



MIOX® On-Site Generated Disinfection Systems: COOLING TOWERS: Frequently Asked Questions (FAQ)

1. Why Consider MIOX?

Consider these (3) three benefits: (a) economic savings, (b) safer operations, and (c) the most sustainable disinfection technique available. Compared to delivered chemical, MIOX can typically generate chemical on-site for 1/3rd to 1/5th the cost. MIOX is ten (10) times more powerful than chlorine, offering enhanced inactivation efficacy for pathogens such as *Giardia*. MIOX eliminates biofilm, driving greater operational efficiencies and offering greater protection against *Legionella*-related outbreaks. MIOX is generated at < one (1) percent concentrations, the OSHA threshold for consideration as a hazardous chemical, and is therefore environmentally benign. And at dilute concentrations, degradation is far less of a concern. Operators exchange the management of hazardous disinfection chemicals with the handling of salt only. Salt is stored and converted on site to a chlorine-based sanitizer, replacing the transport, handling, and storage of delivered chemicals. To generate the same amount of free available chlorine, there is a 3-to-1 carbon emission reduction between the transport of salt and 12.5% liquid bleach.

2. What is a Mixed Oxidant?

A mixed oxidant is a blend of advanced chlor-oxygenated species. Average concentrations are 30-40% mixed oxidants (MOS) and 60-70% sodium hypochlorite. Compared to the generation of standard Sodium Hypochlorite alone, more energy is used to strip electrons off of chloride and oxygen. The MIOX on-site generation (OSG) systems have been developed with a proprietary geometrical design, electrolytic scheme, and solution flow characteristics. Extensive 3rd party research in both the lab and, more importantly, in the field with and by customers has confirmed the competitive advantages of MOS. It has also been confirmed that MOS does not contain chlorine dioxide or ozone.

3. How does MIOX's Conversion Efficiencies Compare to Competitors?

We rarely encounter alternative on-site generation systems in institutional and heavy industrial environments, much less for cooling tower applications. Nonetheless, MIOX's salt- and electrical-conversion efficiencies lead the industry. MIOX's standard sodium hypochlorite OSG systems have salt conversion efficiencies (SCEs) of 3 and electrical conversion efficiencies (ECEs) of 2. This means it takes 3 pounds of salt to generate one pound of 100% Free Available Chlorine (FAC) liquid solution, and 2 Kilowatt Hours (KwH) of electricity. Further, MIOX is the only company that offers mixed oxidant OSGs. MIOX's mixed oxidant OSGs have SCEs of 2.5 and ECEs of 3.5. Depending on the competitor in question, MIOX is typically 15-30% superior.

4. As a Stronger Oxidant, is MOS Going to Damage my Cooling Tower?

There have been numerous studies conducted on the corrosivity of the MOS solution and how it reacts with various cooling tower materials. MOS is no more corrosive than any other type of biocide, non-oxidizing or otherwise, when combined with the proper corrosion and scale control programs. The industry standard for corrosion is < two (2) mils per year (MPY) for steel, copper, and other relevant materials. A mil is one thousandth of an inch.

5. Will the Use of MIOX Damage the Performance of Other Chemicals Used for Cooling Tower Water Treatment?

An important distinction is organic versus inorganic-based chemicals. As an oxidizing disinfectant chemical, MOS can damage the performance of organic based scale inhibitors such as certain azoles and phosphonates. Chemicals that serve the exact same purpose, that are inorganic, are readily available that are compatible with



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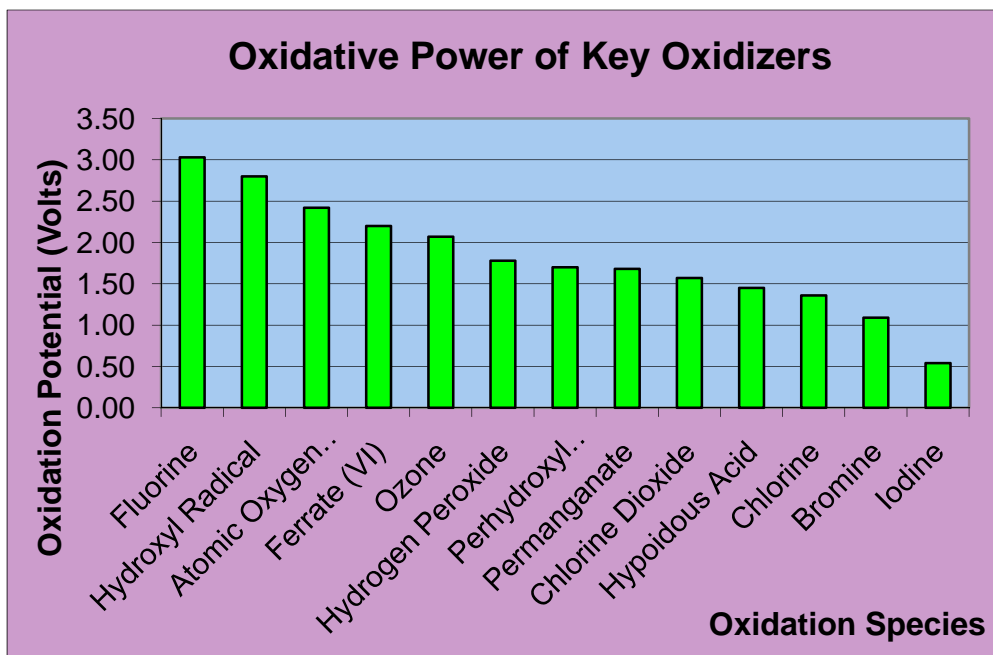
MOS. As necessary, inquire with the end user or consultant water treatment and chemical supplier and MIOX can comment and recommend an alternative.

