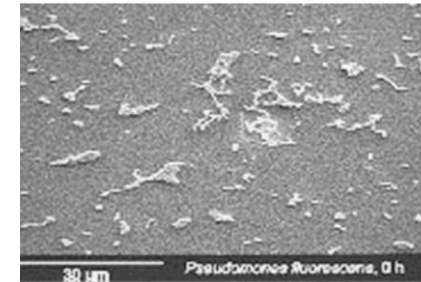
# Biofilm growth

Phase	Time
Colonization	15 minutes
Growth detection	2 days
Biofilm formation (minimum)	5 days
Maximum biofilm growth (8-10 cells thick)	14 days
Full Mature Biofil Matrix	31 – 40 days

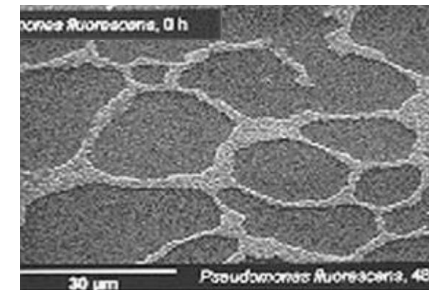
Destroying the biofilm support the goal of getting a more effective cooling towers in two ways.

1. Control biofilm growth is equal to Legionella control.
2. Control biofilm growth increase the efficiency

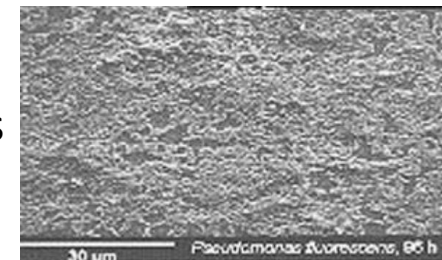
2 hours



2 days



4 days

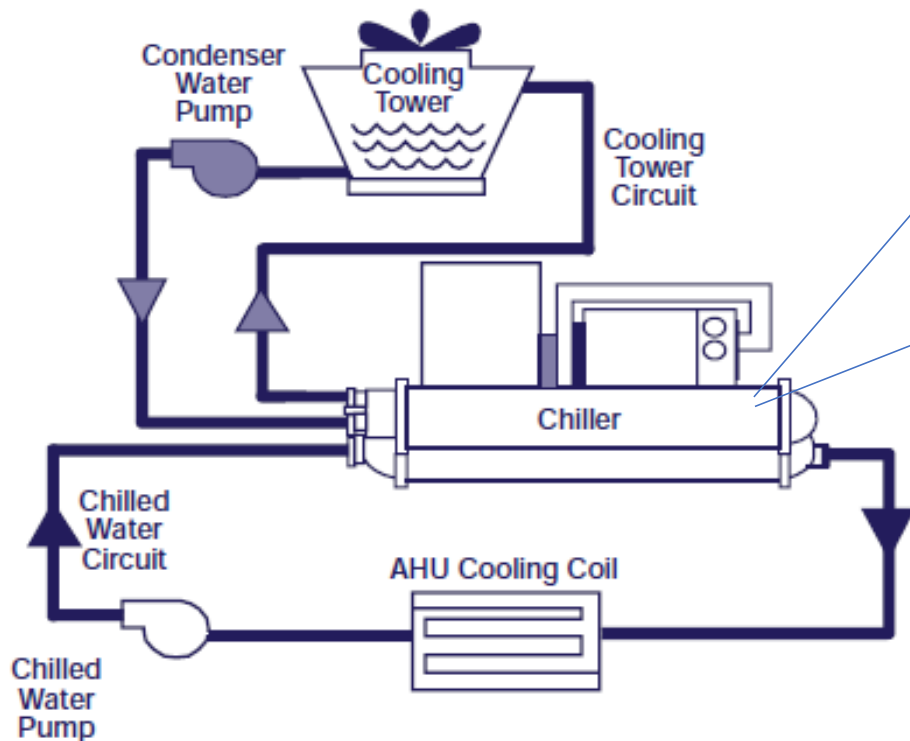


100 micron



# Legionella in the Water System

- evaporative cooling water systems,
- evaporative condensers
- closed-circuit fluid coolers
- cooling towers.



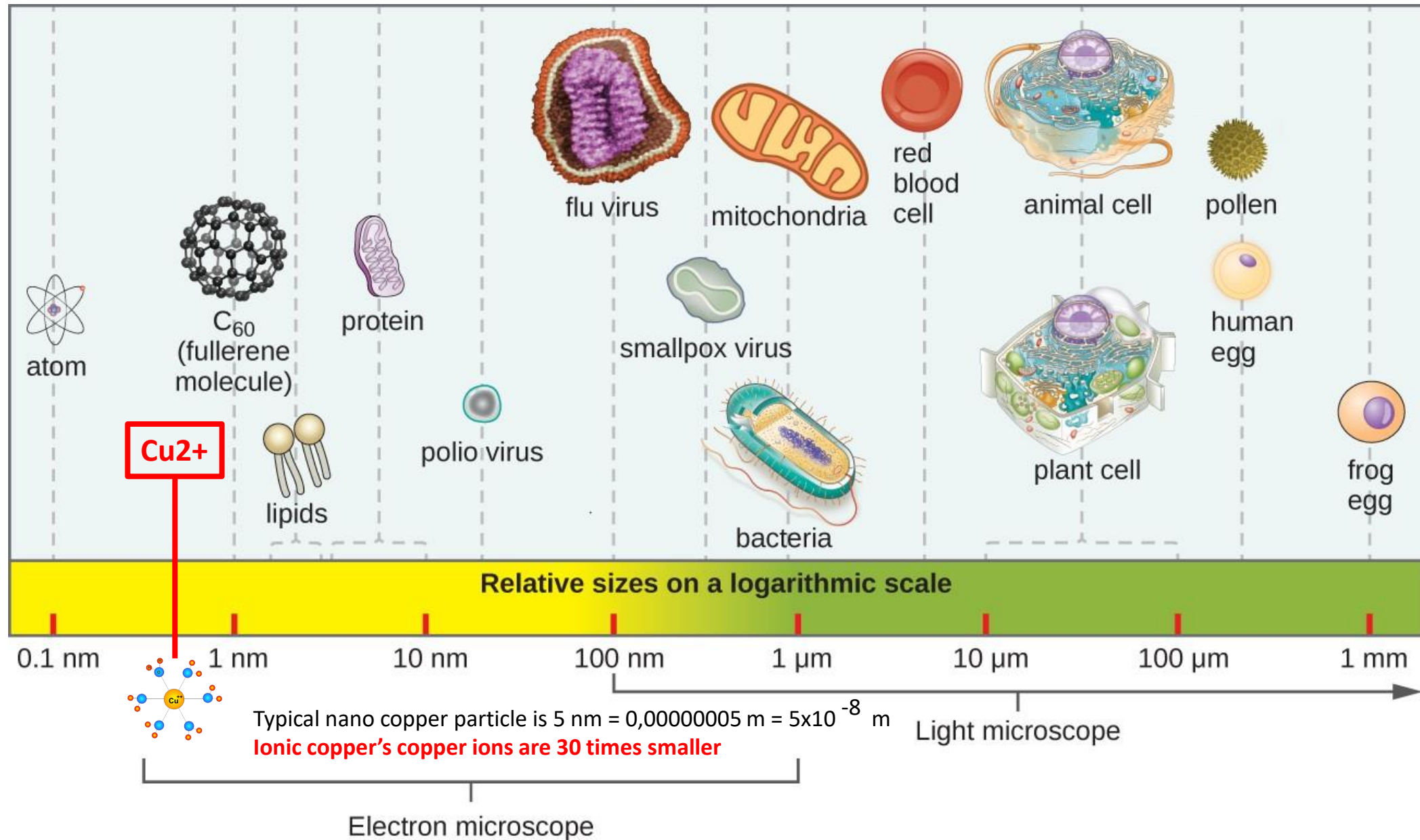
Colorized scanning electron micrograph (8000X) depicting a large grouping of Gram-negative *Legionella pneumophila* bacteria (Source: Centers for Disease Control).



