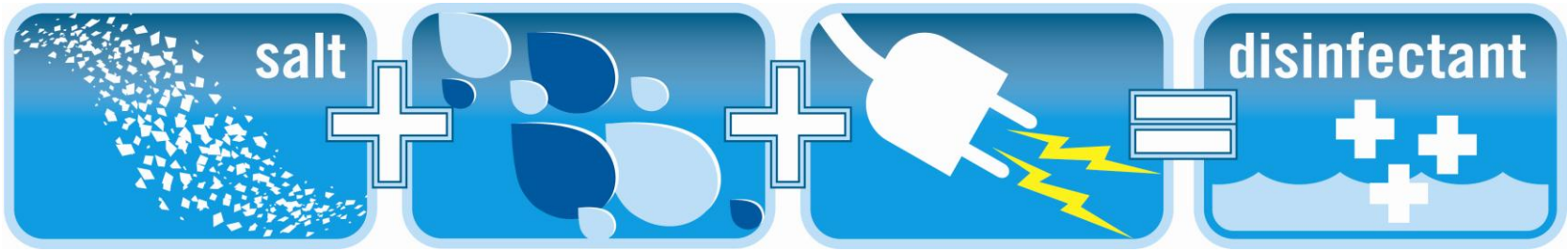
Cooling Tower Water Treatment

MIOX Superior Disinfection

Presented by: Thomas Muilenberg

MIOX On-Demand Chemistry

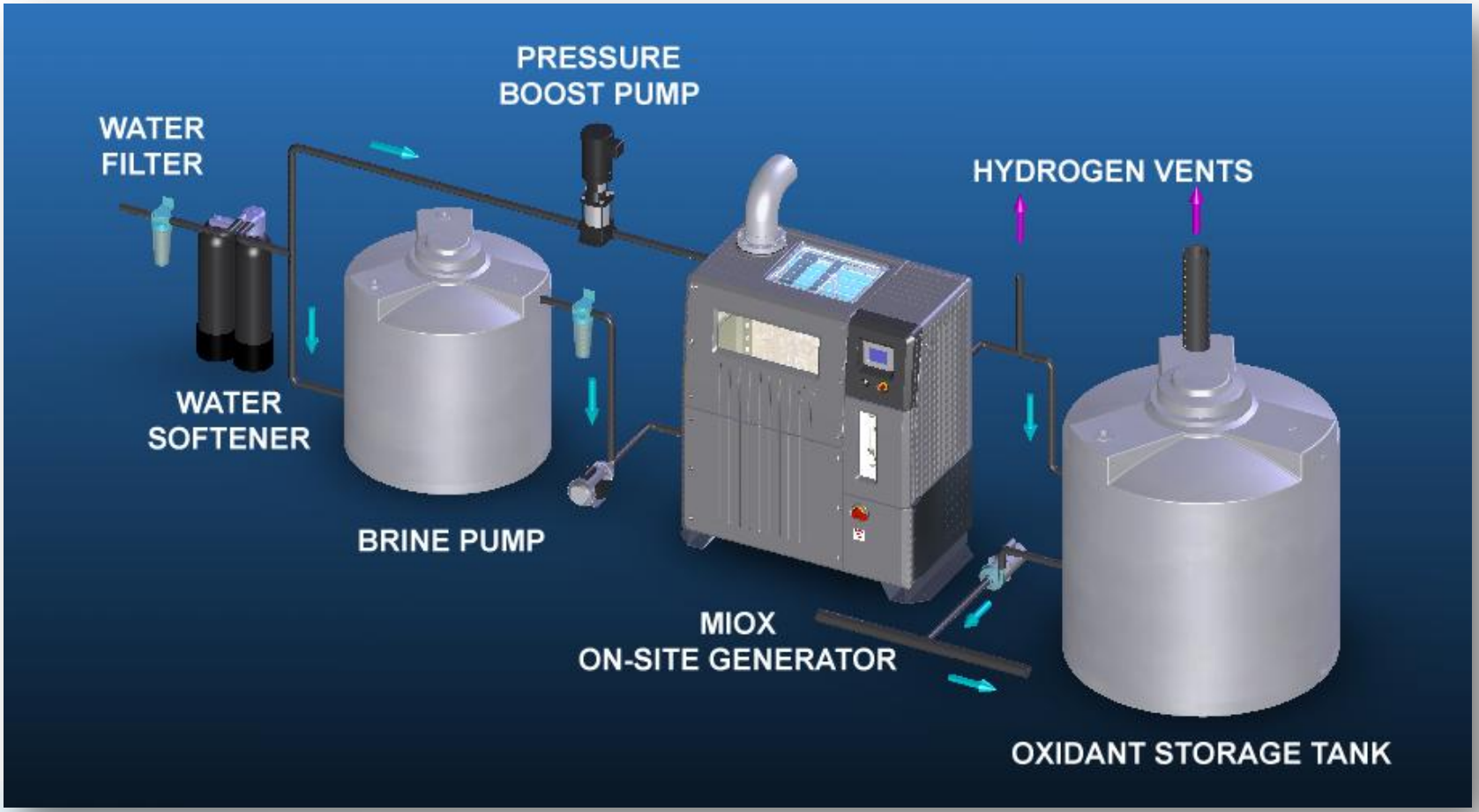
What is On-Site Chemical Generation?



