

Voodaa

Technologies





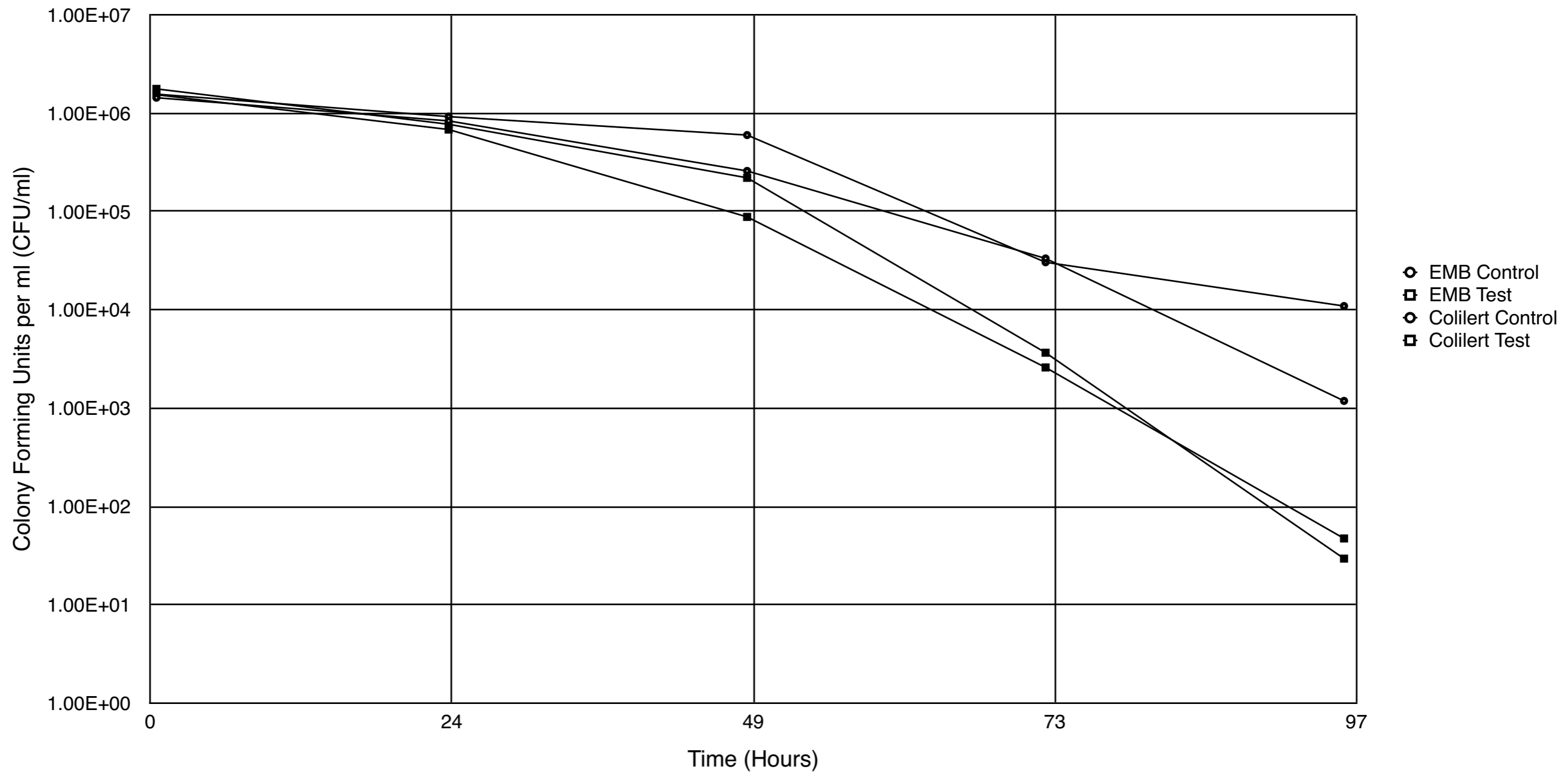
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At the U of A West center

- Phase 1: Study the effects of Vodaa Technologies on e-coli growth in water
- Phase 2: Reduction of Chlorine inputs by Enhanced Degradation of Combined Chlorine via Vodda Technology

*All phases of the study are being performed
at the West Center in Tucson Arizona.

