An Insider's Guide to UV Treatment for Swimming Pools and Spray Pads – Regulations, Technologies, and Configurations

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INTRODUCTION

While UV technology has been used in other industries in the US for many years, the emergence of UV for swimming pools in the US has been more recent, dating back approximately 15 years. Initially, UV was used for removal and control of combined chlorine (chloramines) from indoor pools, with the added benefit of secondary disinfection. Today, growing concerns about the health of patrons has created increased demand for UV in the outdoor pool and spray pad market as well. UV systems are now firmly established as key components for both disinfection and chloramine control.

As stricter codes and regulations are put in place to protect the health and wellness of aquatic patrons, more and more facilities are utilizing UV technology. This article addresses the most common questions asked when owners and operators are considering UV for their new or existing facility. How does UV work? Are there different types of systems available? Are they difficult or expensive to operate? How effective are they? What system is right for our facility? How do we incorporate it into our layout? Before examining the specifics of UV technology, it is helpful to review why it has become indispensible for the safe and efficient operation of virtually every type of aquatic environment.

THE CHLORAMINE PROBLEM

Pool management and maintenance personnel are well aware of the issues related to the presence of chloramines in swimming pool water. Users often incorrectly attribute the familiar odor in a natatorium to too much chlorine in the pool; in reality, the smell results from chloramines in the pool—the undesirable by-product of chemical oxidation in the water. The most conscientious and knowledgeable operators continue to struggle with controlling chloramines, which, if not maintained at low levels, irritate swimmers and foul the natatorium environment.

Historically, the chloramine problem has been managed through plentiful air exchanges, but in recent years, natatorium air handling systems have become more aggressive in limiting the amount of outside air brought into the natatorium in order to maximize energy efficiency. In many modern facilities, therefore, it is not uncommon for airborne chloramines to accumulate, endangering the respiratory health of users and staff.

Airborne chloramines can also result in accelerated corrosion in the natatorium, reducing the life cycle of the building. Maintenance staff must give increased attention to stainless steel deck equipment (lifeguard stands, grab rails, starting blocks, diving board railings, etc.) in order to prevent discoloration and corrosion due to chloramines (See Figure 1). (Stainless steel is definitely not "stainless" in such an environment.) In addition, natatorium air handling equipment can be compromised as air laden with chloramines saturates the system. Thus, the inability to control chloramines in the pool water is more than just an air quality issue for users: damage to the physical plant is likely (and costly) as well.

Figure 1: Corrosion of natatorium equipment due to chloramine issues.

Management and maintenance staff often treat chloramines in the pool water through a process known as superchlorination, or "shocking" the pool. The chlorine level is raised significantly with the goal of reaching breakpoint. If breakpoint is reached successfully, the chloramines in the pool water are reduced. It sounds easy: determine the amount of chlorine to add to reach breakpoint, add the chlorine at closing, get a good night's sleep, return to find that the added chlorine has been consumed as it removed the chloramines and that free chlorine level is back to normal, ready for the day's activities. Most find it isn't this simple. Maybe the chloramines were reduced slightly; sometimes the chloramines were worse! The blame is usually placed on not reaching breakpoint, so the general practice to guarantee reaching breakpoint is to overshoot breakpoint by adding more chlorine than calculated. Unfortunately, over-dosing the chlorine during this process can have undesirable results also, such as di/tri-chloramine formation. The most active form of free chlorine is hypochlorous acid (HOCl), because the HOCl is 60 to 100 times more effective than hypochlorite ion (OCl-), the other component of free chlorine. Superchlorinating quickly raises the pH, causing more OCl- to form and less of the beneficial HOCl, making matters worse. And if this method of treating chloramines wasn't difficult enough already, the off-gassing which occurs during the process needs to be removed from the water surface for a successful superchlorination. The result: total frustration for the management/maintenance staff who are trying to be conscientious and provide a healthy experience for all users.