SALTS + ON-SITE WATER + POWER = CUSTOM CHEMICAL

- Specialty chemistry generated on site, on demand
- Replaces multiple delivered chemicals
- Ability to create unique product characteristics

On-demand Chemical Process



Two System Configurations Include:

- Basic Bleach Generators
  - Nominally 0.6 – 0.8% concentration
  - Very efficient salt and energy conversion efficiencies
  - Good “general purpose” biocide
- Mixed Oxidant Generators
  - Uses slightly more power to make stronger oxidant
  - Great biopenetrant for better biofilm and organism control
  - Also has stronger oxidation power for certain applications

Mixed Oxidant Solution Chemistry

Vital Disinfectant for Cooling Towers and Loop (Exchanges, Chillers)

Major Challenges in Tower Maintenance

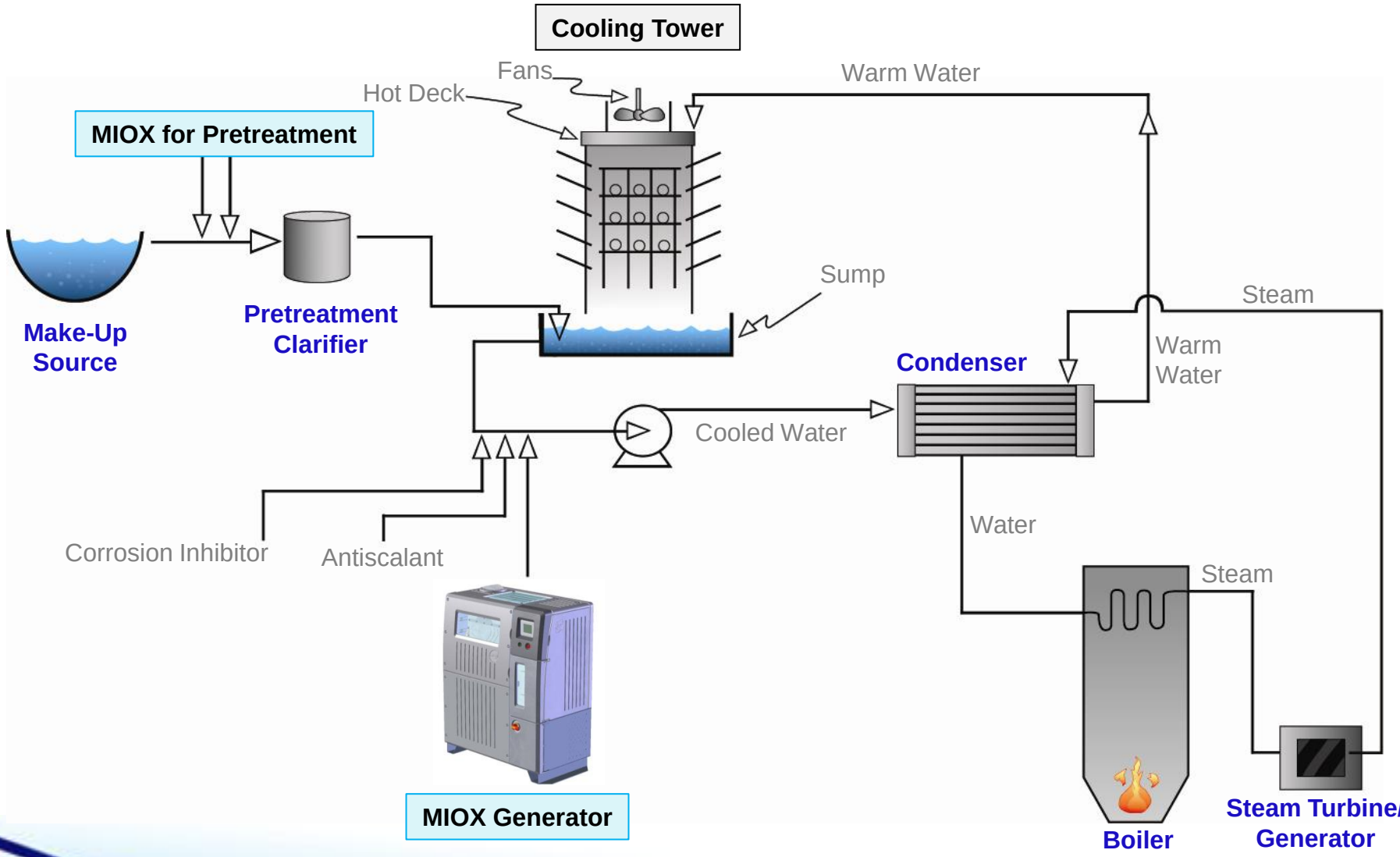
1) Control disease outbreaks caused by aerosolization of bacteria
2) Prevent fouling in exchangers / condensers
3) Control microbiological growth
4) Control scale deposition
5) Provide corrosion protection