Seek & Destroy with  
biostatic effect

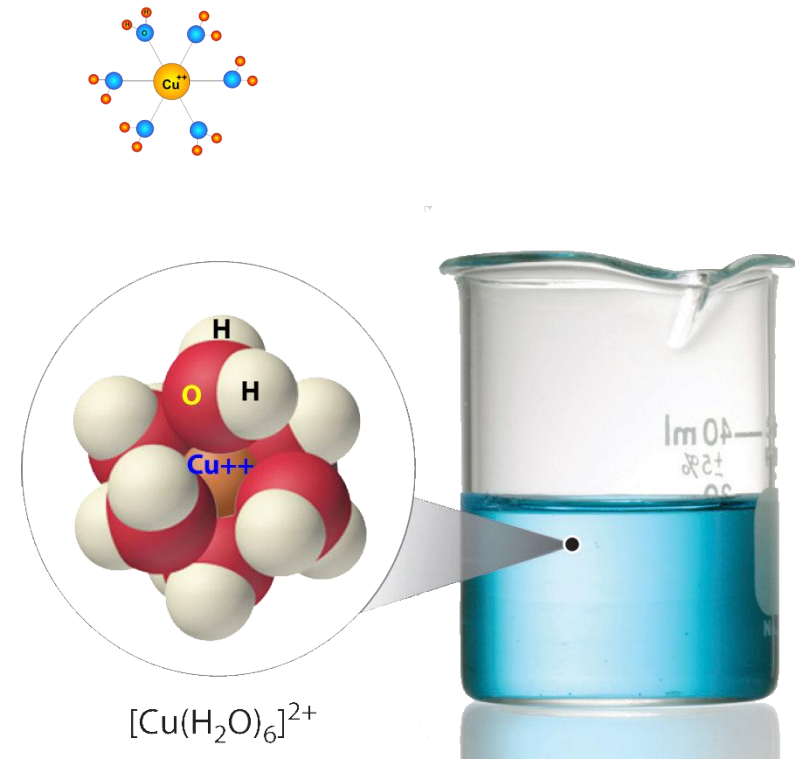
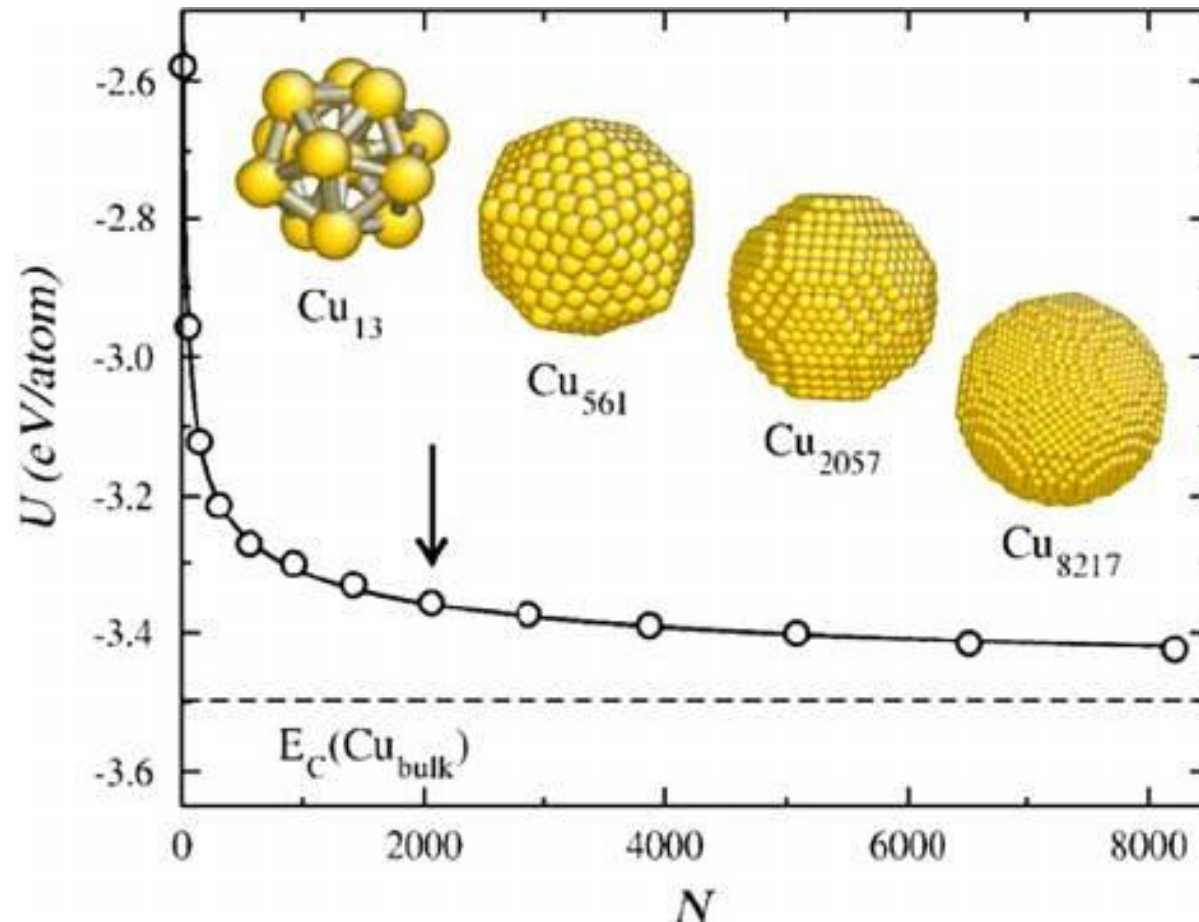
Ionic Nano Copper as  
biocide, fungicide and  
algaecide