This frustration created a demand for non-chlorine oxidizers that could be used to reduce chloramines. The effectiveness of non-chlorine oxidizers has been debated. The advantage is that there is no breakpoint that needs to be reached; any amount used will treat chloramines until exhausted. The chemical can be added manually or dosed through a dedicated pump. One downside is that any residual oxidizer present in the water is an irritant for swimmers. Also, when testing for the combined chlorine level of the water, this chemical gives a false high combined chlorine reading when a residual is present—exactly what the operator is using the chemical to reduce—possibly leading to over-dosing. Reagents are available to remove this interference, but this potential interference is not well understood by operators. Non-chlorine oxidizers are expensive, and regular use can increase annual budgets substantially.

Another method of controlling chloramines is by adding fresh potable water to a pool. One common practice is to send the pool chemical controller sample stream to waste instead of returning the water to the pool, thereby reducing the volume of the pool and creating a need for fresh fill. Or, the water level is manually dropped periodically and fresh water added. Unfortunately, many cities use chloramines at their water treatment plants, so, in areas where this is done, adding fresh water only increases the problem of chloramines in the pool.

THE ULTRAVIOLET SOLUTION

Controlling chloramines with UV saves the operator time, energy and the chemical costs necessary for superchlorination. Medium pressure UV destroys all chloramines, monochloramines, dichloramines, and nitrogen trichloride (trichloramines), which will be discussed in more detail later. Automatically and consistently minimizing chloramines in the pool water significantly reduces the off-gassing and contamination of the natatorium air, resulting in a healthier and more pleasant indoor environment, along with extended building and equipment life.

While chlorine is still the gold standard in swimming pool disinfection, the rise in bacterial outbreaks and failure to adequately control harmful microorganisms with conventional methods left the industry looking for a reliable secondary form of disinfection. UV, with its powerful ability to kill water-borne bacteria, has now taken the lead in

secondary disinfection in the US and Canada. As recognition of this need increases, UV will only become more prominent as an effective disinfectant, particularly to control Cryptosporidium. In many instances, compliance with updated codes will necessitate adding UV to more traditional sanitizing systems.

While the chloramine control benefits of UV are obvious for indoor pools, UV as a secondary disinfectant is beneficial to every aquatic environment, including outdoor facilities such as activity leisure pools, competition pools, spray pads, therapy pools, tot pools, spas, and plunge pools. The importance of UV for outdoor pools has been recognized nationwide. When a well-publicized Cryptosporidium outbreak occurred in New York several years ago, many state and local governments were forced to change and modify procedures and standards that had been in effect for many years. State spray pad codes have been the most reactive to this situation, and many states now require UV on spray pads. Currently, the CDC has appointed a committee that is trying to create a "standard code" for the aquatics industry known as the Model Aquatic Health Code (MAHC). This has been a long time coming and should at the very least be a guideline for facilities to follow in the absence of other regulations or may replace state codes eventually. Currently in draft form only, the MAHC is addressing the issue of secondary disinfection, and, not surprisingly, UV is one of the preliminary solutions.

UV EXPLAINED

UV systems all come with two major components: the reaction chamber, which houses the UV lamp and a protective quartz sleeve and wiper, and the control cabinet, which is the command center of the system. The reaction chamber will have an intensity monitor and temperature sensor and comes in two styles, in-line and "U" shape. Both have their advantages and disadvantages. The "in-line" systems appear at first glance to be easier to install because the unit can be mounted both vertically and horizontally; however, either type should be installed with a by-pass loop for ease of maintenance and repair. When performing the preventive maintenance it is easier to put the UV in by-pass and service the unit without interruption of pool operation. If there is no by-pass installed, the pool pumps and filters must be shut off while the maintenance is conducted.

Due to the contact time being shorter for in-line chambers, these units will require more lamps than a U-shape unit. Power control is also an important consideration; some manufacturers offer dose control in which the UV automatically adjusts to water conditions by ramping up or down to different power levels. Other manufacturers offer a feature known as 50% power-down. The UV runs at either 100% or 50%. Both methods are designed to save energy costs and extend the lamp life. The power-down is typically operated by a timer that puts the unit in power-down during the evening. Recently, a couple manufacturers are promoting running the UV power-down from a chemical controller combined chlorine reading. Additional probes are required for this system, namely a ppm and total chlorine probe. Other system considerations include the kW power of a UV system, type of ballast, type of automatic wiper mechanism, the voltage the unit can run on, and manufacturer warranty and support.

