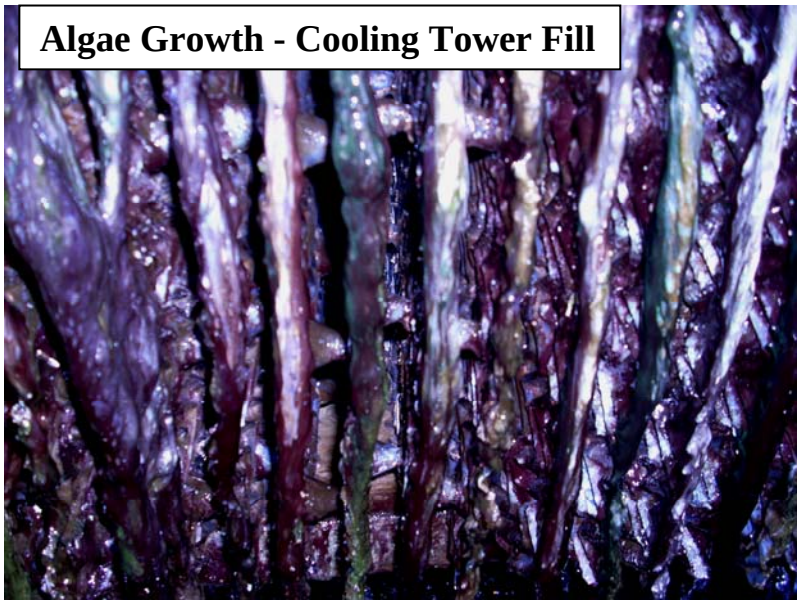
Technology Application Bulletin
ElectroBrom Electrolytic Bromine Unit



Algae Growth - Cooling Tower Fill

Cooling towers require use of toxic chemicals, biocides, to control growth of microorganisms which cause accelerated corrosion, system plugging, and harbor disease causing bacteria like Legionella. Biocides, while often quite effective, present their own problems as they are costly; dangerous to ship, store, and handle; and can do significant environmental damage when spilled or discharged.

Eliminate Biocide Use With The
ElectroBrom Electrolytic Bromine Unit

Patented **ElectroBrom** technology was developed by ProChemTech to be a cost effective means to control growth of microorganisms in cooling water that is **totally non-hazardous.** A solution of common table salt and sodium bromide is converted into electrolytic bromine, a very effective biocide, via electrolysis at the point of use. **No costly, hazardous chemical transport, storage, and handling!** A side benefit is that operation cost for an **ElectroBrom** system is much less than traditional biocides while unit cost is comparable to many competing biocide delivery systems.

ElectroBrom units are supplied as complete skidded units that require only water, power, and a cooling tower connection for operation. They can easily replace gas chlorine, hypochlorite, ozone, solid bromine, and any liquid alternating non-oxidizing - oxidizing biocide program.

USEPA primary registered precursors PCT 3023 and 3024 can be used with ElectroBrom units as well as any other USEPA registered source of sodium bromide. ElectroBrom units are manufactured in USEPA registered facilities.

US Patent 7,927,470

ElectroBrom Model EB 30

Technical Information

The following tables provide toxicity and cost comparison data on commonly used hazardous chemical biocides, efficacy information, and specification information on **ElectroBrom** units.

Toxicity Comparison Table – Typical Hazardous Biocides to ElectroBrom

Product	CAS	acute oral toxicity, rat LD 50
glutaraldehyde	111-30-8	134 mg/kg
isothiazolin	26172-55-4	57.2 mg/kg
dithiocarbamate	142-59-6	395 mg/kg
hydantoin	32718-18-6	877 mg/kg
ElectroBrom 3024	mixture	> 3500 mg/kg

As shown in the preceding table, the **ElectroBrom** precursor is substantially less toxic than any other biocide. To put this information in prospective, common table salt has an oral toxicity value of 3000 mg/kg!

Aquatic Toxicity Table – Typical Commonly Used Persistent Hazardous Biocides

Product	CAS	96 hr LC 50 aquatic toxicity	
glutaraldehyde 25%	111-30-8	rainbow trout	56.2 ppm
isothiazolin 1.5%	26172-55-4	rainbow trout	0.14 ppm
dithiocarbamate 30%	142-59-6	rainbow trout	0.10 ppm
polyquat 20%	7173-51-5	bluegill sunfish	1.6 ppm
ElectroBrom 3024	mixture	rainbow trout	> 1,000 ppm

Many commonly used biocides do not degrade and are persistent, toxic pollutants when discharged in cooling tower blowdown. In contrast, the electrolytic bromine produced by the **ElectroBrom** does its job and then degrades back to harmless bromide ion, **found in sea water at 65 mg/l.**