# Ionic Nano Copper Size



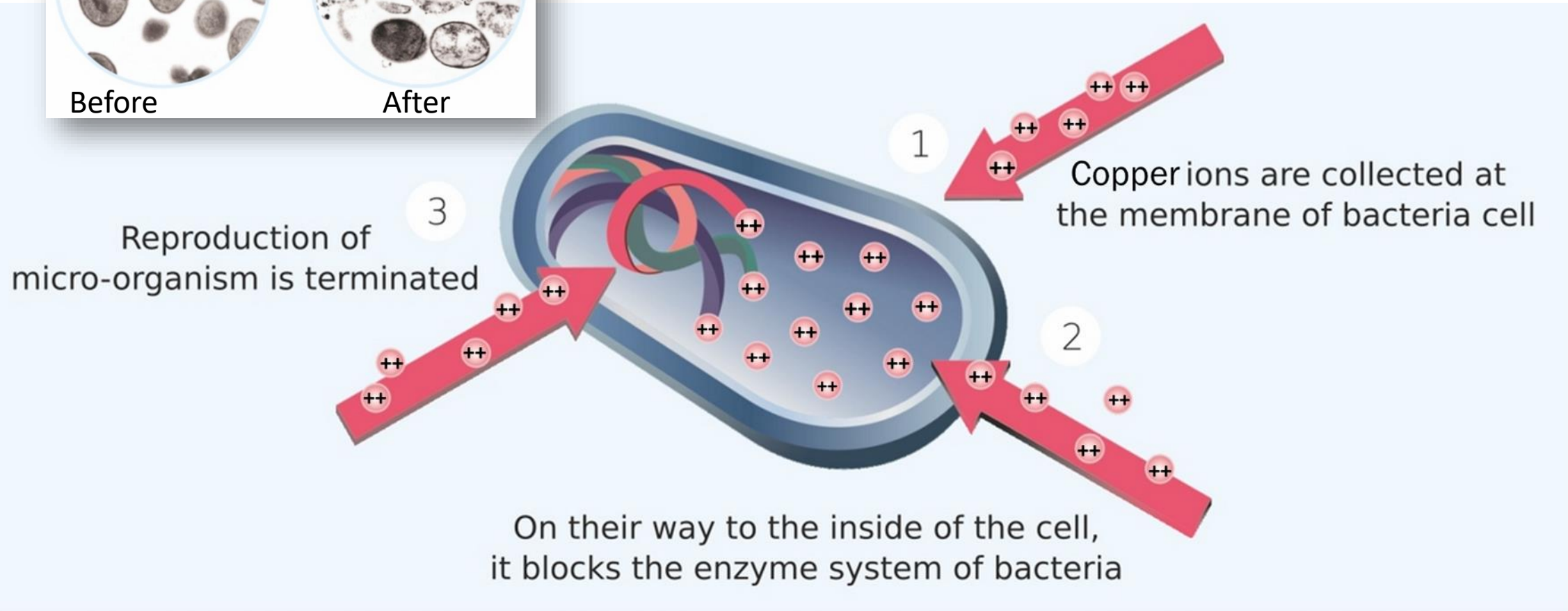
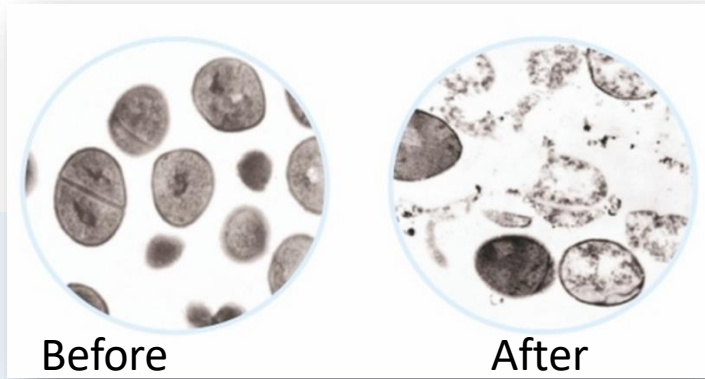
Smaller size causes higher electrostatic

“Disruptive force for breaking cell membrane”





# Ionic Nano Copper – Seek & Destroy Mission



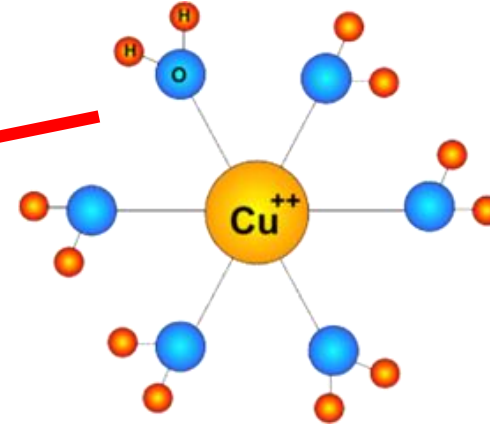
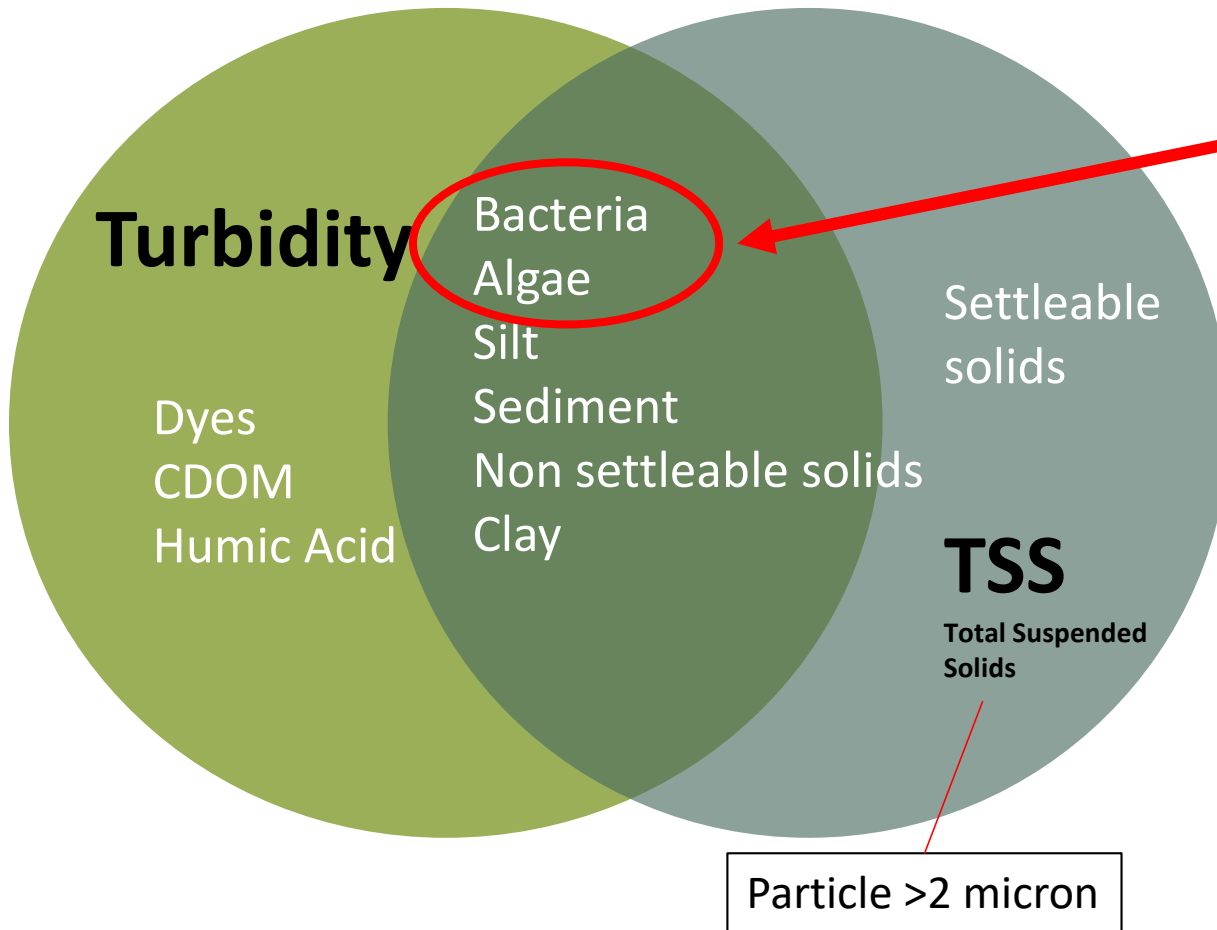


# Comparison of Technologies

## Comparison of technologies

	<b>UV</b>	<b>Sodium Hypochlorite</b>	<b>Chlorine Dioxide</b>	<b>Ozone</b>	<b>Ionic Nano Copper</b>
Prophylactic effect	No	Yes	Yes	Limited	Yes
Destroys biofilms	No	Limited	Yes	Limited	Yes
Safe for operators	Yes	No	No	Yes	Yes
Effective against legionella colonization	No	Yes	Yes	Limited	Yes
Environmentally safe	Yes	Yes	Yes	Yes	Yes

# Ionic Nano Copper targets bacteria & algae



Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration 3.

