



Cooling Towers

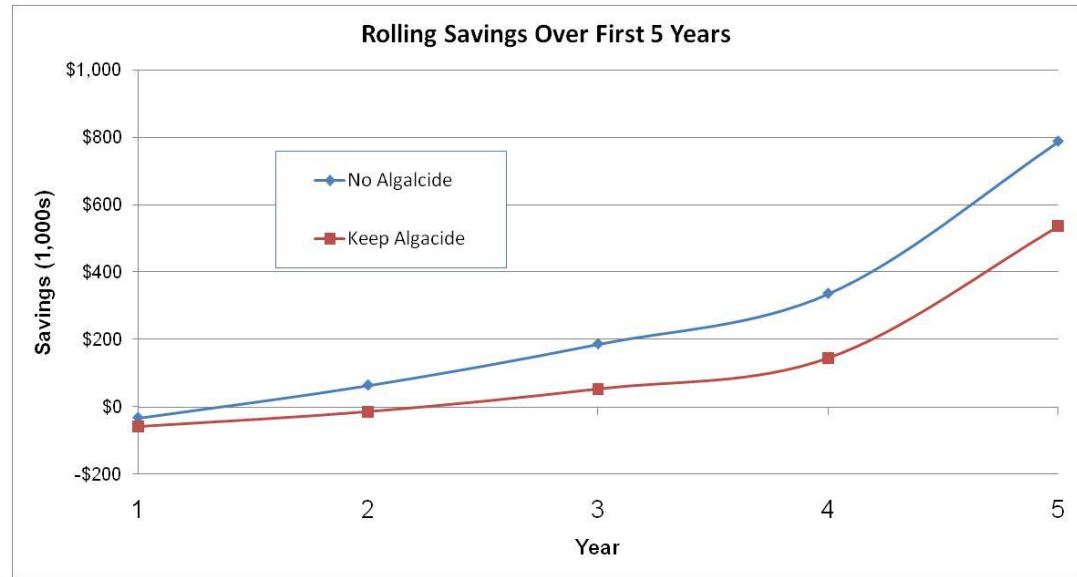
Benefits in Cooling Tower Applications Include:

- ▶ Improved safety
- ▶ Cost effective
- ▶ Reduced environmental impact
- ▶ And...improved performance!



Mixed Oxidants can save money by...

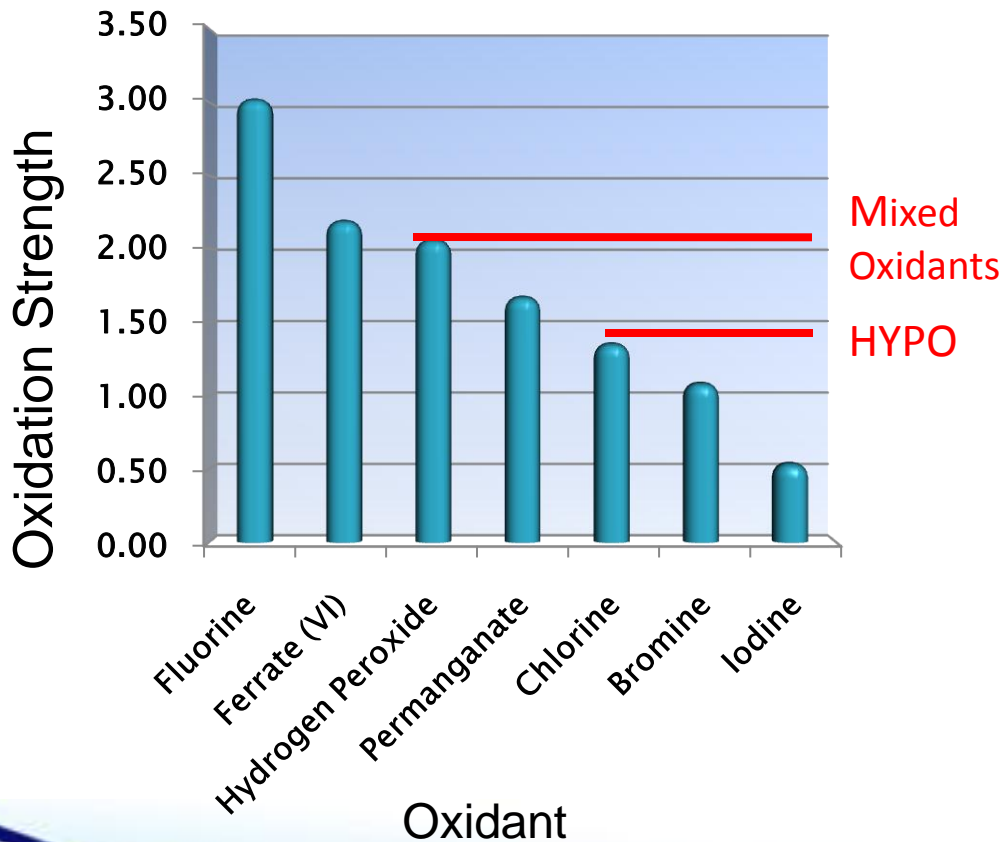
- ▶ Replacing multiple chemicals:
 - Hypochlorite
 - Bromine
 - And possibly others: algaecides, proprietary biocides
- ▶ Low cost of generation