Mixed Oxidant Solution Chemistry

- ✓ Superior disinfectant even at high pHs
- ✓ Replaces chlorine, bromine, proprietary biocides and algaecides
- ✓ Eliminates Biofilm: Control Legionella Growth & pitting corrosion
- ✓ Improves plant and community safety

...at a comparative price to Bulk Hypochlorite

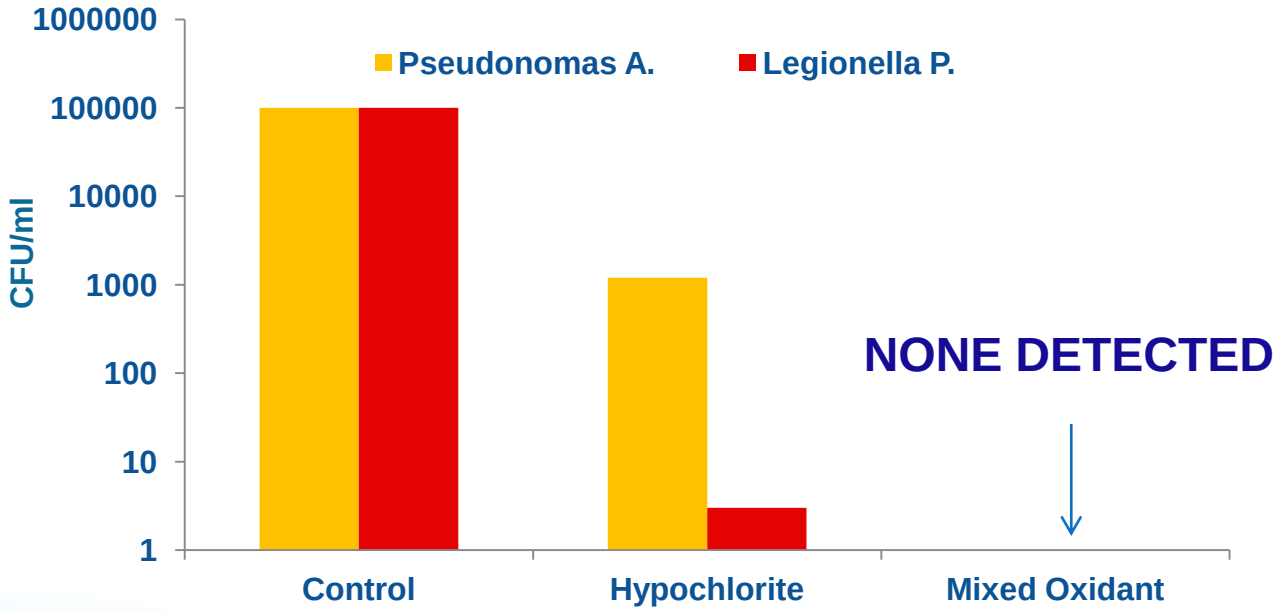
Process Train for Cooling Water Treatment



Disinfection Comparable to or Better Than Hypochlorite and Bromine Chemistry

- Produces more powerful disinfectant than Hypochlorite
- Easily replaces proprietary biocides (NIPSCO, IN; San Juan, PR) even at higher pH
- More power is derived from Hydrogen Peroxide in solution with Hypochlorite in 24-48 hrs

No Legionella detected at 2 mg/L Mixed Oxidant solution at 8.0 pH in 10 mins



Larry Barton, PhD, University of New Mexico
"Disinfection of Simulated Cooling Tower Water" – 3/4/96

Eliminate Biofilm

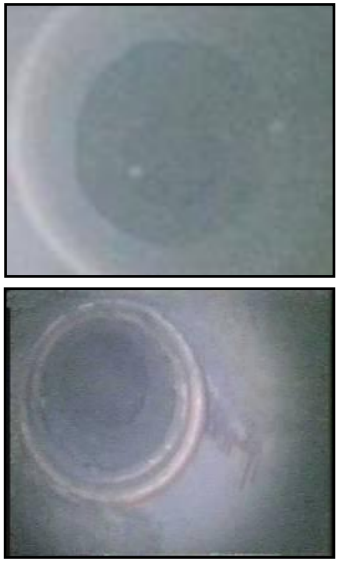
CASE STUDY

Spa in Japan previously using **Bulk Hypochlorite** 1.5 mg/L had Legionella cases. In 5 hours of Mixed Oxidant solution biofilm started sloughing