# The Effect on bacteria & algae reduction

Water analysis Parameter	Untreated Sample	Sample treated with INC (3days)	Improvement
Color	70	5	93 %
Turbidity	11.2	3.55	68 %
pT@25 C	8.4	7.67	
Total Alkalinity	64	11.4	82 %
Total Suspended Solid	78	5	94 %
BOD5	7	4	43 %



**Sample Treated with Ionic Cupric Copper After 3 day**

**Sample Untreated**

Water source: man made lake





# Dilution Method and Dosage

Cost Effective Prevention of Biofilm and Corrosion


Ratio 1:60.000		
Concentration 1 ppm		
Water in M3	Water in Liter	Ionic Nano Copper in mL
100	100,000	<b>1,667</b>
200	200,000	<b>3,333</b>
300	300,000	<b>5,000</b>
400	400,000	<b>6,667</b>
500	500,000	<b>8,333</b>
600	600,000	<b>10,000</b>
700	700,000	<b>11,667</b>
800	800,000	<b>13,333</b>
900	900,000	<b>15,000</b>
1000	1,000,000	<b>16,667</b>
2000	2,000,000	<b>33,333</b>
3000	3,000,000	<b>50,000</b>
3001	3,001,000	<b>50,017</b>
4000	4,000,000	<b>66,667</b>
5000	5,000,000	<b>83,333</b>

1 M3=1000 L  
1 L=1000 mL

Ratio 1:60.000 (concentration 1 ppm)					
Water in M3	Water in Liter	Ionic Nano Copper in mL	Water in M3	Water in Liter	Ionic Nano Copper in mL
1	1,000	<b>17</b>	16	16,000	<b>267</b>
2	2,000	<b>33</b>	17	17,000	<b>283</b>
3	3,000	<b>50</b>	18	18,000	<b>300</b>
4	4,000	<b>67</b>	19	19,000	<b>317</b>
5	5,000	<b>83</b>	20	20,000	<b>333</b>
6	6,000	<b>100</b>	21	21,000	<b>350</b>
7	7,000	<b>117</b>	22	22,000	<b>367</b>
8	8,000	<b>133</b>	23	23,000	<b>383</b>
9	9,000	<b>150</b>	24	24,000	<b>400</b>
10	10,000	<b>167</b>	25	25,000	<b>417</b>
11	11,000	<b>183</b>	26	26,000	<b>433</b>
12	12,000	<b>200</b>	27	27,000	<b>450</b>
13	13,000	<b>217</b>	28	28,000	<b>467</b>
14	14,000	<b>233</b>	29	29,000	<b>483</b>
15	15,000	<b>250</b>	30	30,000	<b>500</b>

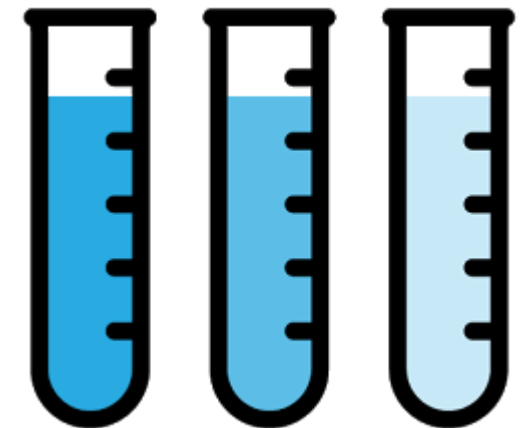
1 M3=1000 L  
1 L=1000 mL

### Copper



0    0.5    1.0    2.0    5.0  
mg/L or ppm

- Administer & maintain 1 ppm
- Don't go below 0,1 ppm

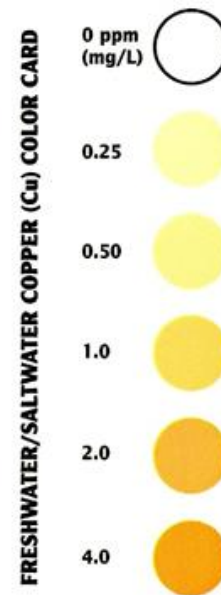
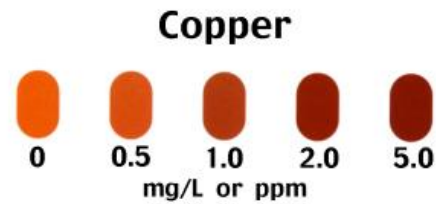


# Dilution Methode

To obtain 1 ppm, add 1 part of INC<sup>®</sup>-IONIC NANO COPPER to 60,000 parts of system water or 1:60,000 dilution.

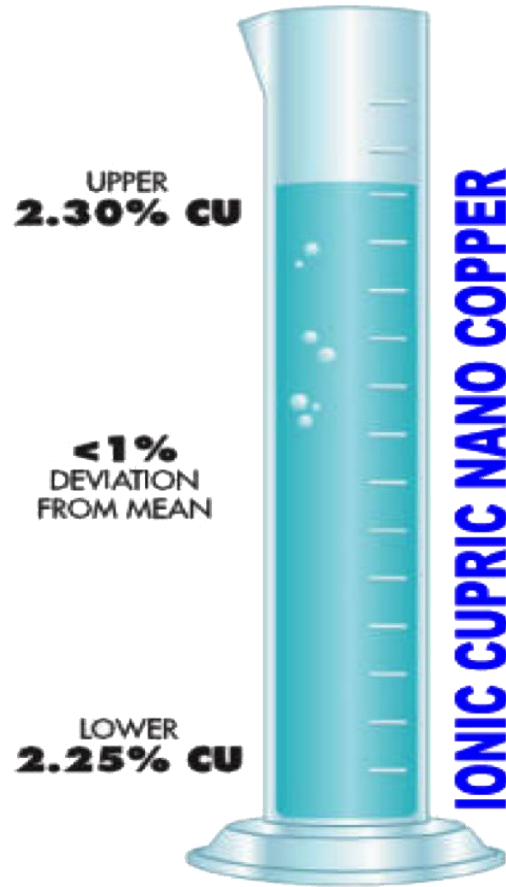
Example 1: For 1,000 liters of pool water, use 17 ml of INC (QuaDrop).