Vodaa Technologies Microbial Assessment (EMB and Colilert)



*Graph shows results from Phase 1 of the academic research using two different testing methods EMB & Colilert
Highlighted in blue are the two different testing methods test results of the drop in unit. In Yellow is the control test with out the drop in.

Bacteria Data

3000 ton Cooling tower system in Phoenix Arizona

No chlorine added to system

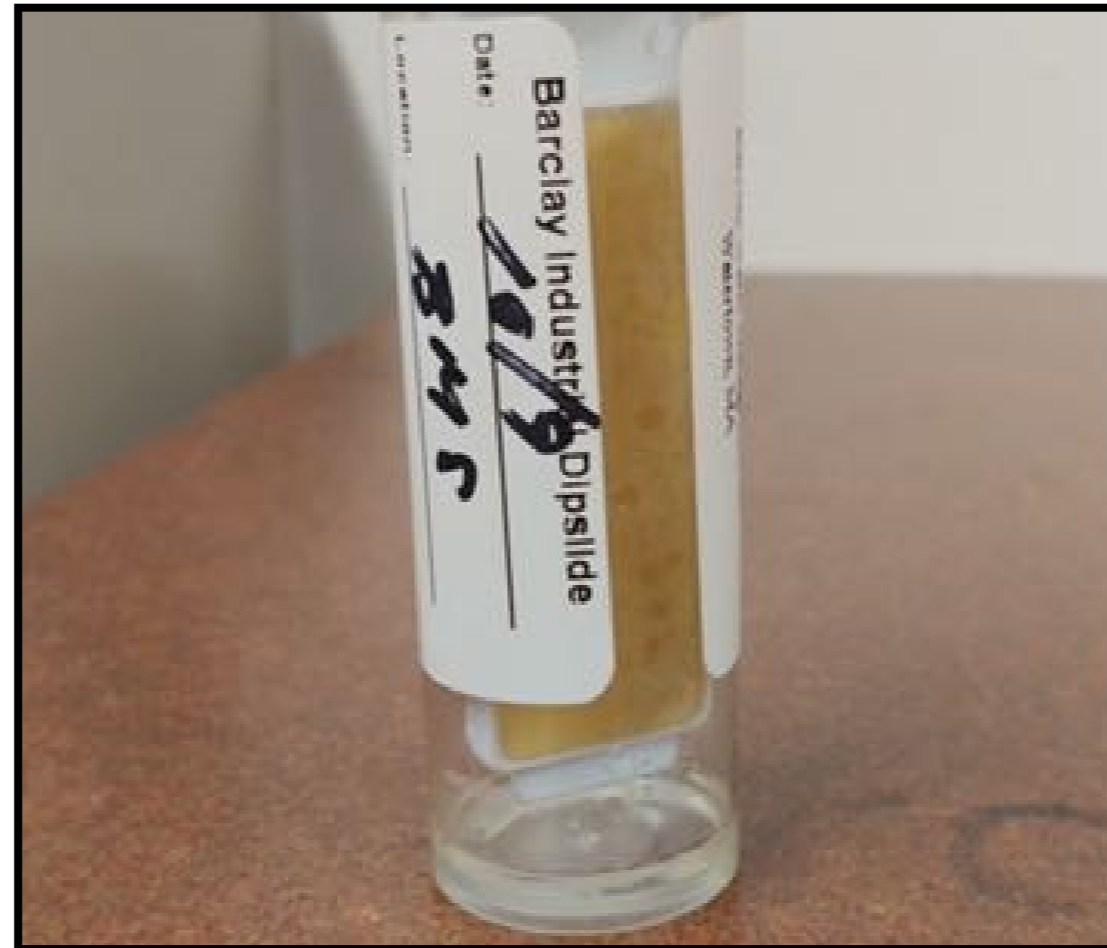
Date	Bacteria	Date	Bacteria	Date	Bacteria
9/15	47 mpn/mL	9/16	110 mpn/mL	9/17	39 mpn/mL
12/15	30 mpn/mL	1/17	62 mpn/mL	11/17	37 mpn/mL
3/16	56 mpn/mL	3/17	39 mpn/mL	3/18	51 mpn/mL
6/16	360 mpn/mL	6/17	26 mpn/mL	6/18	20 mpn/mL