Figure 2: UV system installation in pool pump room

One of the problems with swimming pools and spray pads is that monochloramines are constantly creating di- and tri-chloramines, and dichloramines and trichloramines off-gas at much lower levels than monochloramines. The faster the water can be treated by the UV system, the better control the UV has over the chloramines. Thus, swimming pools and spray pads are at the mer-

cy of the filtration system turnover rate in trying to combat this problem. When utilizing UV, the laws of dilution state that it takes four turnovers to treat 98% of the water. Today, aquatic consultants have recognized the need for faster turnovers for high-use pools and spas, and some state codes are requiring faster turnovers for specialty pools and spray pads. A faster turnover benefits the UV's ongoing disinfection capability. If a tot pool has a 30 minute turnover, 98% of the water is treated every two hours; a spa on a 15 minute turnover will treat 98% of the water every hour. Leisure pools are typically designed in the 2-3 hour turnover rate range, meaning every 8-12 hours that body of water is being disinfected by the UV. Years ago pools were designed to meet codes requiring a 6-8 hour turnover. Most codes will allow a six hour turnover for competition pools. Regardless of the turnover rate, during the four turnover time span, some of the water will be treated several times, and some will be treated only once, which allows for untreated monochloramines to convert to di's and tri's continuously.

LOW OR MEDIUM PRESSURE?

Which system to use for effective control will depend on a number of factors, including the size of the body of water and the turnover rate. Both Low Pressure (LP) – monochromatic and Medium Pressure (MP) – polychromatic UV systems are effective as far as disinfection is concerned, and both methodologies have been found to be effective in controlling the harmful bacteria and pathogens associated with swimming pools and spray pads. Both provide the 254 nm wavelength required for disinfection. There have been many studies done regarding the effectiveness of low pressure and medium pressure systems for the inactivation of Cryptosporidium. In dealing solely with disinfection of swimming pool and spraypad water, either LP or MP prove to be similar in efficacy; however, with respect to chloramine destruction, there are some differences in technology.

UV does not replace the need for chlorine, as chlorine is an excellent disinfectant providing the instant kill for many harmful pathogens. But, unfortunately, some pathogens are resistant to chlorine, the most notable being Cryptosporidium and Giardia. Information from the CDC states that 1.0 ppm free chlorine level with a 7.5 pH will take 6.7 days to effectively treat Cryptosporidium.
LP UV provides a 254 nm wavelength which is adequate for disinfection and destruction of monochloramines (which are absorbed at a wavelength near 245 nm). Spas and smaller pools tend to do better with LP units than the larger and high bather loaded pools because the turnover rates are generally faster (15-30 minutes for spas), so the water tends to be treated more often and the LP units have an easier time keeping up with the demand. The most harmful and annoying di (297 nm) and tri (340 nm) chloramines can only be removed by the MP polychromatic systems.

There are many differences and selling points to LP and MP that need to be addressed as well. LP units don't remove as much free chlorine as the MP units do, so there is a savings in chemical usage. LP units can operate at a lower electrical cost because they are using less energy than MP. LP units require more lamps than comparable MP units. Some MP units are capable of treating a flow rate of nearly 1,400 gpm with a single lamp which would take most LP units about 8-12 lamps, so the lamp replacement costs are less for MP.

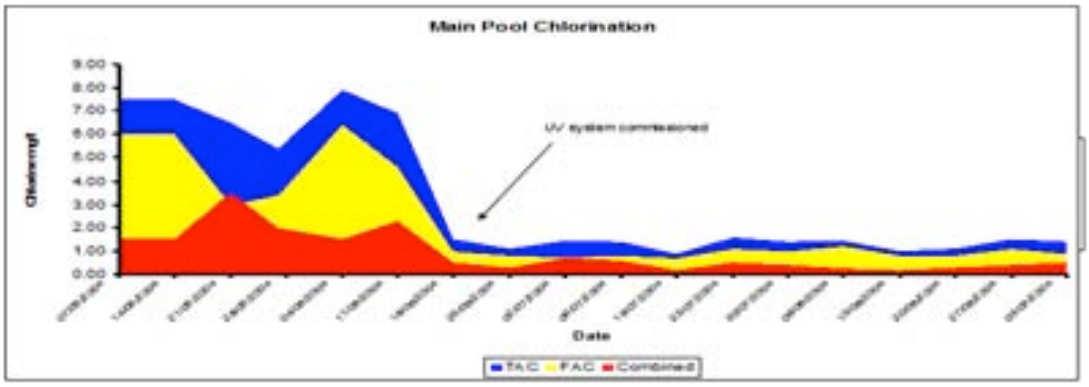

Figure 3: Effect of MP on chloramine at natatorium.

