CLO$_2$IX™

APPLICATIONS

Disease, Energy & Water

Cooling Tower disinfection is important for two reasons – disease control and energy savings.

Cooling Towers are one of the most prominent emitters of water aerosols into the environment. The white cloud of *steam* is visible for miles around any facility with a cooling tower, but that *steam* is really a cluster of water droplets which has the potential to carry the Legionella bacteria along with it in flight. Without proper disinfection, Legionella flourish in the biofilm of the towers. For this reason, cooling towers are targeted in the fight to control Legionnaire's Disease.

Ranking of Common Foulants

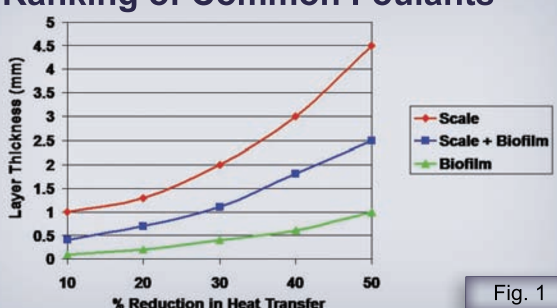

Fig. 1

CLO$_2$IX™ Systems

CLO$_2$IX™ System	Production Rate (lb/day)	Installation Type	Ion Exchange	Typical Application
Commercial	0.1 - 1.5	Permanent	Replaceable	Biofilm Removal
Service DI	0.1 - 1.5	Permanent	Regenerated Off-Site	Biofilm Removal
Industrial	0.1 - 50	Permanent	Regenerated On-Site	Biofilm Removal
Portable	0.1 - 20	Temporary	Replaceable or Regenerated	Annual/ Semi-Annual Disinfection or Emergency Use

CLO$_2$IX™ offers Chlorine Dioxide productions systems for both permanent cooling tower installations and for annual or semi-annual cleaning.

But that Legionella harboring biofilm plays an equally important role in the energy cost to operate a cooling tower. It does this in two ways. First the biofilm itself is mostly water, so it is a very good insulator, something you do not want in a cooling tower. Second, the biofilm can act as a site of nucleation for the formation of scale, which itself is a very good insulator. A clean tower free of algae with a biofilm layer of only 6 mils can save 12% annually on energy costs by merely removing the biofilm layer. This translates to over $65,000/year per 1,000 tons of cooling in energy savings based on $0.10 per KWH. If the same tower develops scale deposits as part of the biofilm layer or has algal growth, the potential for cost savings is even greater. The relationship for biofilm and energy savings is fairly linear with thin films, which occur in relatively clean towers. *Figure 1* illustrates the relationship between common cooling tower foulants and the reduction in heat transfer, which correlates directly to increased energy costs. But the biofilm problem is only a part of the problem associated with cooling towers.

Cooling towers use evaporation to remove heat from the system. Two things happen during evaporation:

1) the minerals in the water concentrate
2) the pH of the water rises due to the release of CO_2 from the water

When the concentration of minerals is too high as a function of the high pH, scaling occurs, further fouling the tower. In order to prevent this scaling, acid is added to the water to bring down the pH. However, eventually, the water containing the concentrated minerals becomes so concentrated that scaling cannot be avoided, and the concentrate must be purged from the tower. This purge water is called *blow down*. The object of the game is to minimize the amount of blow down in order to conserve water, especially in water short areas. However, as fate would have it, many of the water short areas are also the areas with the highest concentration of minerals and CO_2 alkalinity in the natural water supplies used to feed the cooling towers.

And what about the acid? The acid serves two purposes. It helps to prevent scaling as described above, and it also lowers the pH of the tower so that traditional biocides maintain their effectiveness. This is why acid is added even in naturally soft water areas. But there is bad with the good as the addition of the acid can also increase the potential for corrosion, causing the need for additional chemicals to be added to the tower.

