



# Pool and Spa Disinfection

## A Reduced Chemical Approach

The maintenance of a pool or spa can become tiresome for the average consumer. Owning this type of recreational luxury can create a chore most people despise. Sparkling clear pool water can be easy to obtain or it can be a nightmare, especially if there is a lot of rain or many swimmers. Opening a pool in the colder areas of the world often is a dreaded and avoided task, and year-round pool ownership is never as simple as it looks. There are alternatives on the market that work rather well for any size pool or spa—public or private. Chlorine has been used and accepted for years because it is inexpensive and easy to use. In addition, most health department regulations are set for chlorine use, and a residual must be maintained. Bromine is used for spas and hot tubs since the bromide ion can remain more stable at higher temperatures. This

article will address the use of ozone, copper ionization and proper injection of chlorine for a reduced approach to chemicals in providing a clean, clear, healthy pool and spa experience.

### Bio-Slimes and Bacteria

Bio-slimes can form on the inside of pipes and filters and on the walls of pools and spas that are improperly maintained. Organic matter in the circulating water provides nutrition to the bacteria, and they form strong bonds to the surfaces to which they are attached. Stagnant water exacerbates the formation of biofilms. As the bacteria grow they form polysaccharides that essentially are “bacterial cities,” which are groups of bacteria and can contain multiple species. The bacteria form these biofilms, a common occurrence in nature, because there is strength in numbers. However, in a pool or spa

environment, they can cause disease and sickness. To prevent the spread of a disease or waterborne illness, pools and spas must be properly maintained and disinfected. Public and private pools, spas or water parks must keep water bacteria free to prevent biofilms from forming. Chlorine has been the choice for decades, but technologies such as ozone and copper/silver ionization have been used to reduce the amount of chlorine needed for disinfection while still retaining the residual that health organizations require.

### Understanding Oxidation Reduction Potential (ORP)

Understanding what ORP means will help explain how to reduce the use of chlorine. ORP levels need to be maintained in order to render bacteria ineffective. ORP stands for oxidation-reduction potential, which in practical

terms is a measurement of the potential to oxidize contaminants. It is the method that is used to electronically monitor a sanitizer’s effectiveness. “Redox potential” is another term that is used to explain this phenomena. In the late 18th Century the word “oxidation” meant to combine with oxygen and was a pretty radical concept. Examples of oxidation can be seen daily and at different speeds. A piece of iron rusting or slices of an apple turning brown are slow processes of oxidation. A fire, of course, is an example of rapid oxidation and, as we now know, is the exchange of two electrons. The atom that loses an electron is “oxidized” and the atom that gains the electron is “reduced.”

Chlorine, bromine and ozone are oxidizers because of this electron reaction. In picking up an extra electron, they lose electrical energy,



**Picture A.** Just a few weeks after an ionization, ozone and chlorine injection system was installed. Iron is removed from the pipes and causes the brownish-green color.



**Picture B.** After just a few more weeks, the pipes were freed from scale and biofilms and the pool cleared up as particulate was filtered.



#### About the Author

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making them hungry for more electrons, which makes them good water sanitizers. It is their ability to oxidize or steal an electron from other substances that makes them so good at sanitizing water. They alter the chemical makeup of unwanted plants or animals and kill them. The remains are burned up and produce byproducts that can be filtered.

In this process of oxidizing, the oxidizers are reduced, and they lose the ability to further oxidize substances. They simply are used up. To make sure that the chemical process continues, there must be a high enough concentration of an oxidizer in the water to complete the process. This is where the term "potential" comes into play. Potential

Sizing, flow rates and the amount of water to be treated should be taken into consideration when employing the technology described in this article.

energy is a word that refers to ability, rather than action. It is energy that is stored and ready to be put to work. In electrical terms, this potential is measured in volts. In using the term to describe ORP, we are talking about the electrical potential or voltage that is created when a metal is placed in water in the presence of oxidizing or reducing agents. This voltage gives an indication of the ability of oxidizers in the water to keep the water free from contaminants.

Without going into the actual explanation of how an ORP meter works, let it be said that this meter measures the amount of oxidizers or "good guys" in the water. The higher the voltage reading, the more oxidizers there are available to combat the reducers or "bad guys," since it measures the electrical action created by the stealing of electrons. If there were the same amount of oxidizers as reducers in the water, the measurement would be zero and the water would be in pretty sad shape. Balanced water has the ability to achieve a higher ORP level since there is a balance of electrons. This is why alkalinity and pH are so important to proper pool and spa maintenance.

In 1972, the World Health Organization set the standard for drinking water disinfection at 650 millivolts (mV). This means that when a body of water measures 650/1,000 (about 2/3) of a volt, the sanitizer in the water is active enough to destroy harmful organisms almost instantaneously. Germany, which has some of the strictest water quality standards in the world, has set its standard at 750 mV for pools and

spas. In 1988, the National Spa and Pool Institute (NSPI) stated that ORP could be used as a supplemental measurement of proper sanitizing activity when chlorine and bromine are used as the primary disinfectant. The minimum reading would be 650 mV with no ideal or maximum reading. The NSPI also stated that the use of ORP measurement does not supersede or eliminate testing of sanitizer levels with standard kits.