IMPROVED PERFORMANCE



Mixed Oxidants Have Enhanced Oxidation Power



- ▶ Chlorine-based, but more powerful disinfectant than conventional chlorine
- ▶ MIOX optimizes chemistry performance with a superior cell design and more energy applied
- ▶ Chlor-oxygen species:
 - $\text{H}_2\text{O} + \text{NaCl} \gg$ Disinfectants have been used for years
- ▶ No O_3 or ClO_2 – EPA does not require DBP monitoring

Cooling Towers May See Numerous Performance Improvements

- ▶ Removal of biofilm
- ▶ Better residuals
- ▶ Reduced algae loading

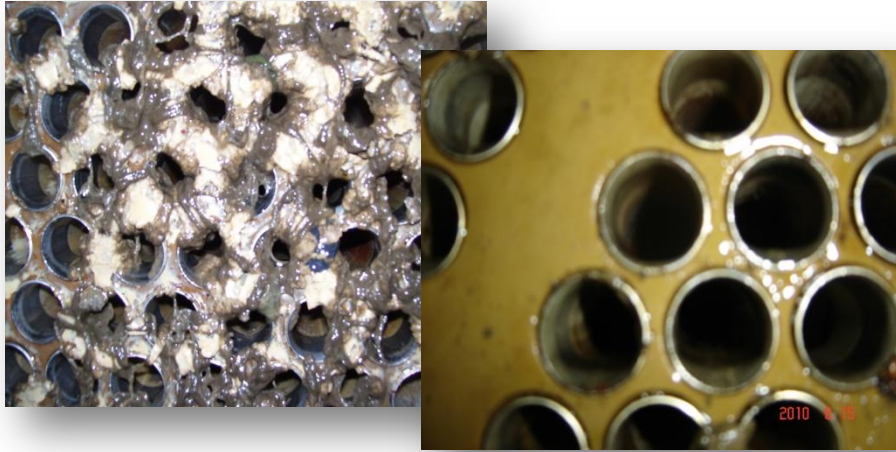


Filter recirculation pipe
with sodium hypo



Filter recirculation pipe
22 days after mixed oxidants

Mixed Oxidants Reduce Biofilm and Algae Fouling.



BEFORE MIOX

Condenser Tube Sheet (Midwest Power Generation Site)

AFTER MIOX

Condenser Tube Sheet after 2.5 months of using MIOX.