Economic Use Cost Comparison Table – Typical hazardous biocides to ElectroBrom

Product	Dose mg/l	lb/1000 gal	$/lb	$/1000 gal
10% quat	100	0.83	1.95	1.62
16% quat	65	0.54	2.50	1.30
30% carbamate	50	0.42	3.15	1.32
98% hydantoin	24	0.20	5.20	1.04
20% DBNPA	38	0.32	4.80	1.54
1.5% isothiazolin	127	1.06	3.65	3.87
15% glutaraldehyde	228	1.90	2.80	5.32
ElectroBrom	28*	0.23	1.30	0.30

The **ElectroBrom** is clearly the **most cost effective biocide for typical cooling tower applications on the market.** It is especially cost competitive against the very toxic isothiazolin and glutaraldehyde biocides favored by such firms as Ecolab-Nalco and GE Betz. The purchase cost of an **ElectroBrom** is generally comparable to, or less than, the cost of a traditional biocide feed installation when the costs of chemical pumps, double containment (not needed with the **ElectroBrom**!!), safety equipment, and special feeders (for dry products) are accounted for.

The costs of an accident or environmental spill incident can far exceed any costs related to normal operation, especially when bad publicity and the potential for litigation are considered. Replacement of toxic biocides with an **ElectroBrom** eliminates these potential problems.

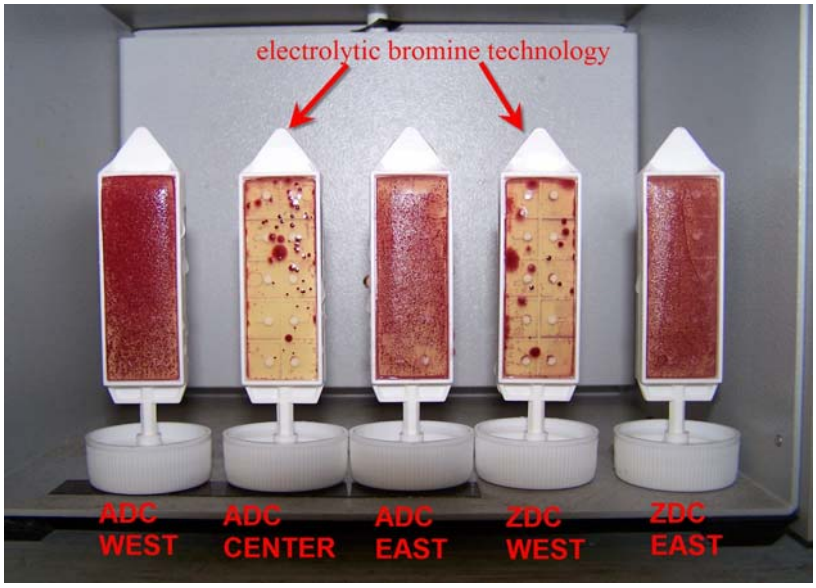
A quick comparison between **ElectroBrom** and a traditional program using alternating glutaraldehyde and isothiazolin for a 5000 ton cooling tower load operating 52 weeks a year gives the following annual costs:

Traditional Program - $35,841 **ElectroBrom - $3,510**

The cost savings here, with an ElectroBrom Model EB-15 priced at $20,580, pays for the ElectroBrom purchase in less than one cooling season!

Power cost to operate an **ElectroBrom** system is insignificant. For example, an EB-15 operating at three doses per week treating a 5000 ton cooling system for 52 weeks with power at $0.10/kwh would use $63.35 worth of electrical power. The only other cost to operate the **ElectroBrom** EB-15 is a replacement electrolysis cell on a typical three year life cycle at $3,000.00.

Efficacy



Traditional biocide programs generally require that two biocides be alternated on a routine basis to prevent long term development of a resistant biota in the treated system. Due to the fact that resistance cannot be developed to a strong oxidizer, like the electrolytic bromine produced by the **ElectroBrom,** it replaces dual product programs with a single product.

Shown above is a set of biological test slides from two cooling towers treated with electrolytic bromine and three others treated with alternating biocides. These test slides, taken from five cooling towers located at a single plant on the same day, clearly document the superior microorganism control obtained by use of electrolytic bromine produced by an **ElectroBrom** unit. This plant subsequently converted the remaining three cooling towers to **ElectroBrom** as the sole biocide. Picture provided by customer.

The **ElectroBrom** is much more effective in high pH cooling waters than traditional chlorine based biocides as shown in the following table:

water pH	% bio active Cl	% bioactive Br	water pH	% bioactive Cl	% bioactive Br
7.0	90	100	8.5	9	60
7.5	50	94	9.0	3	33
8.0	24	83	9.5	0	11

Oxidizing biocides, such as the electrolytic bromine produced by the **ElectroBrom,** are recognized to be effective against the bacteria that cause Legionnaire's Disease by both OSHA and CDC; many traditional, commonly specified biocides are not recognized as being effective.