6. Can MOS Perform in High pH Conditions?

Similar to bromine, MOS performs effectively in high pH conditions. Chlorine notoriously is not the disinfectant of choice when source water conditions include a high pH, based on its relationship with chlorine and the production of hypochlorite ions versus hypochlorous acid. In high pH conditions, for example at eight (8) and above, there are a higher percentage of hypochlorite ions which are known as a weaker disinfectant as compared to hypochlorous acid. While MOS is a chlorine-based disinfectant, MOS also includes the unique chlor-oxygenated species (i.e., oxygen component of the oxidizer). These chlor-oxygenated species perform well in a high pH condition.

7. How do you size MOS in cases where ozone or chlorine dioxide is being replaced?

MOS should be sized based on equivalent oxidative strength or “stoichiometry.” Oxidative strength can be equating on a basis of milligrams per liter (mg/L) or parts per million (PPM). There is an oxidation strength measurement, as shown in the below graph.



As a rule of thumb, MIOX historically has sized MOS as compared to chlorine dioxide or ozone on a pound for equivalent pound basis. But the greater oxidative strength, plus residual strength, of the 30-40% active MOS chemistry must be considered. When replacing either chlorine dioxide or ozone, MOS has been able to accommodate the disinfection needs of a given cooling tower on a pound for pound basis.

8. Does the use of MIOX's OSG Systems require FIFRA Registration?

MIOX has been told by EPA's FIFRA that, since MOS is not a “regulated” insecticide, neither MIOX nor its customers require FIFRA registration, for two (2) reasons: (a) mixed oxidants are generated using salt, water, and electricity (i.e., no harmful constituents), and (b) it is generated on-site at < 1% concentrations. At <1%, the solution is not OSHA-classified as a hazardous chemical. When the EPA took over FIFRA from the Department of Agriculture, it initiated a priority shift to a focus on “control of pesticides for reduction of unreasonable risks to man and the environment.” In other words, it was a shift toward minimizing risks associated with toxicity and



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environmental degradation and away from pesticide efficacy issues. As a result, program focus is now safety and not efficacy.

The second part of this question is, "do OSG customers require FIFRA registration when producing MOS or Sodium Hypochlorite onsite at their facilities?" Over MIOX's history, FIFRA has confirmed that neither the equipment nor the chemical produced by the equipment needs to be registered, but we are revisiting. MIOX is currently investigating this issue further. Chlorine has a registration number from FIFRA, which implies if one is generating it then registration must be completed, but it is not actively monitored by FIFRA.

9. What is the Difference between Biofilm and Algae?

Biofilm is an aggregate of microbes with a distinct architecture. A biofilm is like a tiny city in which microbial cells, each only a micrometer or two long, form towers that can be hundreds of micrometers high. The "streets" between the towers are really fluid-filled channels that bring in nutrients, oxygen and other necessities for live biofilm communities. Bacteria growing in a biofilm are highly resistant to antibiotics, up to 1,000 times more resistant than the same bacteria not growing in a biofilm.¹ Whereas algae is a group of aquatic, photosynthetic organisms ranging from unicellular to multi-cellular forms, and generally possess chlorophyll but lack true roots, stems and leaves characteristic of terrestrial plants.² Both can affect the proper operation, useful life, and thermal efficiency of a cooling tower. Biofilm is typically the harder of the two to control through water disinfection, as it is often resistant to chlorine alone.

10. How Should Injection Pumps be Sized with MIOX OSG systems?

MIOX's on-site generation systems generate a dilute concentration disinfectant. In the case of the sodium hypochlorite generators, it is 15 gallons of solution per one pound 100% active FAC (or .8%). In the case of the mixed oxidant generators, it is 35.8 gallons of solution per one pound 100% active FAC (or .4%). The difference is that, as compared to, for example, 12.5% concentration chlorine, more volume of fluid must be injected into the cooling tower. As a result, the injection pumps must be evaluated, or at times new pumps included, ensuring the proper volume of fluid can be injected to maintain desired chlorine-based residuals.

11. Does MIOX Contribute to the Accumulation of Total Dissolved Solids (TDS)?

Average TDS within source potable water is 300-500 PPM. Mixed oxidants are no more contributive to TDS than any other disinfectant, when looked at on a PPM or mg / L basis. The use of mixed oxidants, or a sodium hypochlorite generator for that matter, does not materially add or detract from the management of TDS in a cooling tower operation.

¹ <http://www.medterms.com/script/main/art.asp?articlekey=16932>

² <http://www.biology-online.org/dictionary/Algae>



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