DISINFECTING WATER WISELY

CLO_2IX^{TM} IS THE BEST CHOICE FOR COOLING TOWER TREATMENT

Fig. 2

$$ClO_2 \left(\frac{lb}{day}\right) = \frac{ClO_2 \text{ conc } \left(\frac{mg}{l}\right) \times \text{treatment time (min)} \times \text{recirc rate } \left(\frac{gal}{min}\right) \times 8.34 \left(\frac{lb}{gal}\right)}{1{,}000{,}000 \left(\frac{lb}{\text{million lb}}\right)}$$

Fig. 3

$$ClO_2 \left(\frac{lb}{day}\right) = \frac{ClO_2 \text{ conc } \left(\frac{mg}{l}\right) \times ((\text{treatment time (min)} \times \text{make up rate } \left(\frac{gal}{min}\right)) + \text{system vol (gal)}) \times 8.34 \left(\frac{lb}{gal}\right)}{1{,}000{,}000 \left(\frac{lb}{\text{million lb}}\right)}$$

There is no debate that Chlorine Dioxide is the best biocide available to remove biofilm. However, Chlorine Dioxide has not been used in cooling towers traditionally for three reasons:

1) there is a perception that Chlorine Dioxide is too volatile to be effective in a cooling tower,
2) former methods of generation were complicated or not built for the harsh, moist environments surrounding cooling towers, and
3) the perception exists that the cost of equipment and operation is too high to support a reasonable payback.

Quite frankly, none of these things are true when using CLO_2IX^{TM} Catalytic Chlorine Dioxide Production Systems.

The perception that Chlorine Dioxide is too volatile to be used in a cooling tower is based on 20-year-old data obtained from dosing protocols based on tower recirculation rate instead of the combination of the makeup water and the total system capacity, which is the accepted protocol today. To simplify, the old recirculation rate protocol would use the *Figure 2* formula.

The proven protocol substitutes the makeup volume during treatment plus the total system volume for the recirculation rate as shown in *Figure 3*.

The amount of Chlorine Dioxide required per day using each of the two formulas is calculated below based on a 65,000 gallon system volume, 180 gal/min make-up, and 22,000 gal/min recirculation rate. For the intermittent case, the dosage rate is 1.5 mg/l, and for the continuous case, the dosage rate is 0.4 mg/l. As you can see, the old protocol uses 50 to 100 times more Chlorine Dioxide to treat the same tower, as seen in *Figure 4*. Under these circumstances, the Chlorine Dioxide cannot help but be stripped from the tower!

Former methods of generation were complicated or not built for the harsh, moist environments surrounding cooling towers. This is true. But the CLO_2IX^{TM} systems are simple to use and constructed of rugged, proven industrial components, thus overcoming the problems of the past generation systems.

The perception that the cost of equipment and operation is too high to support a reasonable payback was true when energy was inexpensive, but energy is no longer inexpensive, and the statement is no longer true. As the cost of energy rises, the need for Chlorine Dioxide intensifies, because Chlorine Dioxide is the only biocide that can effectively remove the energy consuming biofilm from the towers. End users and tower owners are becoming more educated about where their energy dollars are spent, and as they are becoming more educated, they are expecting more from their Water Treaters. As described previously, even relatively small, clean towers which are free of algae can save tens of thousands of dollars per year by merely changing biocides and removing the biofilm.

But as we know, biofilm is only part of the story. In hard water areas, scale prevents water conservation by forcing more blow down water down the drain. This is why CLO_2IX^{TM} has expanded its cooling tower offering to include a highly efficient water softening option for its Chlorine Dioxide production systems. These softeners utilize the same efficient Impulse technology as the CLO_2IX^{TM} Industrial systems. By utilizing the Impulse technology, approximately one-third as much water is used for regeneration as a traditional softener. Softening works on a cooling tower by removing the majority of scaling minerals from the incoming water, thus decreasing the scaling potential. As the pH of the water rises, there is less need for corrosion inhibitors. However, in this elevated pH range, traditional biocides such as chlorine and bromine are no longer effective. However, Chlorine Dioxide is not pH sensitive, which makes it even more valuable in cooling towers. Chlorine Dioxide is effective up to pH 10, so as the pH of the water increases, there is no need to add the potentially corrosive acid to maintain an effective pH for the biocide.

Chlorine Dioxide is the best biocide for cooling water treatment, and CLO_2IX^{TM} systems are the best solution for providing the Chlorine Dioxide. The CLO_2IX^{TM} systems are based on *pure water* technology found routinely in the pharmaceutical and semiconductor industries where purity and safety are not optional. The systems utilize a patented combination of ion exchange and catalysis to produce Chlorine Dioxide on demand. Because the Chlorine Dioxide is not produced as a batch process, there is no need for storage of the resultant solution. These reasons and others make the CLO_2IX^{TM} method of producing Chlorine Dioxide ideal for biofilm removal in cooling towers.

Fig. 4	Old Protocol Recirculation Rate	New Protocol Makeup + System Volume
Intermittent Dosing 6 hr/day	99 lb/day	1.62
Continuous Dosing 24 hr/day	106 lb/day	1.08

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