#### Ozone as an Oxidizer

Now that there is a better understanding of what ORP is and how the electrons produce measured activity to gauge potential, it can be determined how ozone can be applied to oxidize con-

taminants in water. The differences and sizing of the ozone generators will not be discussed in this article because the two methods of ozone generation (ultraviolet [UV] light and corona discharge) on this specific application would need to be addressed in much more detail. Ozone is very good in spa and pool sanitation, but since it leaves no residual, it needs to be applied in conjunction with other treatment methods. Ozone helps flocculate

particles in the water to make them filterable. If well water that has high iron and manganese is used to fill the pool or spa, these contaminants will be oxidized first. Chlorine has the same effect, and these contaminants are part of the biological oxygen demand (BOD) on the water that reduces the effectiveness of sanitizing. Since ozone is good at providing oxidation of these contaminants, then less chlorine will be needed to maintain the residual, reducing chemical use. Another factor to consider is that when less chlorine is used, it is easier to maintain a proper pH level since chlorine raises the pH and acid must be used to reduce the pH. This is another chemical-savings advantage that ozone has to offer. Ozone also is known to help flocculate body oils and suntan lotions and makes these particles easier to filter, thus polishing the water. Ozone does not affect the pH or alkalinity.

#### Copper and Silver Ionization for Disinfection

Copper and silver ionization are very good disinfectant methods. They help kill many microorganisms and also control algae. Ionization takes the brunt of the disinfection process, is not affected by sunlight and does not alter the pH or alkalinity. The copper levels don't have to be high (0.3 to 0.5 ppm usually is sufficient to help control algae and render many bacteria lifeless). The electrical charge to the water can help reduce scaling in the plumbing and on the sides of the pool. Picture






Copper and silver ionization play an important role in the pool disinfection process by helping to kill microorganisms and control algae.

(A) shows a pool a few weeks after an ionization, ozone and chlorine injection system was installed. The brownish/green color is from the iron being removed from the inside of the pipes. There were massive amounts of iron and hardness scale when the flow cell was installed, since the pool was filled with iron-laden water from a well for many years. Picture (B) shows how the pool cleared up after a few weeks and, over time, cleared even more as the particulate was filtered and removed. The pipes now are free from any scale or biofilms. Copper and silver are very safe if monitored and will not cause staining if proper levels are maintained.

#### Chlorine as a Sanitizer

Maintaining the chlorine residual is easier when using ozone and copper/silver ionization. The copper, silver and ozone do most of the disinfection process. Therefore, not as much chlorine is needed to maintain

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the proper ORP levels. UV light ozone generators are used in most cases because they don't produce as high a level of ozone as corona discharge systems. However, on larger pools and spas corona discharge is the best method to produce enough ozone to satisfactorily maintain proper ozone levels. The ORP can be monitored and chlorine automatically can be injected with the proper residual, as required by health organizations being maintained. ORP monitors do not distinguish between chlorine and ozone; they measure only the potential by a means of electrical voltage as defined earlier. If the ozone does not reach this level, then the injector injects chlorine until the set level is achieved. A well-designed system will adjust the pH first, freeing up hypochlorous ions that will increase the ORP level. Once the pH is adjusted, the monitor will dose the correct amount of chlorine to reach the set point. This method of control can reduce chlorine and acid usage substantially, since it is dosed only when needed. Manual testing is recommended to ensure the safety of the swimmers and monitor possible equipment failure.

Conclusions can be drawn on the fact that copper/silver ionization, when

monitored and controlled, kills many bacteria and helps control algae and bio-slimes. Ozone oxidizes contaminants and helps reduce chlorine and other chemical use.

There are many parameters to take into consideration when employing the technology described in this article. As with any other water treatment devices, ozone generators, copper/silver ionizers and chlorine injectors need to measure for and meet specific criteria. Flow rates and the amount of gallons to be treated must be analyzed carefully or system failure will be experienced. A thorough understanding of ORP monitors, ozone, ionization and chemical feed pumps need to be addressed in order to obtain optimum results. **WQP**

#### References

- 1 Lowry, Robert W., and David Dickman. "The ABC's of ORP—Clearing up some of the mystery of Oxidation-Reduction Potential," *Service Industry News*.
- 2 Barnes, Ronald L., and D. Kevin Caskey. "Using Ozone in the Prevention of Bacterial Biofilm Formation and Scaling," *Water Conditioning and Purification*, October 2002.

### Drinking Water Quality Test Kits



Bacteria Check is a drinking water quality test kit that tests for four major concerns in water: bacteria, nitrates, nitrites and ammonia. This kit offers results to ensure safe drinking water at most any residential location.

Industrial Test Systems, Inc.,  
Rock Hill, SC Write in 1127

### Ozone Water Purifier



The USO-3 undersink ozone water purifier provides bottled-water-quality tap water at the touch of the faucet. The compact unit requires no special tools or complicated plumbing hookup. The unit is free-standing and portable, and because it requires no

permanent attachment to the house, the unit can be removed and taken to a new location. Dimensions: 16 in. H x 14.5 in. W x 9 in. D.

Ozone Pure Water, Inc., Sarasota, FL  
Write in 1128

### Blended Phosphate Solution

Aqua Mag is a concentrated liquid phosphate compound designed to keep iron and calcium suspended in water.

This product can reduce the reddish iron stains that form on driveways, walkways, buildings and plants during irrigation. The solution mixes instantly and stays in suspension in the mixing tank prior to injection.

Pro Products LLC,  
Fort Wayne, IN  
Write in 1129



### Shower Filter



This shower filter comes with an LED light that indicates when the cartridge needs replacement. The KDF-patented media can remove chlorine for up to six months (or 10,000 gallons). When capacity is reached, the light becomes red, indicating the need for a cartridge change. Another feature of the filter is the shut-off valve that enables users to stop water flow without altering the hot/cold water mix.

H2O International, Inc., Deerfield Beach, FL  
Write in 1130

### On Site Ozone Analysis System

A specific ozone dosage must be given time to react. Analysis of the water yields information of the efficacy of ozone for the intended treatment process. This company's engineers will collect data to determine the precise ozone dose to achieve satisfactory results.

Ozotech, Inc., Yreka, CA Write in 1131



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