BEFORE MIOX

- **Extensive biofilm**
- **Legionella CFU >5**
- **Dose: 1.5 mg/L Hypo**
- **Residual: 0.2 mg/L**

22 days AFTER MIOX



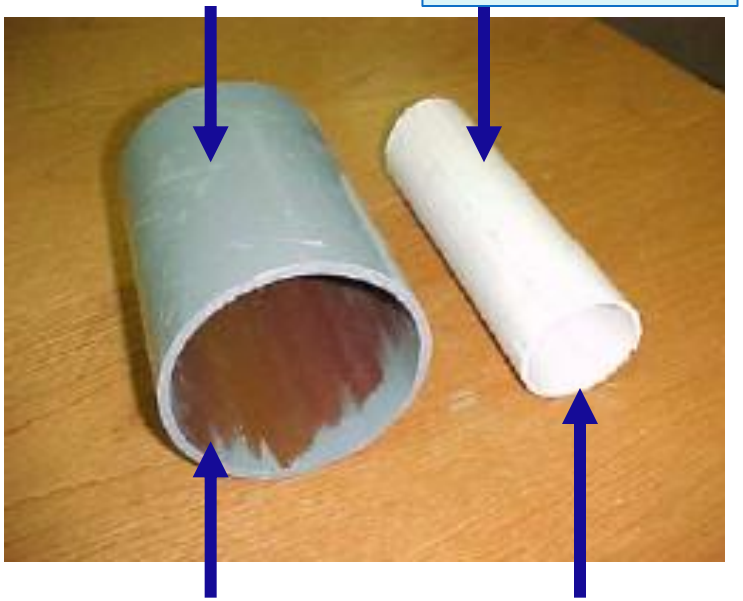
- **Biofilm eliminated**
- **No bacterial hits**
- **Dose: 0.6 mg/L Hypo**
- **Residual: 0.4 mg/L**

CASE STUDY

A city in Texas was using **Gas Chlorine** where brown biofilm slime on pipes in distribution system commonly noticed.

BEFORE MIOX

1 Year AFTER MIOX



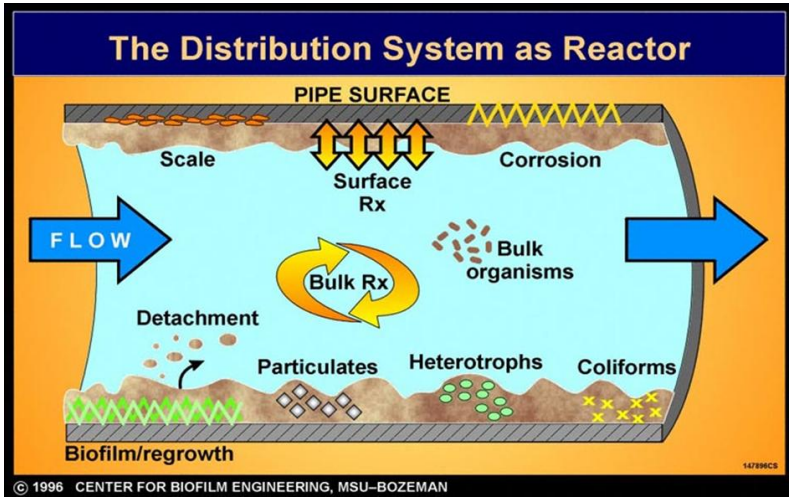
Distance from Treatment Plant: **200 feet**

Distance from Treatment Plant: **1/2 mile**

Biofilm Harbors Legionella & Corrosion

Biofilm Harbors Coliforms

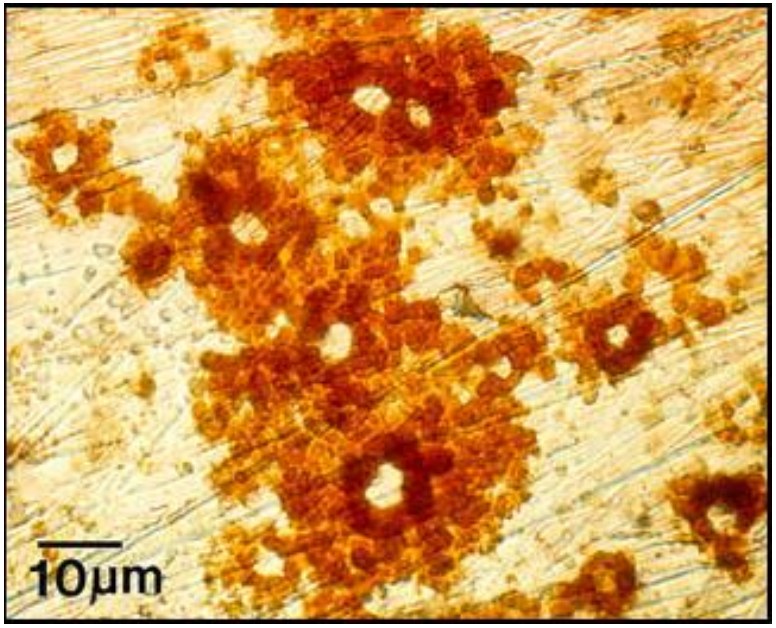
Collective neutralizing power of groups of cells leads to slow and incomplete penetration of the antimicrobial in the biofilm.*