Example 2: For 100 M3 (100.000 L) of system water, use 28 ml to 1.667 ml of INC (QuaDrop)



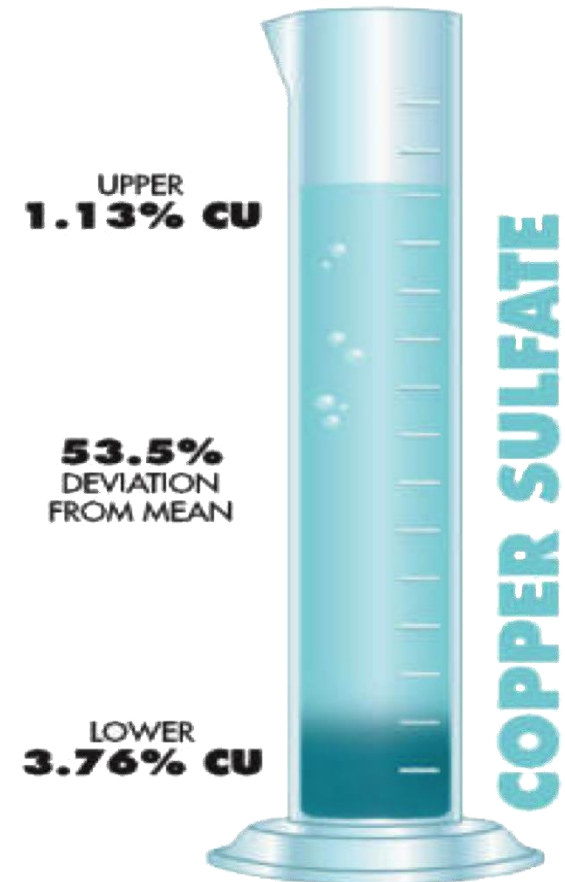
# Ionic Nano Copper is self mixing

No precipitation  
(No settling  
of  $\text{Cu}^{++}$ )



Water soluble

1 ppm of stable copper ions



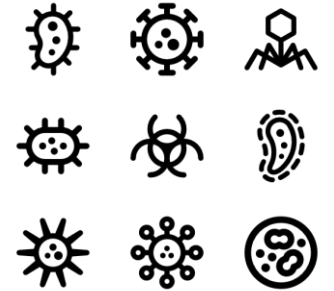
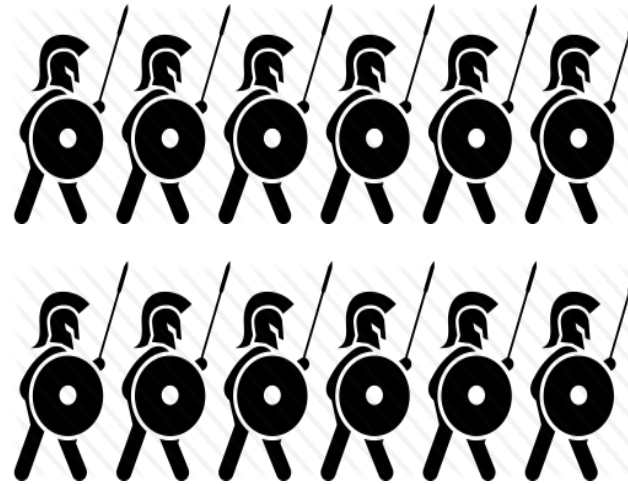
5000 ppm



# *Ionic Cupric Copper* does not dissipate



it is ONLY used up by biological demand & no other matters



*Ionic Cupric  
Copper* is  
uniformly self  
dispersing



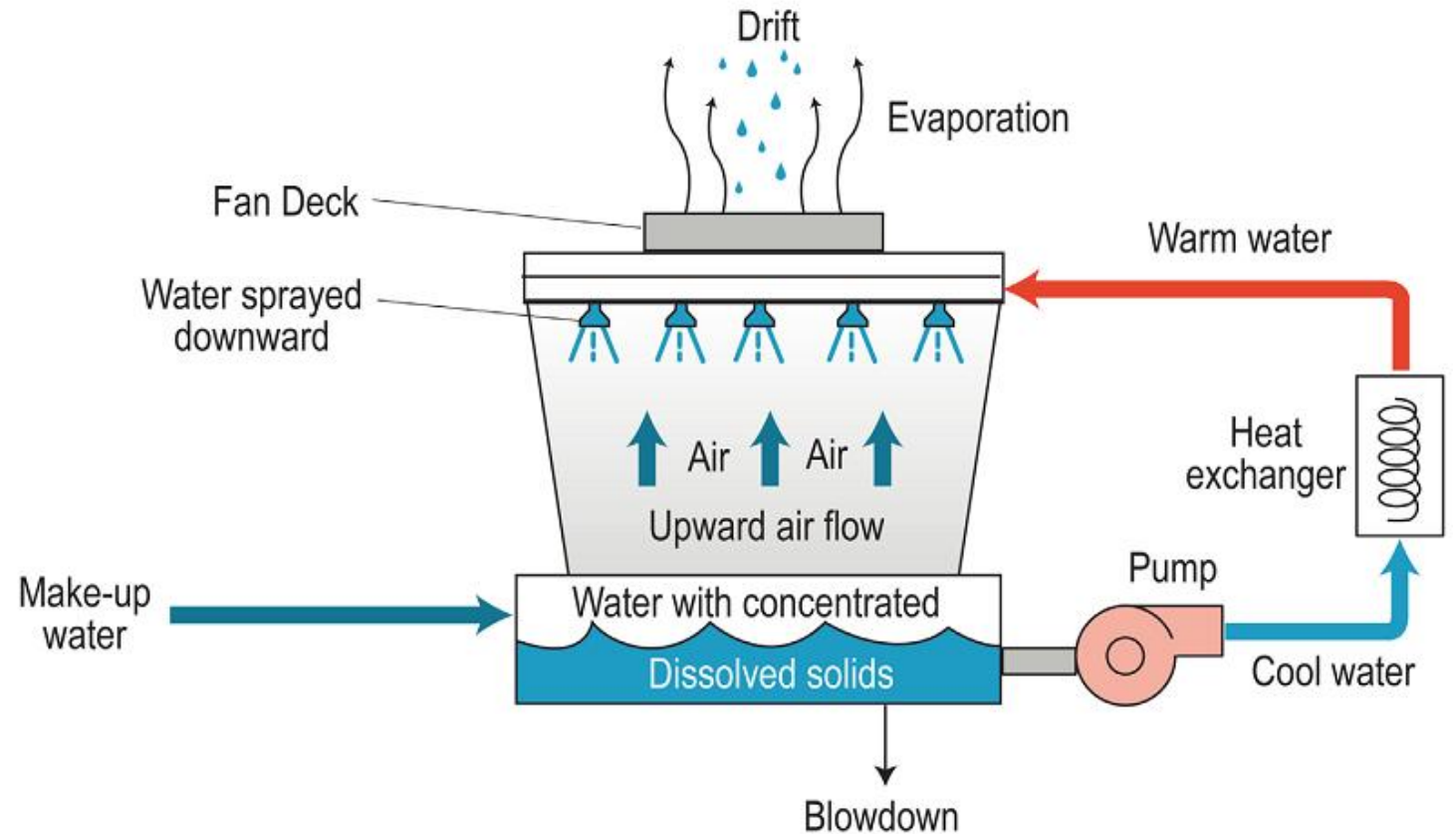
# When is periodic disinfection necessary?