*Cooling tower institute recommended target values <10,000 CFU/mL to avoid any Legionella outbreak in cooling system.
Above results come from third party testing performed by Test America

COOLING TECHNOLOGY INSTITUTE: Legionellosis Guideline: Best Practices for Control of Legionella page. 6 * Testing not performed by UofA

Bacteria Data

Cooling tower bacteria test NYC



October 9, 2019 Bacteria levels are N/A with just .5PPM chlorine

* test not performed by University of Arizona

Reduction of chlorine inputs by enhanced degradation of combined chlorine via Vodaa Technologies

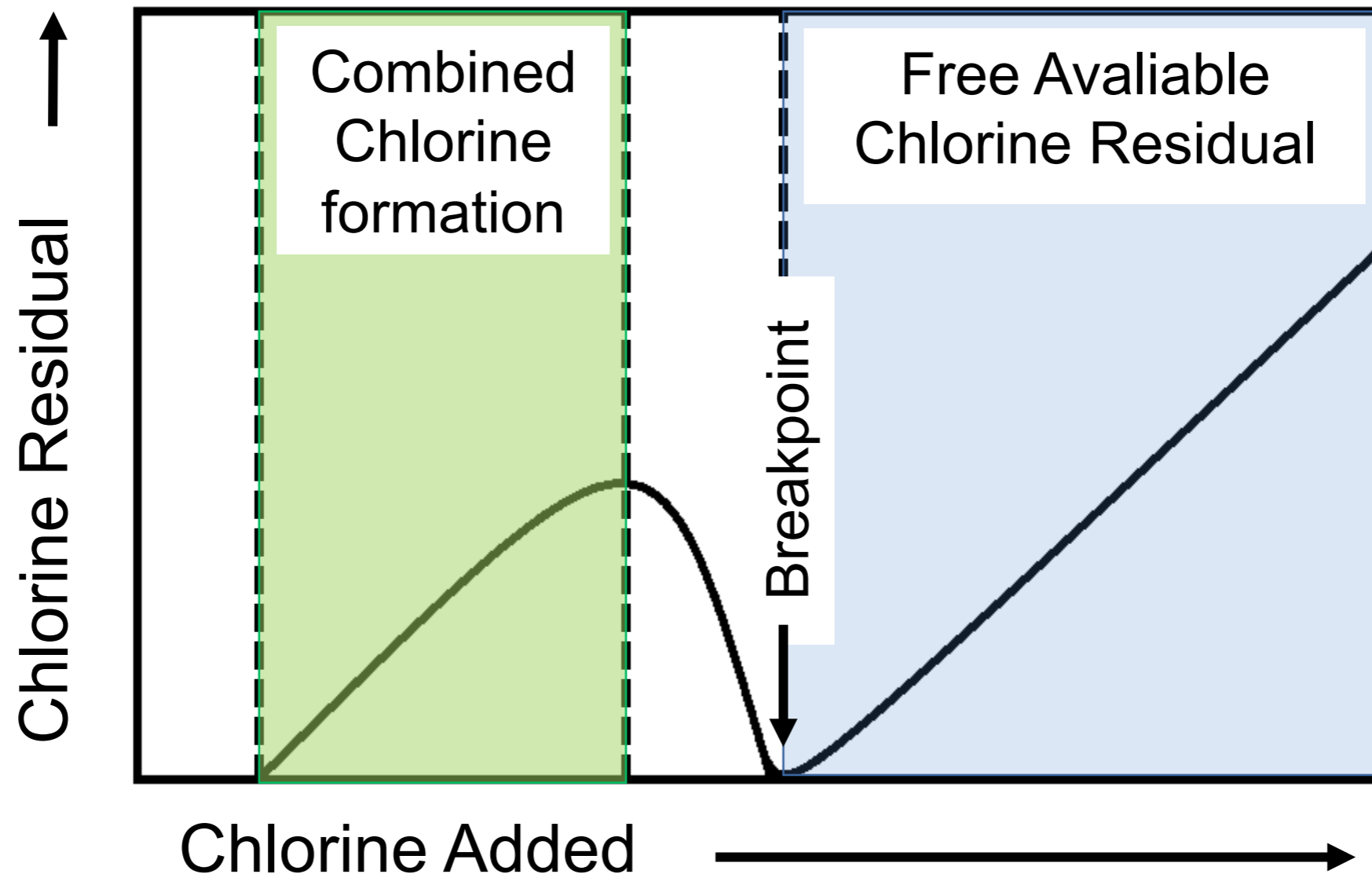
ABSTRACT

- Vodaa Technologies electromagnetic device reduced the chlorine demand in pools due to a reduction of monochloramine.
- After 24hr exposure to Vodaa Technology in bench scale pool studies (151L bins), an average of 26.9% increase in final free chlorine concentration occurred relative to no exposure.
- 1hr of exposure was sufficient to achieve a 11.0% reduction in monochloramine in contaminated waters over 12hrs.
- Use of magnetic fields to decrease chlorine demand in pool systems may lead to a greater disinfection potential.

Background

- Calcium or sodium hypochlorite are the most common disinfectants for pool waters due to cost and disinfection properties.
- Pools are “breakpoint” chlorinated to maintain a free available chlorine residual for disinfection.