Although Hypochlorite and other proprietary biocides perfectly inactivates Legionella, it cannot inactivate Legionella in the Biofilm

Microbially Influenced Corrosion (MIC)

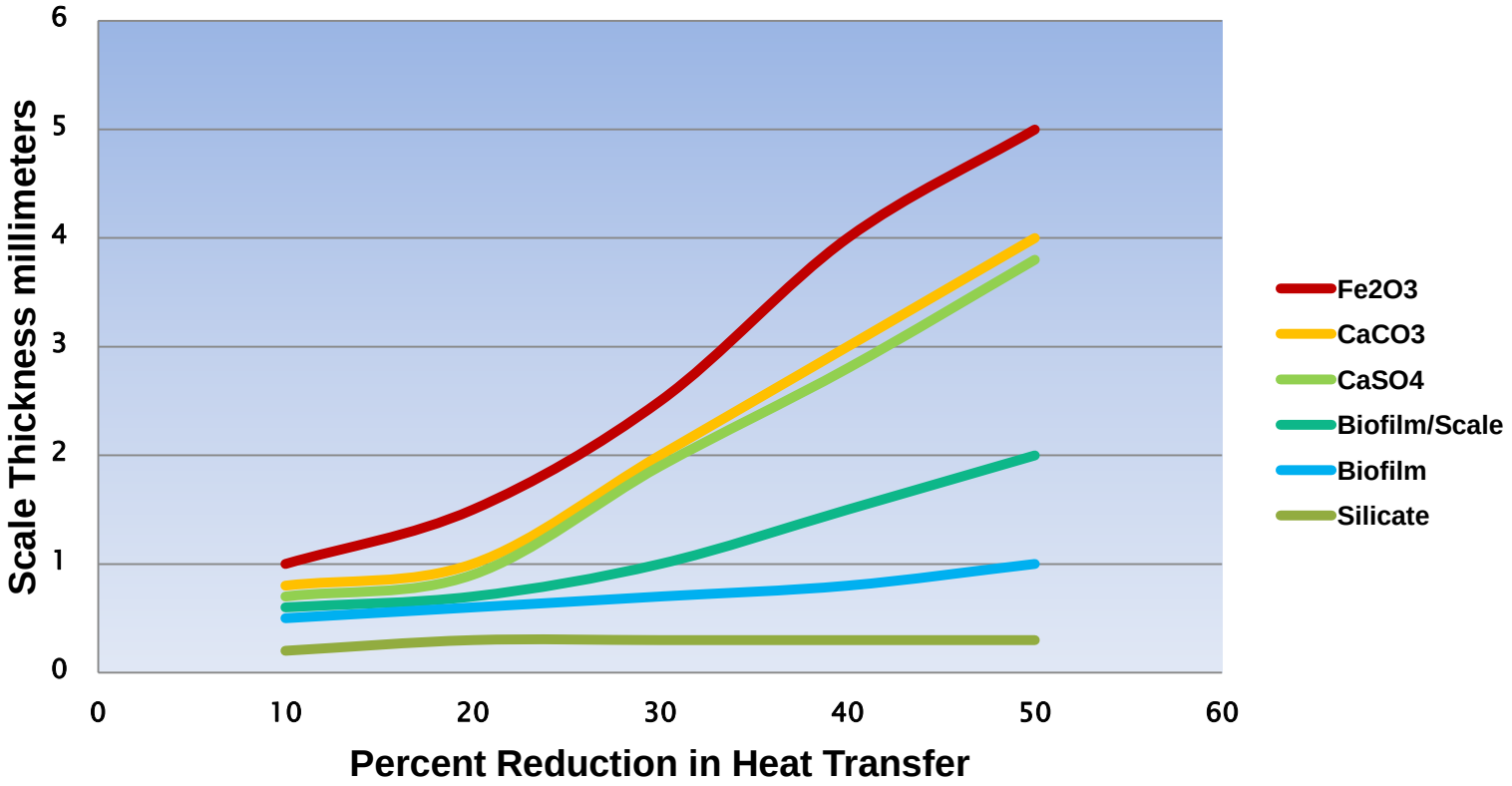
The presence of biofilm modifies deposition and dissolution rates of minerals, and by this mechanism, influences the electrochemical properties of the metals or alloys. Pitting corrosion is a great example as seen below.*