It is for systems that:

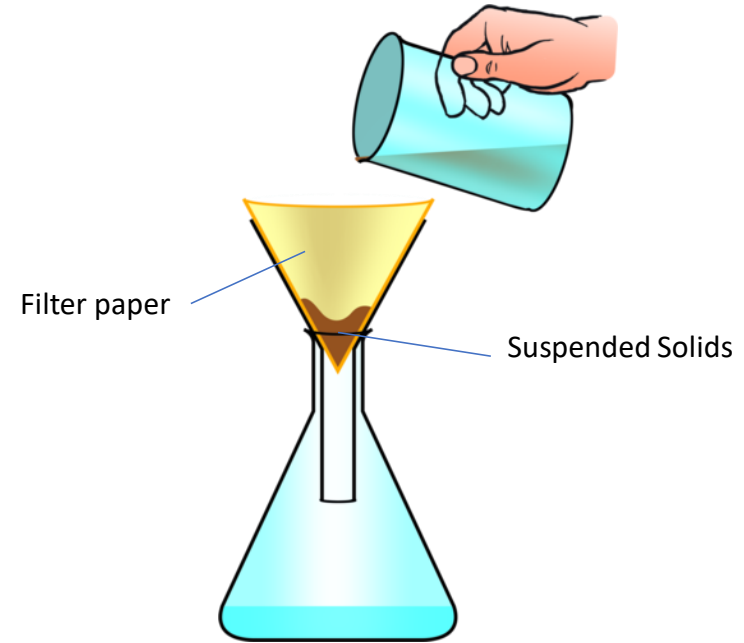
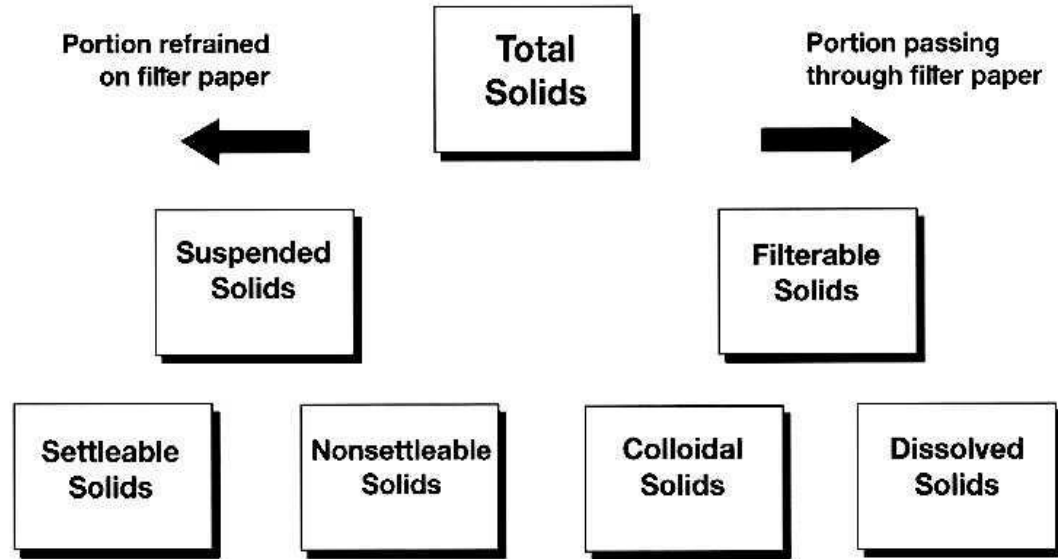
- That have process leaks
- That have heavy biofouling
- That use reclaimed wastewater as makeup
- That have been stagnant for a long time
- When the total aerobic bacteria counts regularly exceed 100,000 CFU/ml
- When Legionella test results show greater than 100 CFU/ml

# After Biofilm Control Program Treatment

After a biofilm control program treatment, you should also see *an increase in **suspended solids**, ATP, and bacterial counts in the bulk water as deposits are released*. After removal of the released deposits by filtration or blowdown, **repeated treatment should show decreasing evidence of biofouling**.



# SOLIDS CLASSIFICATION



# Suspended Solids



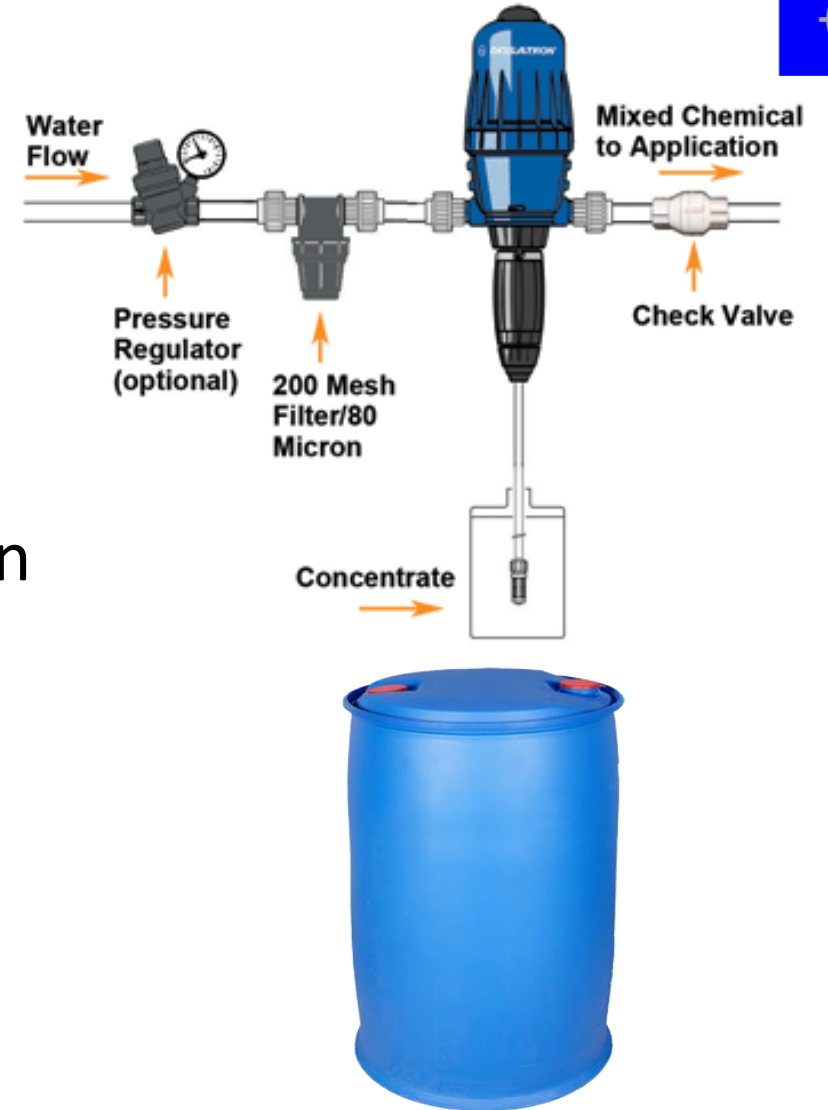


One agent for two  
challenges – it fights the  
planktonic bacteria and  
the biofilm