BEFORE MIOX

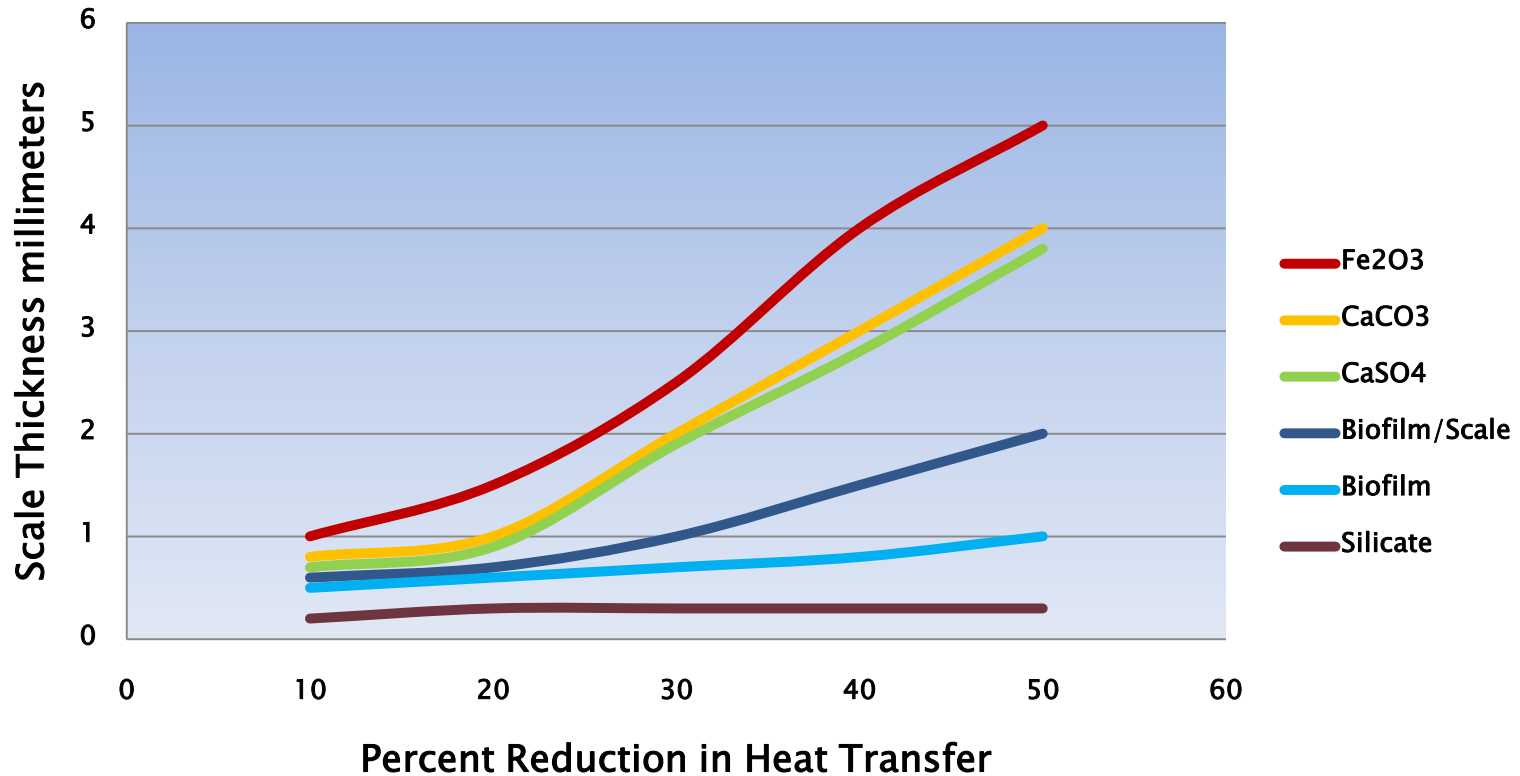
Algae is rampant with conventional biocide program for cooling tower application

AFTER MIOX

Algae eliminated with mixed oxidants.