Pitting corrosion on 316S stainless steel*

* Montana State University, Center of Biofilm Engineering (MSU-CB)

Biofilm Reduces Thermal Efficiency



- *Biofilm (1mm thick) Reduces Heat Transfer by 50%*
- *In a 200 ton chiller, energy costs can increase by 35%*

Mixed Oxidant Solution Chemistry

Less corrosive than Hypochlorite at same doses

	0.2 mg/L DOSE			
	Mixed Oxidant Solution		Sodium Hypochlorite	
	Total Pb	Total Cu	Total Pb	Total Cu
Pb	.16	-	.20	-
Cu	-	.20	-	.47
Pb/Cu	.17	.10	.21	.51

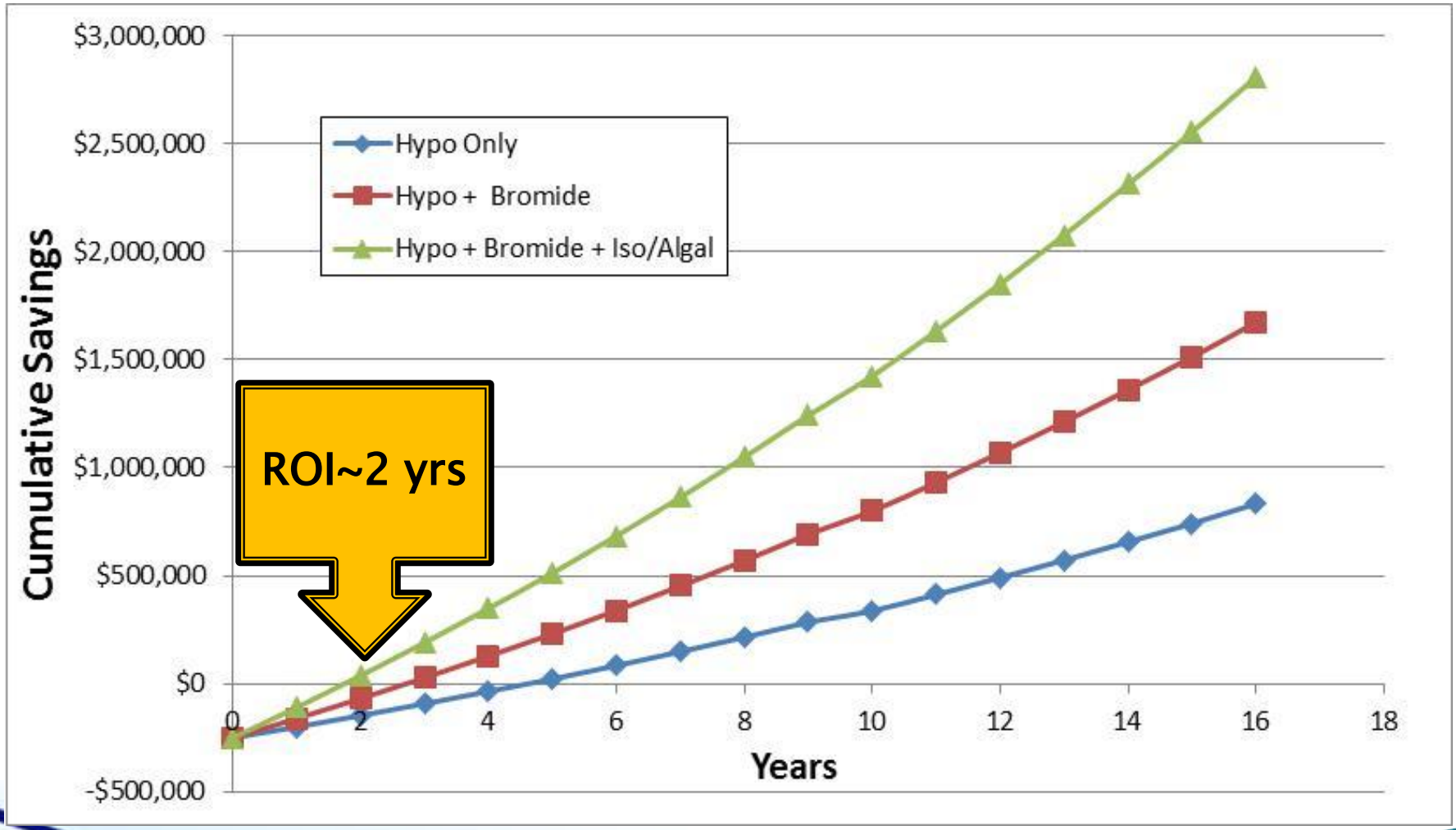
1.2 mg/L DOSE			
Mixed Oxidant Solution		Sodium Hypochlorite	
Total Pb	Total Cu	Total Pb	Total Cu
.14	-	.31	-
-	.17	-	.45
.14	.04	.38	.48