Low pressure systems do not need automatic wipers for the quartz sleeves as do the MP units. MP first dollar costs are typically higher than comparable LP systems. LP chambers are available in Schedule 80 PVC as opposed to MP only being available in 316L stainless steel. Automatic wipers on the MP systems will need occasional maintenance. LP sleeves will need to be cleaned from time to time by manually removing the sleeves or running an acid solution through the chamber. Some factors to consider when determining the desirability of LP or MP for a given application are: whether the facility is indoor or outdoor; whether it requires disinfection and chloramine control or disinfection only; and ongoing costs of LP and MP, to name a few. As a rule of thumb, each facility should be treated independently when in the design phase to give the owner the greatest benefit for the money.

EQUIPMENT ROOM DESIGN CONSIDERATIONS

As for the sizing, design and placement of the UV system in the filter room, there are many factors that need to be taken into consideration. First and foremost, it is imperative to select the correct model for the pool being treated, taking into consideration the flow rate, the return to pool pipe diameter, type of pool being treated (therapy pool, spa, competition pool etc), bather load, and method of disinfection (salt, bromine, or chlorine), as well as the footprint of the filter room. UV is not just for new construction. When UV is being considered for an existing facility, a UV system can be easily added to the current mechanical system due to the minimal space requirements.

Placement of each system is relatively easy. On new facilities, simply place the UV system on the return to pool line, after the filter and before the peripheral equipment such as heat exchangers and HVAC lines, and chemical injection ports. One of the differences between treating pool water and other types of water is that pool water is usually on a loop. The water goes from the pool to the filter and back to the pool again. In other applications, the water gets treated and is then used or sent to waste. Pool water is recirculated, therefore it has the opportunity to be treated repeatedly by the UV.

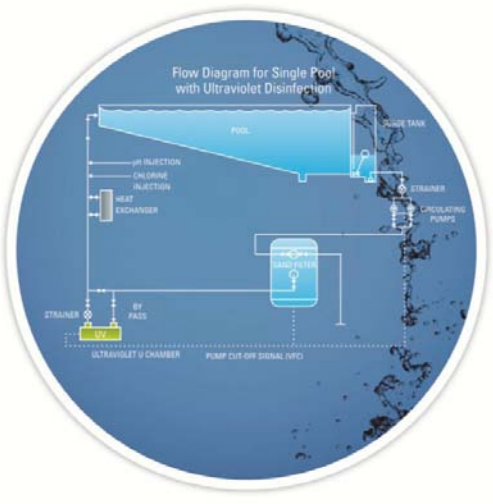

Figure 4: Swimming pool schematic.

The UV treatment will be most efficient when the water entering the unit is as clean as possible. To that end, the water will come from the pool and go through the hair/lint strainer, filter, UV, peripherals, and back to the pool. When you are placing a system on an existing facility it can be harder to place the unit exactly where you want it, so it can be placed anywhere in line after the filter. The water should still be at its best possible when treating it with UV.

SUMMARY

UV provides healthier water due to chloramine destruction and disinfection and increased user comfort. If the UV controls the proliferation of chloramines, there is no longer a need to superchlorinate the pool. Free chlorine is more efficient since the UV is helping with the workload of the chlorine, and the free chlorine can thus be maintained at lower levels. Due to reduced chlorine use, fewer chlorinated by-products are formed, less pH buffer is required, and less total alkalinity adjustment chemicals are needed. Overall, fewer chemicals are added to the water which is beneficial for any type pool. With UV, the life cycle of the building envelope and HVAC system may be extended, as well as the life cycle of pool deck equipment. Less fresh water addition may be needed and less natatorium maintenance will be necessary for cleaning stainless steel deck equipment. In addition, operators have been pleasantly surprised by UV's ease of operation along with its effectiveness.