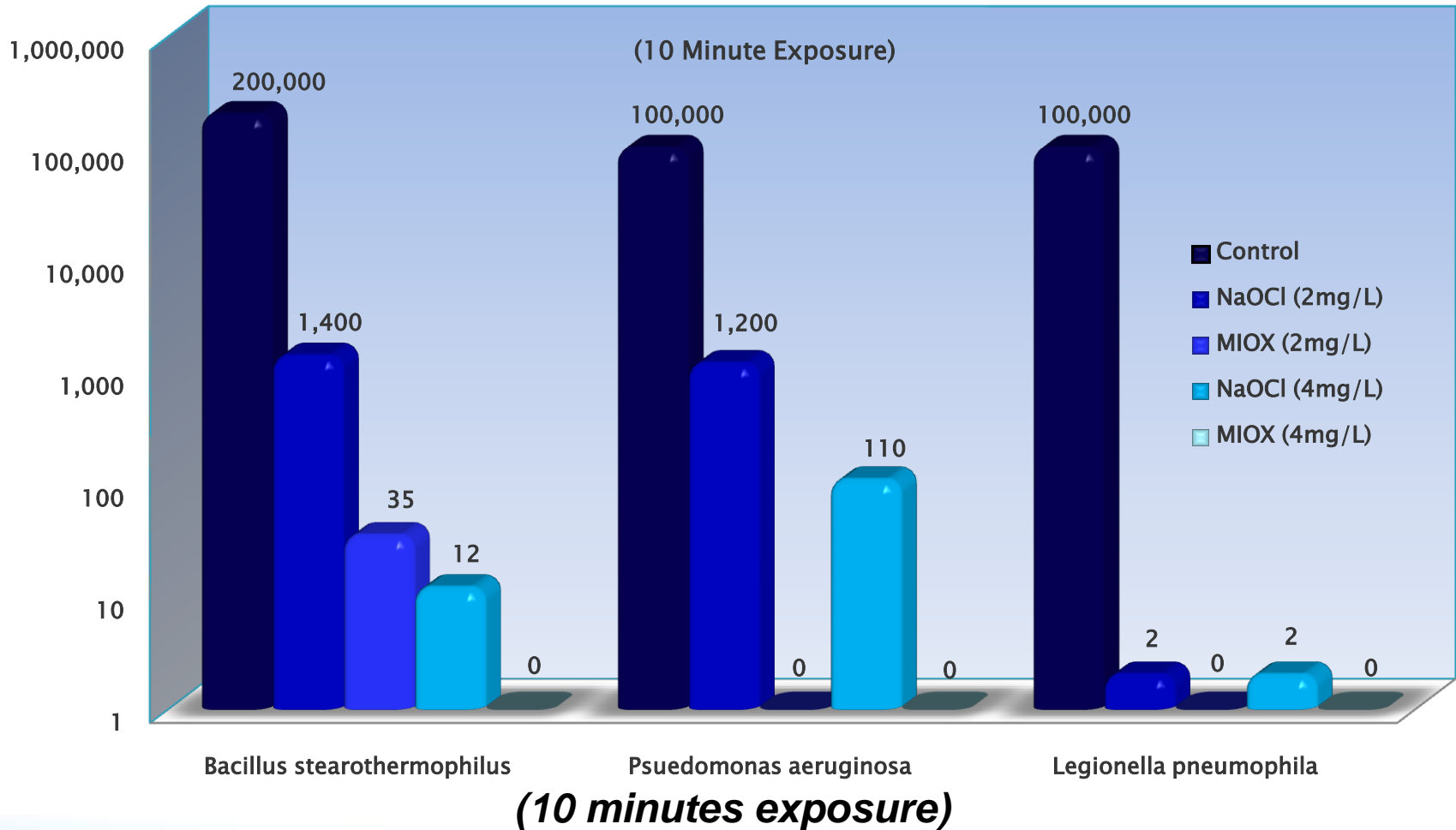


Presence of Biofilm Reduces Thermal Efficiency



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

Microorganism Kill in Simulated Cooling Tower Waters was Superior Using MOS



Larry Barton, PhD, University of New Mexico
"Disinfection of Simulated Cooling Tower Water" - March 4, 1996



Best Practice to Minimize Risk

- ▶ OSHA, Cooling Technology Institute, ASHRAE and others recommend maintaining a continual free halogen residual within the cooling tower system as a Best Practice to minimize the risks associated with *Legionella*.
- ▶ The mixed-oxidant solution has been shown to be very effective against *Legionella*.