4 WEEK AVERAGE CORROSION RATES, mg/L

***Corrosion Study done by C&E Engineering Partners Inc. at Westerly, RI installation*

Sample ROI

Less than 2 years payback when compare to Biocide regimes



Sample Cost Saving With MIOX
Replace Current Disinfectants

	Today	With MIOX	Net Savings
Hypochlorite cost ($/year)	$ 164,250	-	
Sodium Bromide ($/year)	$ 55,480		
MIOX Salt consumption	-	$ 32,850	
MIOX Electricity consumption	-	$ 13,688	
TOTAL Operational Cost	$ 219,730	$ 46,538	**$ 173,193**

Return on Investment = 21 months

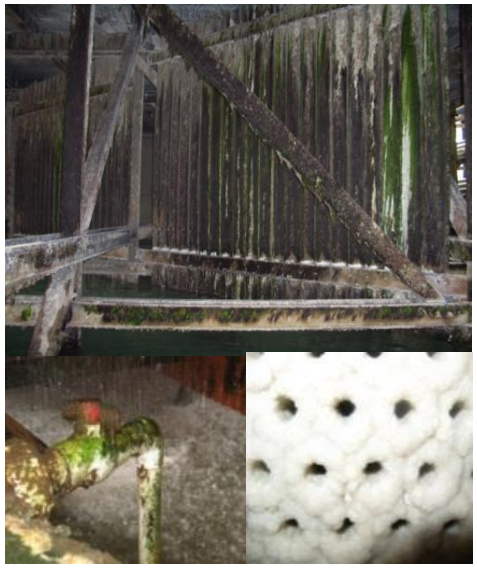
Assumptions
- 90,000 ton tower, 4 cycles
- 300 lbs/day 100% FAC
- Bulk Hypo 12.5% cost $0.15/lbs
- Sodium Bromide Active $3.8/lbs

MIOX Equipment
- RIO M5 – 300 lbs of 100% FAC/day
- Equipment cost $125,000
- Peripheral + Installation $175,000
- Total out of pocket $300,000

Puerto Rico PREPA Power Plant

Biofilm Removal → Increased Thermal Efficiency → ~9% Production Capacity Increase