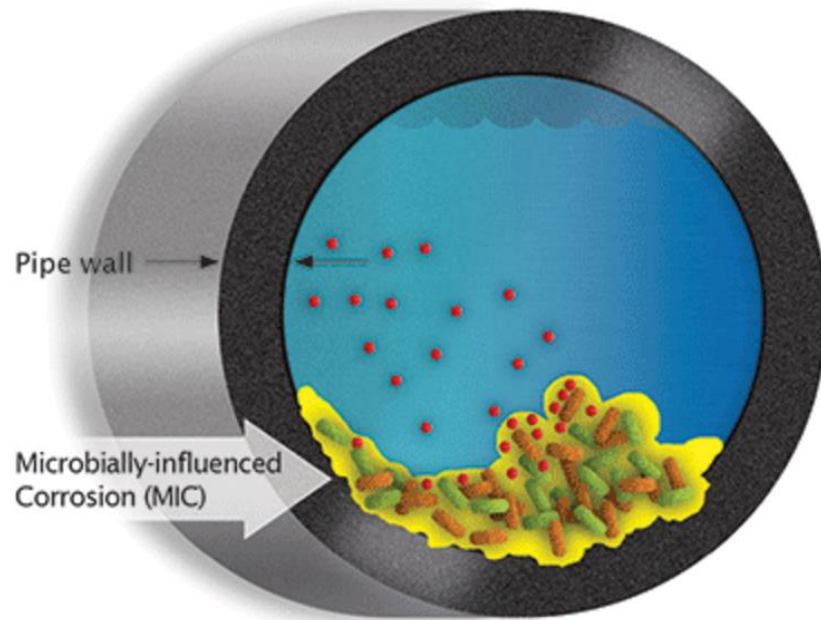
# Advantage of Ionic Nano Copper

# Ionic Nano Copper Benefit

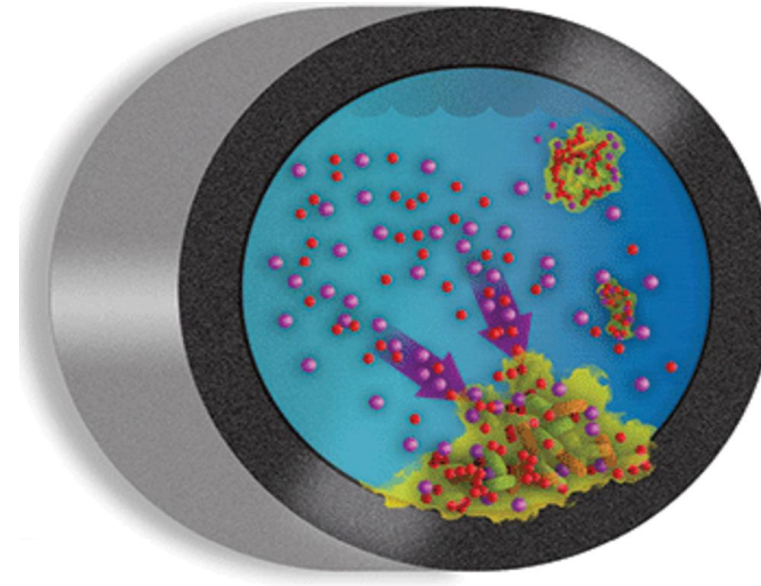
- High efficacy in very low dosage
- Removes and prevents biofilms
- Totally Chlorine Free (TCF)
- Inhibits Microbiologically induced corrosion
- Non-foaming
- Compatible with glycol and brine systems



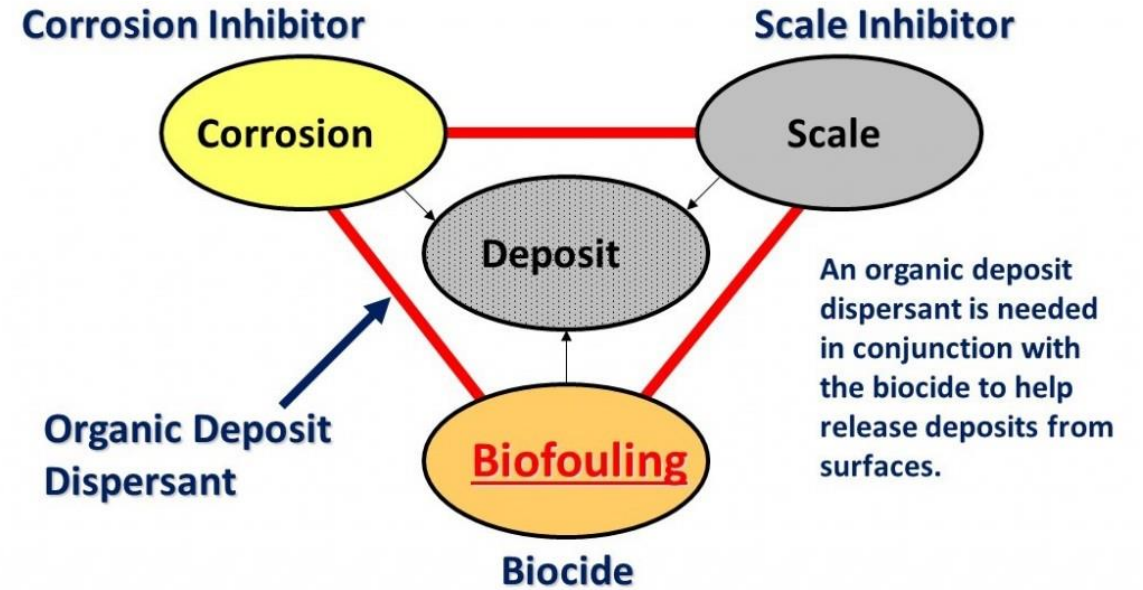
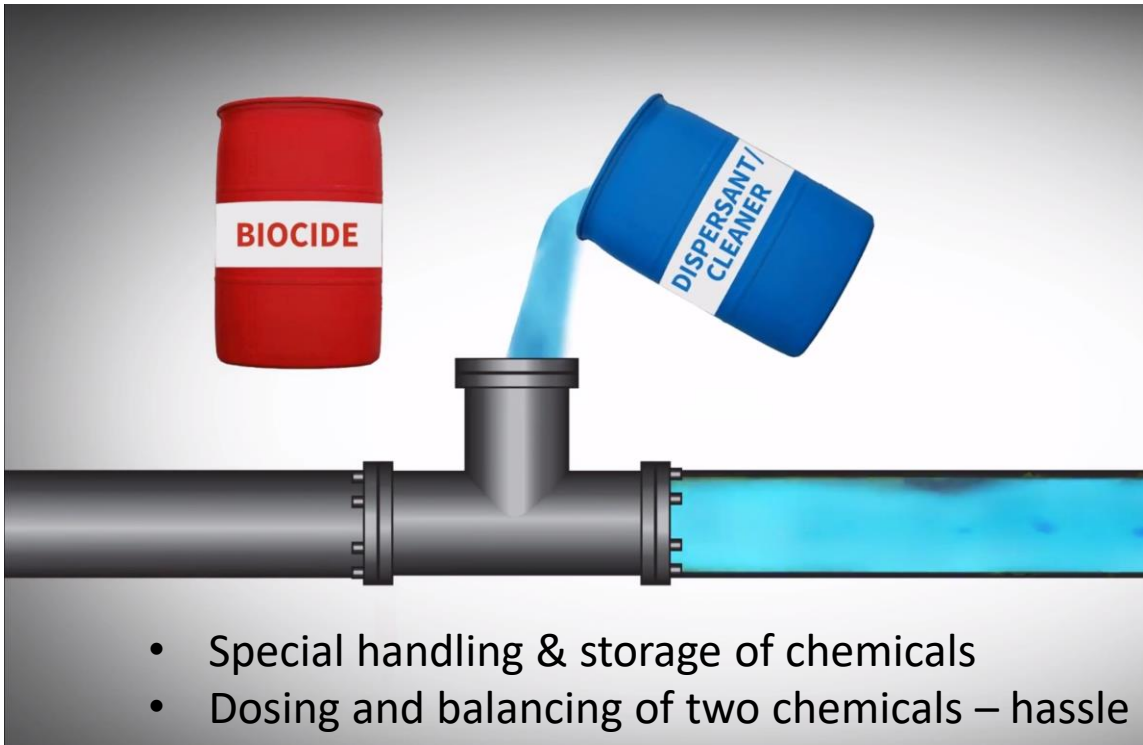
# Ionic Nano Copper's penetration into biofilm



