ENVIROTECH

BROMMAX

CASE STUDY

BromMax™ vs. Bleach in Cooling Water

Sodium hypochlorite (bleach) is one of the most common and ubiquitous products used in industrial water treatment for the inhibition of bacteria, slime, algae, nuisance and pathogenic microorganisms in recirculating cooling water. As the water is recirculated continuously evaporation concentrates the remaining solids and the pH naturally rises. Sometimes the pH rises to levels above threshold maximums and requires supplemental additions of sulfuric acid to keep the alkalinity and pH within limits.

The chief advantage of bleach is that it is inexpensive. Costs for large quantities of bleach are as little as $0.15/lb (or $1.50/gal) if purchased directly from a manufacturer. Some chief disadvantages of bleach is that it is very pH limited and restricted by pH levels above 7.3. Another disadvantage is that it is highly corrosive, and perhaps most importantly, it contributes significantly to the TDS (conductivity) and alkalinity of the recirculating water.

Liquid Stabilized Bromine was first introduced in 1998. It has since proven to be a very viable and effective alternative to traditional cooling water treatments such as BCDMH tablets and sodium hypochlorite (bleach). Enviro Tech has invented a new type of stabilized bromine which is identical to the other products used within the market previously, with the exception that it contains 33-48% more active ingredients than any other product on the market. Thus, the name BromMax!

It is not the purpose of this paper to propose or evaluate the advantage or disadvantage of each product chemistry. Economics is an important issue in evaluating each alternative for any application (but economics may be 75% of the customer's ultimate decision, however.) We have therefore proposed the economics of bleach vs. stabilized bromine (BromMax) by comparinged the two chemistries based on the pH of the recirculating systems, which is the most limiting factor when considering bleach as a microbiocide in any cooling water application.

The table below is easy to read. It establishes the chemical cost to treat 1 million gallons of water (based on the data that follows). Note that there are 3 graph lines, one for bleach and one for BromMax at 1 and 0.5 ppm (reported as total chlorine). We are reporting the two BromMax application lines because the great majority of the end-users apply stabilized bromine at 0.5 ppm, but some water treatment service companies prefer 1 ppm for safety or assurance purposes. Thus, you may choose which intersecting line best reflects your application philosophy.

Note that in the worst case scenario the break-even level of BromMax vs. bleach is a maximum pH of 8.6 (at 1.0 ppm residual BromMax). One must turn to the data presented (below the table) to establish or determine the reasons for, and explanation of, the resultant graphs. Typically, however, most users would use the 0.5 ppm BromMax graph curve.

Some of the data highlights and explanations are:

- At the top of the data chart note that the "background demand" has stated bleach at '1' and BromMax at 0.05. Fact: stabilized bromine does not display a "chlorine demand".
- Note the prices reported are approximate "retail".
- The most important issue to consider is the "pH Dependent Chemical Demand" table which is classic for chlorine. It is based on Clifford White's "Handbook of Chlorination" 4th edition, table 4.4 page 218, "percent HOCL at various pH values".
- For example: at pH 8.4 the active chlorine (as HOCL) from bleach addition is 11.1%. At a pH of 9 only 3.05% is active.
- An indirect economic impact is the amount of salt added, due to the use of bleach or BromMax at different pH values, especially in areas of restricted outfall for TDS or discharges restricted in relation to salt constituents and/or conductivity. Fact: each gallon of bleach ultimately creates almost 2.5 lbs of salt in the circulating water...but if sulfuric acid addition is needed to control alkalinity or pH, the total salt contribution goes up to almost 4 lbs of salt for each gallon of bleach added.
- In most cases, when utilizing bleach, the cycles of concentration are limited to 2.5 due to the negative influences of pH and alkalinity on other scale and hardness inhibiting water treatment additives.
- Note that the chart below is based on the costs of chemicals in a circulating water system. On the bottom of page 3 it is made clear that the total water treatment cost for bleach and BromMax are quite similar at pH 8.2 and using 2.5 or 3.5 cycles. It is an important issue to note that