 - The “breakpoint” is the point at which all chlorine demand is met.
 - Additional chlorine results as free available chlorine (fig 1.)
- Contaminants added to a pool result in a “chlorine demand”.
 - If the contaminant is ammonia, chloramine species are formed adding to chlorine demand as a form of combined chlorine.

What is Breakpoint?



When chlorine is added to contaminated water combined chlorine is formed, which adds to the chlorine demand of the system. As more chlorine is added the combined chlorine is oxidized resulting in the “**breakpoint**” as the combined chlorine is consumed. After the “breakpoint” additional chlorine is as a free chlorine residual and which can oxidize any additional contaminants

Method 1

Experiment 1

- Water was pretreated with calcium hypochlorite (chlorine) and cyanuric acid (stabilizer).
- Ammonia nitrate was added as a contaminant to generate combined chlorine.
- Water containing combined chlorine was exposed to Vodaa Technology for 24hrs.
- Additional chlorine was added after 24hrs to achieve breakpoint chlorination.

	Time (hr)	Free Cl (mg/L)		Total Cl (mg/L)		Combined Cl (mg/L)		Free NH3 (mg/L)		Monochloramine (mg/L)		pH	
		Test	Ctrl	Test	Ctrl	Test	Ctrl	Test	Ctrl	Test	Ctrl	Test	Ctrl
Initial	0	5.3	5.3	5.6	5.4	0.3	0.2	0.0	0.0	0.0	0.0	7.8	8.0
Combined Chlorine	24	0.0	0.0	3.9*	4.4*	3.9*	4.4*	0.8*	0.7*	3.6*	4.2*	7.7*	7.9*
Breakpoint	27	1.7*	1.3*	1.8*	1.5*	0.1	0.1	0.0	0.0	0.0	0.0	7.4*	7.5*