Legionella Bacterium
leaving host biofilm

Mixed Oxidants Offer Significant Benefits Over Standard Sodium Hypochlorite

Solution	Category	Cost Benefit
Biofilm Removal	Operations	Longer Media Life
	Operations	Increased Plant Efficiencies
	Operations	Reduction of Chemicals
Safer Chemicals	Safety	Reduced handling & storage hazards
	Health	Reduction of Airborne Pathogens
Increased Efficiencies	Maintenance	Reduced Facility Maintenance
Reduced Logistics	Operations	Reduced Transportation
Reduced Costs	Operations	Industry Leading Operating Efficiencies



Mixed Oxidant is Less Corrosive than a Sodium Hypo Solution

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

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

4 WEEK AVERAGE CORROSION RATES, mg/L

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



PROJECT PROFILES



Power Generation Station-Northern Indiana

Mixed oxidant replaces both chlorine and bromine



- ▶ MIOX[®] Mixed Oxidant RIO[™] (M5 rated @ 300 #/day FAC
- ▶ Replaced both chlorine and bromine for cooling tower water disinfection
- ▶ Partial retrofit using existing tanks
- ▶ Plan to switch three (3) additional towers to switch to mixed oxidant after success at Tower #15
- ▶ Reduced price of disinfectant/oxidant by generating it on-site.
- ▶ Generating a safer chemical below the 1% threshold for consideration as a hazardous material.
- ▶ Improved chemical efficacy
- ▶ Reduced maintenance
- ▶ Early phases of operation in 2010 show promising data

Power Generation Station–Puerto Rico

Algae Removal

Power Plant &
Cooling Tower in
Puerto Rico



MIOX on-site
generator in
portable building



Algae with conventional
biocide program



Algae eliminated
with mixed oxidants



Thermal Chicago Cooling Tower Algae and Biofilm Issues Solved



- ▶ (2) MIOX[®] Mixed Oxidant SAL-80 Units
- ▶ Basin cleared of algae and significant amount of biofilm within 2 weeks; The remaining biofilm was cleared in 4 weeks
- ▶ No degradation of scale and corrosion inhibitors (phosphonates, polymer or azole)
- ▶ Low corrosion – mild steel corrosion rates at 0.9 to 1.4 mpy, yellow metal corrosion at <0.1 mpy
- ▶ Excellent microbial control even at elevated pH
- ▶ Easy to operate and maintain
- ▶ Eliminated 28,500 lbs of sodium hypo and isothiazolin and subsequent disposal of 51 chemical drums



Case History:

Thermal Chicago Cooling Tower

	Before <i>(Dual Biocide Program)</i>	After <i>(Mixed Oxidants)</i>
Aerobic Bacteria Count†	<p>Consistent problems with biofilm in the basin of the cooling towers</p> <ul style="list-style-type: none"> Bacterial counts in the bulk water averaged 10,000 CFU/ml Surface bacterial (sessile) counts averaged 100,000 - 500,000 CFU/ml. 	Complete sterility (< 100 CFU/mL) consistently
Biofouling	Accumulation of biofilms on cooling surfaces	Removed existing biofilm when and where the film was in contact with water
Algae Growth	Algae growth in the cooling water basin	Algae removed and controlled , no terbutylazine shocking was needed
Residual	low	0.6-0.7 FAC
Scaling	Managed using phosphonate/polymer program	No adverse effect on scale formation
Water Clarity	Somewhat cloudy water due to surfactant nature of biocides	Crystal clear water in the basin
Corrosion*	<p>Corrosion levels within industry norms (<2 mils/yr. on steel surfaces; <0.1 mil/yr. on copper surfaces)</p> <p>Copper heat exchange surfaces in good condition – azole program</p>	<p>Corrosion rates maintained within industry norms</p> <p>No effect on azoles used for copper; no effect on copper heat exchange surfaces</p>



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