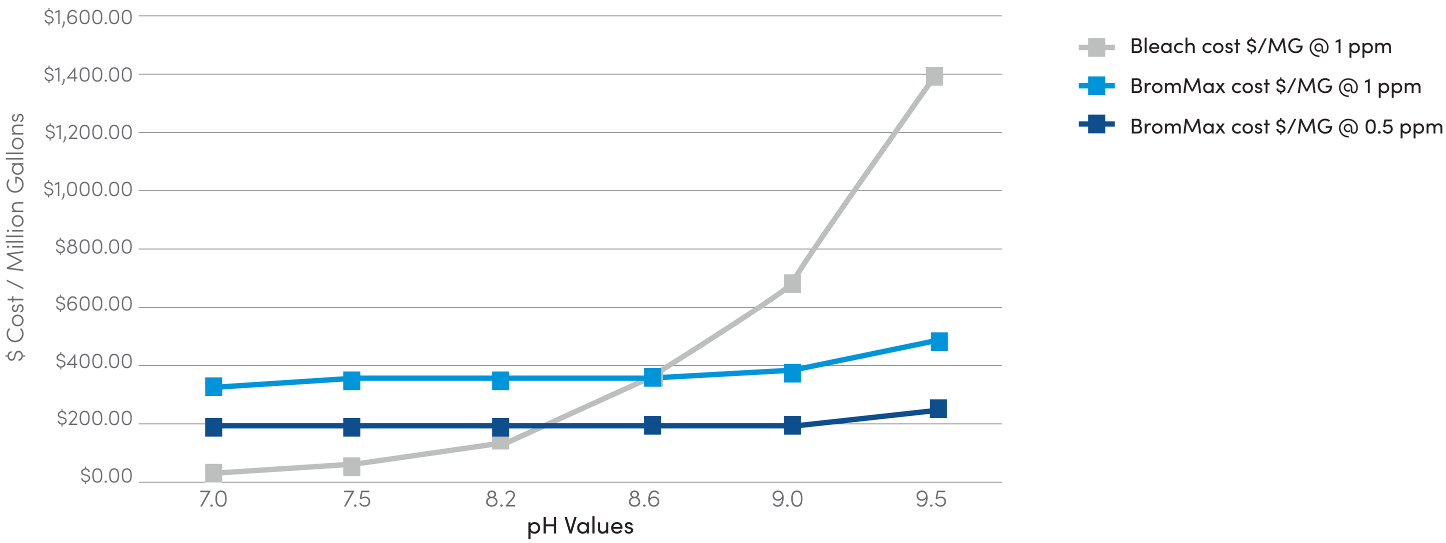
at pH 8.7 BromMax is much cheaper than bleach, and at 3.5 cycles bleach is not a consideration without acid (sulfuric) dosing to control the alkalinity.

- BromMax is NOT affected by high pH excursions and is the product of choice for systems that operate in the pH ranges above 8.8 (but below 9.6) [at a pH of 9.5 the bromine found in BCDMH tablets becomes unavailable for efficacy purposes].

Stabilized bromine products are quite stable at almost any pH value encountered in cooling tower water. However, their mode of action is not like that of chlorine-based products. Systems that are high in ammonia, for example, are not good stabilized bromine candidates because the release of the bromine to affect microbial efficacy is retarded considerably, thus making it more economically unviable. BromMax stabilized bromine (as are other similar products) are much less aggressive to copper and "yellow" metals than are chlorine or BCDMH products.

Also note that BromMax stabilized bromine will show a persistence in the cooling water that is 3-6 times that of chlorine or BCDMH products, which will shift the economics of the chlorine chart line substantially to the left, making BromMax more economically feasible at lower pH ranges.

BROMMAX VS. BLEACH COST COMPARISON



Chemistry Component	Desired ppm	Background Demand
Chlorine residual (ppm)	1.0	1
BromMax residual (ppm)	1.0	0.05
Perasan residual (ppm)	1.0	0.15

chlorine concentration	**12.0%**	*(10 lbs/gal)*
BromMax conc.	**10.2%**	*(12.3 lbs/gal)*
Perasan PAA conc.	**15.0%**	*(9.45 lbs/gal)*

Average User Costs	
chlorine cost $/gal	$ 1.50
BromMax cost $/gal	$ 48.0
Perasan cost $/gal	$ 28.0

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pH Dependent Chemical Demand @ 30 C for 1 ppm Activity

pH	7	7.5	8.2	8.6	9	9.5
gallons bleach	18.27	27.78	83.67	235.40	462.96	925.93
gallons BromMax	7.00	7.15	7.22	7.45	7.87	10.00
gallons Perasan PAA	6.73	7.08	7.91	8.97	11.21	19.36

Costs @ pH	7	7.5	8.2	8.6	9	9.5
Bleach cost $/MG @ 1 ppm	$27.41	$41.67	$125.50	$353.11	$694.44	$1,388.89
BromMax cost $/MG @ 1 ppm	$336.13	$342.99	$346.53	$357.59	$377.68	$480.19
BromMax cost $/MG @ 0.5 ppm	$168.07	$171.50	$173.27	$178.79	$188.84	$240.10
Perasan PAA cost $/MG @ 1 ppm	$188.30	$198.21	$221.53	$251.07	$313.84	$542.09

Total Salt Added to Water Matrix Based on Above Volumes

Bleach / lbs MG	40.2	61.1	184.1	518.0	1018.6	2037.2
Contribution-Bleach-ppm/MG	5	7	22	63	123	256
BromMax / lbs MG	14.7	14.7	16.6	17.2	18.1	23.0
Contribution-BromMax-ppm/MG	3	3	4	4	4	5
Perasan PAA / lbs MG	0.0	0.0	0.0	0.0	0.0	0.0

Cycle factors @ pH 8.5

	2.5 Cycles	3.5 Cycles	
Water & sewer cost ave./MG	$1,400	$1,280	blowdown=evaporation÷(cycles -1)
Inhibitor cost ave./MG	$1,910	$1,360	

Total combined costs	**pH 8.2**		**pH 8.7**	
(per M G)	2.5 Cycles	3.5 Cycles	2.5 Cycles	3.5 Cycles
Bleach cost $/MG	$3,436	$2,766	$3,663	N/A**
BromMax cost $/MG	$3,657	$2,987	$3,668	$2,998
Perasan cost $/MG	$3,532	$2,862	$3,561	$2,891

N/A* = The total alkalinity would rise too high for this scenario without acid feed.

MG = Million Gal. H2O