Low value → High value

Effects of Vodaa Technology on chlorine when exposed to ammonia and subsequently breakpoint chlorinated after 24hrs. Combined chlorine was reduced more quickly under the Vodaa Technology than the control. Subsequent chlorine addition resulted in a 26.9% increased free chlorine due to the previously reduced chlorine demand. *statistically significant ($\alpha = 0.05$)

Method 2

Experiment 2

- Water in bins with combined chlorine were exposed to Vodaa Technology.
- Samples were taken and held in bottles outside the Vodaa Technology.
- Bins were constantly exposed to Vodaa Technologies.
- Both the bottle sample and bin were assayed after 12hrs.

Time	Free Cl (mg/L)				Total Cl (mg/L)				Combined Cl (mg/L)				Free Ammonia (mg/L)				Monochloramine (mg/L)				pH			
	Test		Ctrl		Test		Ctrl		Test		Ctrl		Test		Ctrl		Test		Ctrl		Test		Ctrl	
	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle	Bin	Bottle
Initial	0.0	0.0	0.0	0.0	5.8	5.7	5.8	5.7	5.8	5.7	5.8	5.7	0.1	0.6	0.1	0.6	5.4	5.1	5.4	5.1	7.6	7.5	7.6	7.5
1min*	0.0	0.0	0.0	0.0	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	0.9	0.8	0.9	0.8	4.7	4.8	4.7	4.8	7.5	7.6	7.5	7.6
30min*	0.0	0.0	0.0	0.0	5.6	5.4	5.6	5.4	5.6	5.4	5.6	5.4	0.9	0.6	0.9	0.6	4.6	4.6	4.6	4.6	7.4	7.7	7.4	7.7
1hr*	0.0	0.0	0.0	0.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	0.9	0.8	0.9	0.8	4.7	4.5	4.7	4.5	7.5	7.7	7.5	7.7
12hr	0.0	0.0	0.0	0.0	4.7	4.9	4.8	4.9	4.7	4.9	4.8	4.9	0.3	0.2	0.2	0.1	4.4	4.6	4.6	4.9	7.5	7.5	7.6	7.6
12.5hr	0.0	0.0	0.0	0.0	4.3	4.5	4.8	4.9	4.3	4.5	4.8	4.9	0.4	0.2	0.2	0.0	4.4	4.6	4.6	4.8	7.5	7.5	7.6	7.6
13hr	0.0	0.0	0.0	0.0	4.5	4.6	4.6	4.8	4.5	4.6	4.6	4.8	0.2	0.1	0.1	0.1	4.4	4.6	4.6	4.7	7.4	7.5	7.6	7.5

Low value → High value

Water containing combined chlorine was exposed to Vodaa Technology. Bottle samples were taken after 1min, 30min, and 1hr of exposure and held in chlorine demand free bottles for 12 hours. Bins were exposed to the Vodaa Technology for the duration of the experiment. Bin and bottles samples were assayed after 12 hours. Divergence of test and control appears to occur after 12.5hrs in both the bottle and bins, indicating <1hr exposure is needed for an effect.

Results

Experiment 1

- Combined chlorine (in the form of monochloramine) was reduced 11.0% over the control after exposure to Vodaa Technology.
- Subsequent chlorination resulted in 26.9% free chlorine and 22.2% total chlorine in the test over the control

Experiment 2

- Less than 1 hour of exposure to Vodaa technology is sufficient to see a reduction in combined chlorine.
- The mechanism of chlorine demand reduction persists outside of the Vodaa Technology.

Conclusions

The application of a Vodaa Technology resulted in the reduction of monochloramine, and therefore chlorine demand, in a pool system.

Application of a Vodaa Technology may allow for increased free available chlorine for use as a disinfectant.

Use of Vodaa Technology may enhance for chlorine disinfection of pool water.