

HighCycle™ - Advanced Technology For Cooling Tower Blowdown Reduction

A Safe, Simple, Economic, and Environmentally Responsible
Technology for Reduction of Water Usage in Cooling Towers

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Background



Drought conditions and increasing water usage have combined to **decrease the availability** and **increase the cost** of good quality, low hardness and dissolved solids water desired for use as cooling tower makeup. At the same time, stricter environmental restrictions on effluent discharge have resulted in **increased fees for disposal** of cooling tower blowdown to the sewers. Given these trends, there is a growing desire to increase the cycles of concentration (COC) obtained in cooling tower operation so that makeup, blowdown, and chemical usage can be reduced, giving the **lowest water usage and total cost** for system operation. At the same time, control of scale, corrosion, deposition, and biological growth in the cooling water system must be maintained by the water management program to prevent capital equipment damage, excess energy usage, and extra maintenance costs.

Standard cooling water treatment chemistry uses phosphonate and organic polymer to safely increase COC up to four times over that achievable without any chemical treatment. Use of acid for pH adjustment can increase COC by two, or more, over that obtained by standard treatment chemistry. Acid, however, is a safety hazard for operating personnel, is difficult to control, is not environmentally responsible, is costly, and will cause severe equipment damage if control is lost.

HighCycle Technology

Utilizing our experience in organic polymer and crystal chemistry, we have invented advanced acid free products, which can often **double the COC** obtained using standard cooling water chemistry or eliminate the use of acid pH adjustment for scale control. The basic technology for obtaining higher cycle operation is use of carboxylated phosphonate formulated at a specific ratio to multiple organic polymers. Operating COC is calculated using the equation:

$$\text{COC} = 2 + \sqrt{110,000 / (\text{CaH} \times \text{TA})}$$

This discovery is the basis of our unique, patented **HighCycle** water management products.

In a **HighCycle** program, the blowdown conductivity set point (based on calculated COC) is adjusted to obtain minimum blowdown each time a makeup water sample is analyzed. As makeup water quality often varies substantially with time, routine testing and adjusting cycles based on the test results is required to minimize water use. The Phoenix, Arizona, market, which has hard, high alkalinity makeup waters, was selected for introduction of **HighCycle** technology in 2009. It has proven to be a great success and is currently utilized in many of our Phoenix accounts.

Close control of inhibitor concentration in the cooling water is a key to obtaining minimal blowdown without problems due to scale formation. To obtain close control, an accurate control test is needed. We invented the patented BlueTrace spectrophotometric tracer to provide an accurate, easy to use control test. This technology provides the means to obtain the desired close control of inhibitor. All of our **HighCycle** products utilize BlueTrace for control of inhibitor level in treated cooling water systems



BlueTrak is our completely automatic on line unit for control of inhibitor level in treated cooling water. It utilizes a flow through spectrophotometer to determine the level of BlueTrace in the cooling water and adds product as needed to maintain set control levels. When teamed with Advantage MegaTron controllers, BlueTrak provides complete real time monitoring and tracking via the internet as well as remote cellular alarm capability for loss of control events.

Water Use Reduction

The following table shows the blowdown from a 1000 ton thermal load cooling tower at various COC and the water savings obtained by increasing COC from a baseline of 2.

COC	Blowdown - gal/yr	Water Savings – gal/yr
2.5	6,460,500	3,230,250
3.0	4,845,375	4,845,375
3.5	3,876,300	5,814,450
4.0	3,230,250	6,460,500
4.5	2,768,786	6,921,964
5.0	2,422,688	7,268,063
6.0	1,938,150	7,752,600

Economics

Standard Phosphonate-Polymer Program

The operating cost for a **HighCycle** water treatment program will typically be 25 to 35% less than standard phosphonate-polymer water treatment programs. In general, existing feed and control equipment can be used; any upgrades needed are easily covered by the reduction in chemical, water, and sewerage bills.

To demonstrate the economics of **HighCycle** as compared to standard programs, we have undertaken the following **cost analysis** on a 1,000 ton daily annual load cooling tower system. The following data was used for this analysis:

System evaporation	9,690,750 gpy	City water cost	\$1.75/1000 gal
Sewerage cost	\$2.20/1000 gal	Makeup conductivity	1020 mmhos
Makeup total alkalinity	120 mg/l	Makeup calcium hardness	160 mg/l

A typical acid phosphonate polymer product, PCT 6214 B, at 100 mg/l, with a target COC of 2.4 is compared to a **HighCycle** program based on PCT 6217 B at 150 mg/l with a target COC of 4.4 and no acid feed.

