SERVICE/TECHNICAL

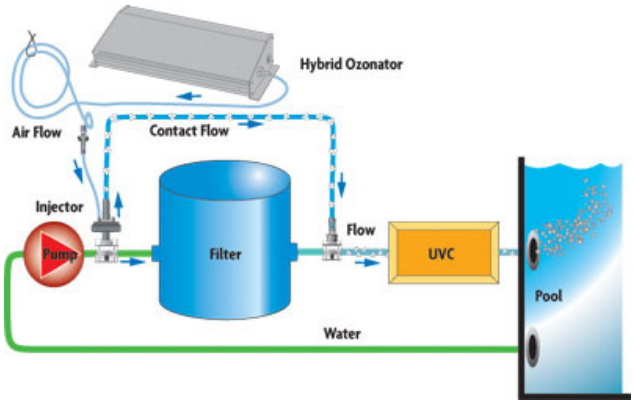
Advanced Oxidation

Ozone and ultraviolet sanitation have their pros and cons — but new technologies combine both for superior results.

By Ron Barnes, Prozone Water Products | 9.16.2011

Pristine, sanitized, non-toxic water is the goal of all recreational water owners and operators. However, not all chemical sanitation and oxidation treatments are created equal.

The challenges of eliminating toxic chemicals and their byproducts while maintaining water sanitation and oxidation have led consumers and health officials to search for chemical-limited (or reduced chemical) solutions to water treatment. Unfortunately, this search has opened the door to highly promoted "alternative sanitizers," some of which are less effective than others.



SOURCE: PROZONE

AOP Type 1
Ozone Generator and Contractor with UVC Within Water Stream

This has inspired some manufacturers to develop Advanced Oxidation Processing (AOP) solutions. AOP devices produce hydroxyl radicals (OH-), which constitute a highly potent oxidizer. Hydroxyl radicals are created when ozone is used in conjunction with intense ultraviolet (UV) light and water.

To produce hydroxyl radicals, ozone is injected into water that is irradiated by UVC light, or water vapor within a VUV ozone generator.

Ozone and UV
Ozone systems oxidize contaminants such as *E. coli*, *Legionella*, and most bacteria and viruses very rapidly. Yet some of the most toxic contaminants can be difficult to destroy, even with ozone. A high ozone concentration is necessary for the more resistant strains of *cryptosporidium*, for example — this parasite calls for an ozone generator package geared toward large commercial pools and waterfeatures.

Meanwhile, ultraviolet sterilizers have been widely used in the water industry for decades. The method destroys dangerous organisms' DNA, preventing their reproduction; however, it does not provide oxidation and biofilm destruction in the return line. Though UV is often touted as having the capacity to convert chloramines to free chlorine, only medium pressure UVB lamps have been shown to possess that capability.
However, by combining the two technologies of ozone generation and low pressure UVC (a wavelength found in germicidal lamps), the Advanced Oxidation Process has emerged as a new solution for oxidizing and sanitizing hard-to-remove contaminants, such as *cryptosporidium*'s cystic form, compound chloramines and pharmaceutical residuals.

What is AOP?
AOP is the conversion of ozone by ultraviolet rays on the UVC wavelength, in the presence of water, to form high-energy hydroxyl radicals.

Hydroxyls function in a manner similar to hydrogen peroxide, which is increasingly common for use as an oxidation shock in pools. However, the hydroxyl radical energy level generated in the AOP process is significantly higher than that generated by hydrogen peroxide alone.

When ozone and AOP are mixed into the stream of water, they oxidize many resistant chemicals, which are known as Advanced Toxic Contaminants (ATCs). These include free organisms such as *cryptosporidium*, *giardia* and *Legionella*; pharmaceuticals, herbicides and insecticides; and cleaning byproducts such as chloramines.

AOP also produces a short-term active residual, as well as a long-acting hydrogen peroxide residual that will continue to sanitize and provide a measurably increased ORP. This makes it an oxidation process that is both environmentally friendly and potent.

How is AOP produced?
There are two major methods for producing AOP, both of which are applicable to swimming pool and spa water.

The first method (shown in the "AOP Type 1" diagram) is to produce ozone with an ozone generator — of either the vacuum-ultraviolet (VUV) or corona discharge (CD) type — and mix that ozone with a stream of water. This ozonated water is then exposed to germicidal UVC

ABOUT THE AUTHOR

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downstream. This combination of ozone, UVC and water generates hydroxyl radicals, which are used up rapidly due to their high reaction rate.

The second method uses a VUV ozone generator to both create ozone and generate hydroxyl radicals. In this method, two dominant UV wavelengths — the 185 nm (VUV) ozone-producing frequency and the 254 nm (UVC) germicidal frequency — are generated from the mercury arc.

VUV systems that generate both ozone and hydroxyls are common in the pool and spa industry. In these systems, the VUV within the generator converts oxygen to ozone. This ozone is then exposed to the germicidal UVC, and to water vapor, to produce hydroxyl radicals and hydrogen peroxide.

In 2006, a third AOP design was developed — this hybrid design controls the lamp contamination variables, and also adds enhanced generation of both ozone and hydroxyl formation. The ozone generator contains both ozone producing VUV and germicidal UVC, plus high-voltage electrical fields produced by a high-frequency power supply, and rectifiers to accelerate the AOP process.

AOP advantages
These designs offer certain advantages over traditional corona discharge or ultraviolet systems. Aside from the mechanical benefits of typical VUV ozone generators — such as simplicity, long life and effective biological destruction — they also offer a number of unique attributes. Chief among these is the fact that AOP systems produce a gaseous form of hydroxyl radicals for both air and water, which generate potent chemical reactions that can effectively destroy contaminants.

The logistical advantages are also significant: AOP can be quickly added to existing circulation systems, adding these capabilities without significant increases in cost or complexity over a traditional ozone system.

In addition, AOP meets current and proposed health standards, because it is used as an oxidizer as an adjunct to existing sanitation systems. For all these reasons, AOP may be an ideal solution for larger pools that must deal with contaminant concerns — particularly in areas where state or municipal laws require quick and effective treatment of these issues.

If a traditional ozone or UV system isn't meeting all the pool's needs, it could be time to look into the more powerful sanitization AOP can provide.

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