As the **ElectroBrom** produces an electrolytic bromine residual in the cooling water, it is effective against both planktonic and sessile microorganisms throughout the entire cooling system. This is in contrast to UV and ultrasonic devices, which can kill only the planktonic organisms that pass through the device. Sessile (including algae) organisms are responsible for most under deposit corrosion and commonly harbor legionella bacteria. Note that the residual bromine can be easily measured in the field for control purposes to ensure control of sessile organisms throughout the cooling system.

Electrolytic bromine is a more effective biocide than chlorine, or hypobromite produced by mixture of hypochlorite and sodium bromide, as it is a mixture of elemental bromine, hypobromous acid, and hypobromite. It is also very effective in systems which have some ammonia present, such as cooling tower systems using reclaimed wastewater for makeup, as produced bromoamines are very effective biocides when compared to chloroamines.

Large Systems

ElectroBrom units have been successfully utilized on some of the largest cooling towers. The cooling tower shown in the photograph on the left services a 1,100 MW power station. An **ElectroBrom** Model EB-60 was utilized to replace gas chlorine in this cooling tower during a successful one year technology demonstration. A paper was presented at the 2004 International Water conference to document the results obtained.

Shown in the photo to the right are two **ElectroBrom** Model EB 60 units with a sodium chloride brine makeup tank and 2000 gallon accumulation tank for slug dosing of produced electrolytic bromine. This would be a typical system for a very large cooling tower or one with high organic loading. Total daily output would be 120 lb as bromine.

ElectroBrom Specifications

ElectroBrom units are self contained units consisting of the power unit and the patented flow through anisotropic graphite electrode assembly mounted on a steel assembly for easy installation. Construction is to NEC specifications, input voltage is 110, 220, or 440 vac dependent upon unit rating and customer requirements, with a maximum electrode voltage of 12 volt dc. Units can be controlled using any stand alone timer, the internal PLC in the unit, or any existing time based biocide controller. Many options for supply of the mixed salt solution are available, from premixed to brine makers, dependent upon installation size and usage. **ElectroBrom** units are presently offered with the following specifications:

Model	Br Output	Power Use	3024 Use	3038 Use	Water Use
EB-10	0.42 lb/hr	14.4 kwh	3.5 lb/hr	1.4 lb/hr	9 gph
EB-15	0.64	28.8	5.3	2.1	13.5
EB-20	0.83	38.5	7.0	2.7	18
EB-25	1.0 l	49.0	8.8	3.2	22.5
EB-30	1.25	57.6	10.5	4.0	27
EB-60	2.5	115.2	21	8.0	54

ProChemTech International, Inc.

"Innovation in Water Management"

Apache Junction, AZ, and Brockway, PA

814-265-0959 **www.prochemtech.com**

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"Demonstration of an On-site Electrolytic Hypobromite Generator at a Power Generation Station", IWC, 2004

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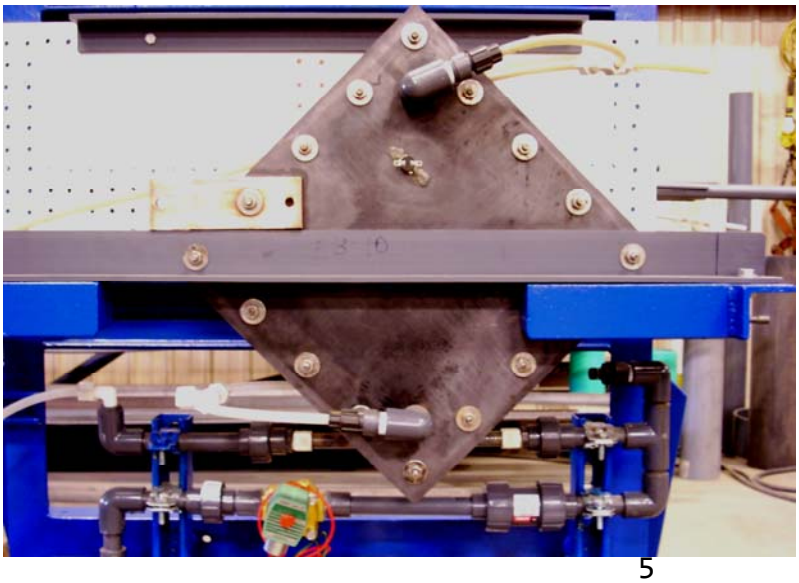
"Electrolytic Bromine: A Green Biocide for Cooling Towers" WEF, 2007



Installed **ElectroBrom** Model EB 10 electrolytic cell.