Using product prices of \$2.10/lb and \$1.90/lb for 6214 B and 6217 B respectively, the following table is calculated using commonly known equations.

Calculated values	COC = 2.4		COC = 4.4.	
Blowdown, gpy	6,921,964		2,850,221	
Makeup, gpy	16,612,714		12,540,971	
Blowdown cost, \$/yr	\$15,228		\$5,415	
Makeup cost, \$/yr	\$29,072		\$21,947	
6214 B use, lb/yr and \$/yr	5,776 lb	\$12,130	0	
6217B use, lb/yr and \$/yr	0		3567 lb	\$6,778
Total Program Cost	\$56,430		\$34,140	

Water Savings = 4,071,743 gallons per year

Cost Reduction = \$22,290 per year

Acid pH Adjust for Scale Control Program

While not commonly used due to environmental, health, and safety considerations; acid pH adjust for scale control is another means to increase COC. **HighCycle** technology can often be utilized to replace acid pH adjustment with a net decrease in operating cost while maintaining the desired high COC. In general, existing feed and control equipment can be used; any upgrades needed can be paid for by elimination of acid costs.

To demonstrate the economics of **HighCycle** and acid programs, we have undertaken the following **cost analysis** on a 1,000 ton daily annual load cooling tower system. The following data was used for this analysis:

System evaporation	9,690,750 gpy	City water cost	\$1.75/1000 gal
Sewerage cost	\$2.20/1000 gal	Makeup conductivity	1020 mmhos
Makeup total alkalinity	120 mg/l	Makeup calcium hardness	160 mg/l
Target pH	7.5		

The acid program will use a phosphonate polymer product, PCT 6214 B, at 100 mg/l, with a target COC of 4.4 and cycled pH of 7.5 compared to a HighCycle program based on HighCycle product PCT 6217 B, at 150 mg/l, with a target COC of 4.4 and no acid feed.

Using product prices of \$2.10/lb and \$1.90/lb for 6214 B and 6217 B respectively, and \$0.45/lb for 98% sulfuric acid, we have calculated the following table commonly known equations.

Calculated values	COC = 4.4		COC = 4.4.
Blowdown, gpy	2,850,221		2,850,221
Makeup, gpy	12,540,971		12,540,971
Blowdown cost, \$/yr	\$5,415		\$5,415
Makeup cost, \$/yr	\$21,947		\$21,947
6214 B use, lb/yr and \$/yr	2,378 lb	\$4,994	0
6217B use, lb/yr and \$/yr	0		3567 lb \$6,778
Acid us lb/yr and \$/yr	41,669 lb	\$18,751	0
Total Program Cost	\$51,107		\$34,140

Water Savings = none

Cost Reduction = \$16,967 per year

Benefits

In our demonstration 1000 ton thermal load cooling tower, conversion of a standard phosphonate-polymer program to a **HighCycle** program reduces water used for blowdown by over 4 million gallons per year. This is significant considering that the average household uses about 90,000 gallons per year. The water use reduction obtained by a simple conversion to a **HighCycle** product would thus supply fresh water to 44 households for a year. An overall cost reduction of \$22,290 per year is also obtained. Proportional water savings and cost reduction can be obtained on any cooling tower by replacing standard water treatment with **HighCycle** technology.

As noted, most conversions from standard water treatment programs to **HighCycle** technology is no cost as existing control and feed equipment can often be utilized.

The major benefit from converting an acid pH adjustment program to a **HighCycle** program is the elimination of dangerous to handle and use acid while keeping a high COC. In our 1000 ton load example, the amount of acid required to maintain the desired pH was quite substantial with the result that conversion to **HighCycle** technology resulted in an overall cost reduction of \$16,967 per year.

Environmental, Health & Safety

All HighCycle products are biodegradable at use concentrations and have been approved for discharge to the sanitary sewer. Some products have also been approved for direct stream discharge by various state regulatory agencies. HighCycle products do not contain any phosphate, molybdenum, or chromium.

HighCycle products are non-toxic based on oral LD 50 values for product at normal use levels ranging from a low of 1,504 g/kg to a high of 4,444 g/kg, differences based upon corrosion control chemistry of the product.

ProChemTech International, Inc. **“Innovation in Water Management”**

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HighCycle US# 8,496,847

BlueTrace/BlueTrak US patent #7,932,091