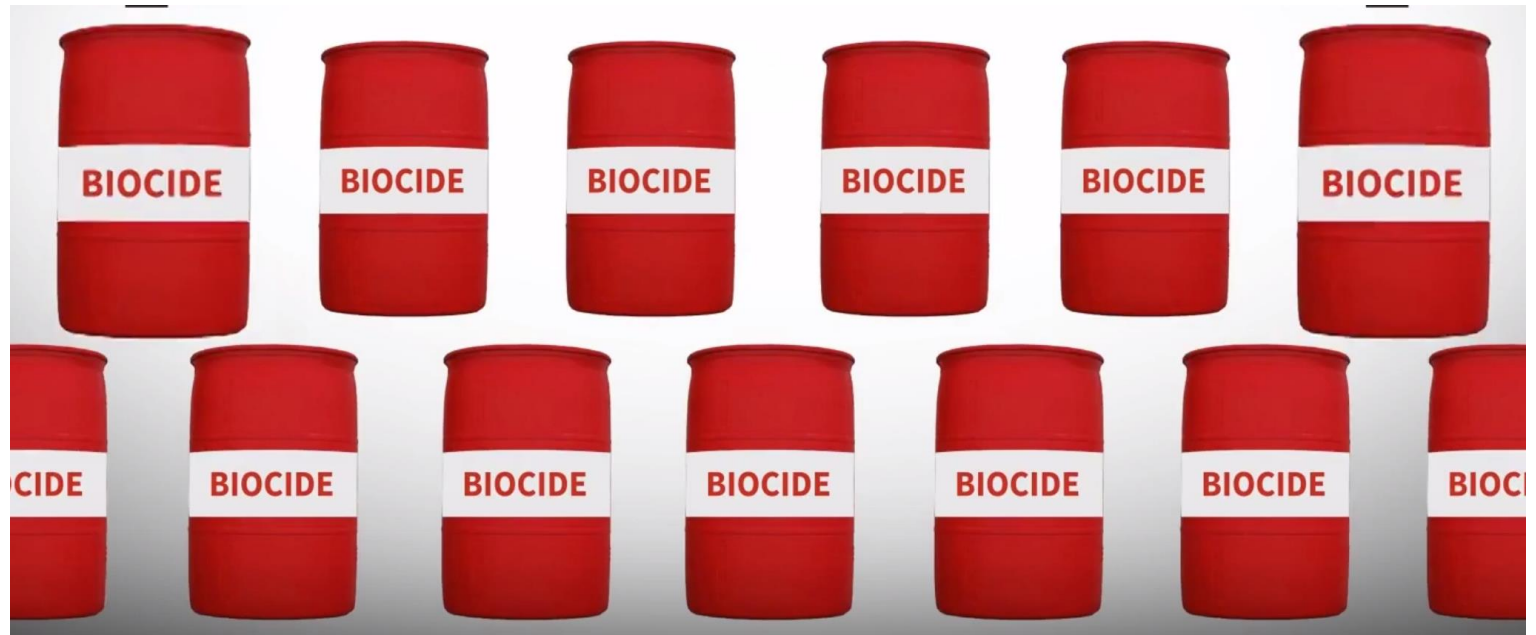
Corrosion is evidence of biofouling



**INC penetrates into biofilm & kill bacteria**  
**INC destabilizes biofouling deposits & removes from surface**  
**Cleaner surfaces with less MIC & better heat transfer**



Existing Practice – The use of two chemicals



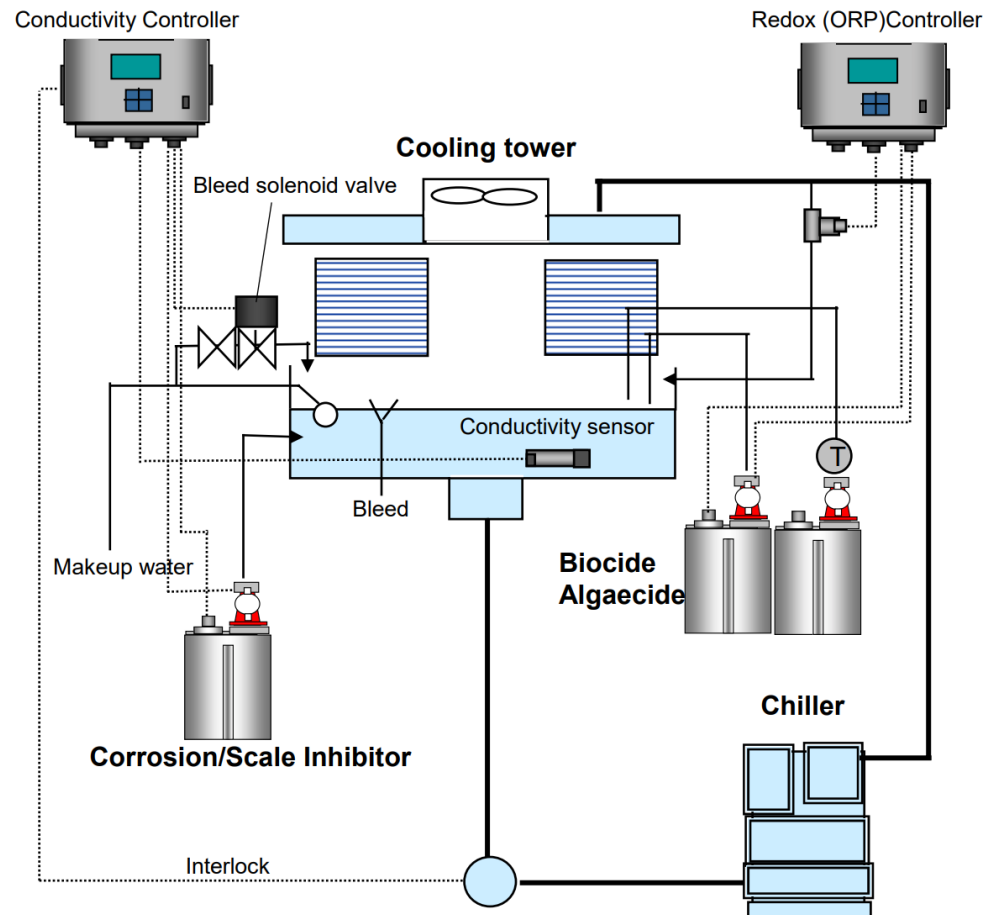
In practice higher concentration of biocide is used – higher cost

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# Last but not Least...

## Chemical Treatment



“ When using Ionic Nano Copper, **Please verify your previous system setting**”



Advanced Greentech Solutions Pte. Ltd - Manufacturer

Distribution with partners

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