BEFORE MIOX



AFTER MIOX

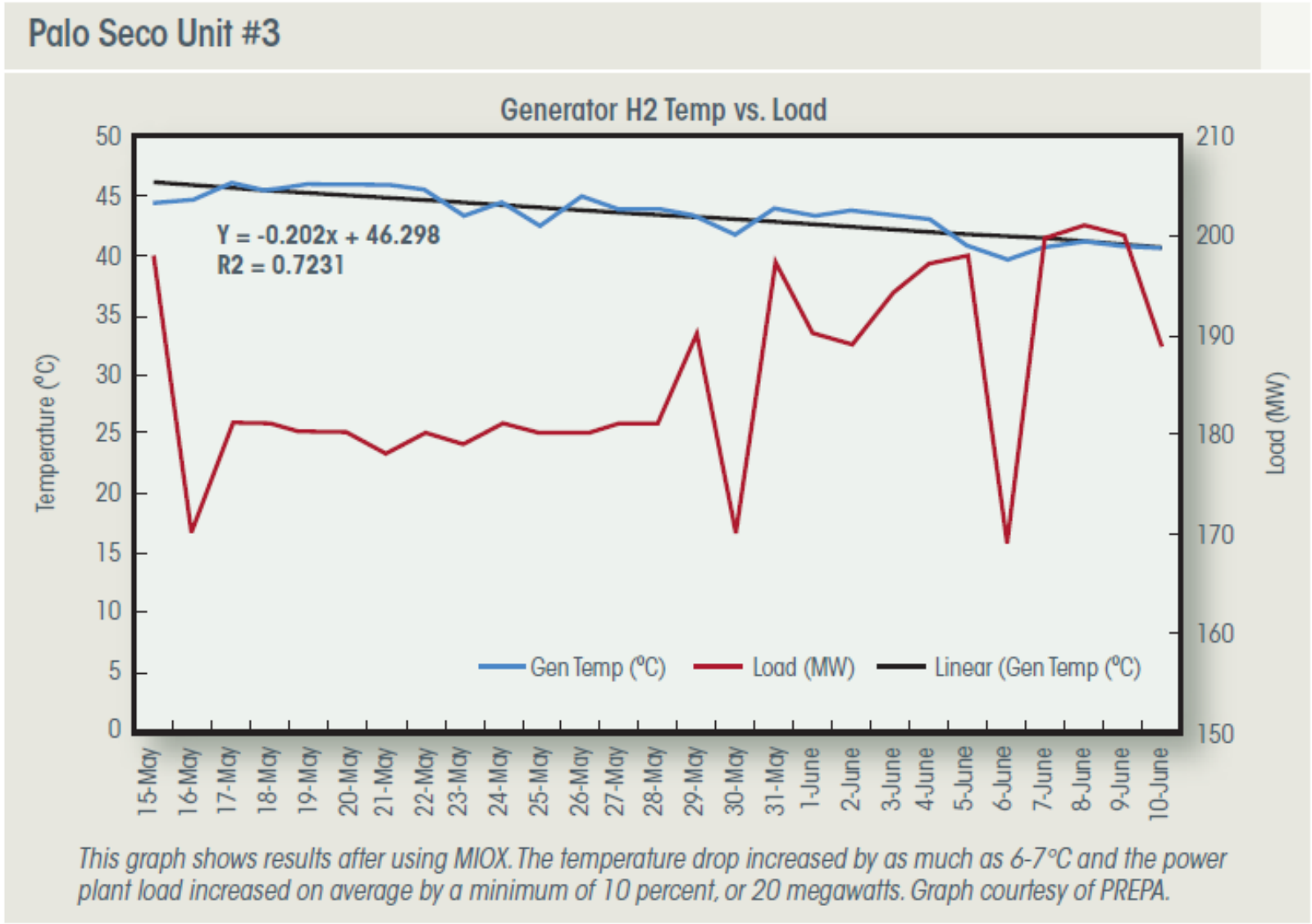
Problem

- Proprietary biocides could not control biofilm in 40,000 ton tower. Visible biofilm/scale build up.

Results After Using MIOX

- Improved thermal efficiency; increased production load by 9%, equaling to $30 million+
- <2 months payback
- Reduction in 31,000 lbs delivered chemical/year
- 57% reduction in water consumption and O&M costs
- Mixed oxidant chemistry eradicated the biofilm. Replaced the biocide regime.

PREPA Power Plant – Production Load

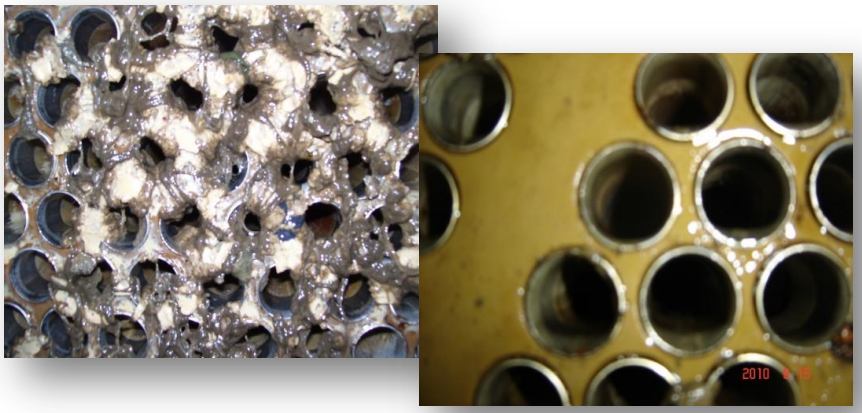


This graph shows results after using MIOX. The temperature drop increased by as much as 6-7°C and the power plant load increased on average by a minimum of 10 percent, or 20 megawatts. Graph courtesy of PREPA.

NIPSCO Power Plant

Cleaner Condensers, Saving ~$160,000/yr per tower, totaling ~$640,000/yr

BEFORE MIOX **AFTER MIOX**



Cooling Tower Condenser Tube Sheet

Problem

- **Proprietary biocides could not control biofilm in 90,000 ton tower. Visible biofilm build up in the condenser (seen on the left)**

Results After Using MIOX

- **Mixed oxidant chemistry eradicated the biofilm. Replaced the biocide regime.**
- **<36 months payback**
- **Reduced chemical cost with complete biofilm removal**

"Reducing our treatment regimen …down to a single mixed oxidant product generated on site has resulted in substantial treatment chemical and labor cost savings."

--Paul Schrock, NIPSCO Senior Chemist

Thermal Chicago Cooling Tower

Cost effective Algae and Biofilm control

Problem

- Constant biofilm and algae growth with Sodium Hypochlorite and Isothiazolin

Results After Using MIOX

- Cooling basin cleared of algae in 2 weeks
- Biofilm cleared in 4 weeks
- <18 months payback
- No degradation of scale/corrosion inhibitors (phosphonates, polymer or azole)
- Low corrosion: steel corrosion at ~1 mpy, yellow metal corrosion <0.1 mpy
- Excellent microbial control even at elevated pH
- Eliminated disposal of 51 chemical drums

Presented by:
Thomas Muilenberg
Director of Commercial Operations
Phone: 515-450-6238
E-mail: Tom.muilenberg@miox.com

MIOX On-Demand Chemistry