By Bruce Laing, Trojan Technologies, Inc.

Disinfection

Part 1: Developments in Ultraviolet Disinfection

Water treatment systems are designed to address public concerns such as taste, odor and hardness. The average person's greatest concern is microbiological safety; he wants to know that there isn't anything in his water that can make him ill. This concern explains why one of the fastest growing technologies in the water treatment industry is ultraviolet (UV) disinfection.

In an age of increased concern for personal health and protection of the environment, UV is an attractive alternative to chemical disinfectants. Chemical disinfectants often produce byproducts that can be harmful and may alter the taste of the water. UV disinfection adds no chemicals, and it does not produce byproducts. Additional benefits include easy installation, low maintenance, minimal space requirements and whole-house (point-of-entry) treatment.

Technology Improvements

There are several recent advances that make UV systems even more appealing today. One is a timer that monitors how long the system has been operating—this feature warns the user when his lamp is nearing the end of its 12-month life so he does not have to try to remember if it was one, two or three years ago that he bought his last lamp.

More efficient lamps are another recent development. These have allowed some manufacturers to produce systems that are half the size of conventional systems—an important consideration given that most systems are installed vertically in the basement.

UV Intensity Monitors

There is no better way to verify the real-time performance of a UV system than with a UV intensity monitor. The monitor is much like an "eye" looking into the reaction chamber. It measures how much light is getting through the water and often is calibrated to set off an alarm when sufficient UV light is not detected. On some systems, such a condition also can trigger a shut-off valve.

Whether it is changing water conditions, lamp fouling or lamp aging, a monitor assures that an adequate dose is delivered at all times.

UV monitors have been available for many years, however some older models tended to drift over time. Some manufacturers are now able to offer sensors that are much more resistant to the degradation caused by exposure to the UV light.

Reactor Efficiency

Pathogens traveling through a UV reaction chamber may follow a number of different paths. Some paths are longer, some are shorter, and some paths flow at faster velocities than others. The result is that the amount of UV light to which a pathogen is exposed can vary. To maximize the efficiency of a reactor, all the paths should expose pathogens to the same amount of UV light.

The best assurance of effectiveness is certification by a third-party testing body.

Only by using sophisticated computational fluid dynamic (CFD) modeling can designers optimize a reactor. CFD modeling is the same process used to optimize car and airplane designs for air flow.

Figure 1 illustrates an efficient CFD-modeled reactor. Each colored strand represents the path of an individual particle through the reactor. The color changes from blue to red as the retention time increases.

For all its strengths, CFD is only a design tool and performance tests must still validate the effectiveness of each system. The best assurance of effectiveness is certification by a third-party testing body such as NSF International.

NSF Standard 55

NSF International is an independent accreditor of water treatment systems. The protocol for validation of residential UV systems is NSF Standard 55. The standard has two parts.

- **Class A** is for UV equipment that is certified to be used for treatment of

Pathogens traveling through a UV reaction chamber follow a number of different paths, resulting in varying amounts of UV light to which a pathogen is exposed. To maximize efficiency, all the paths should expose pathogens to the same amount of UV light.

Fundamentals of Ultraviolet Disinfection

Ultraviolet light inactivates pathogens by damaging their DNA, thus killing them or at least destroying their ability to multiply. The result is that the pathogens are rendered harmless.

UV "dose" is a measure of how much light a pathogen is exposed to within a UV system. The dose generally is given in units of milli Joules per square centimeter (mJ/cm2). Each type of organism has its own level of susceptibility to UV inactivation. However, viruses typically are more resistant than bacteria and protozoa.

A number of recent studies have concluded that UV can inactivate *Giardia* and *Cryptosporidium* cysts at relatively low doses.[1,2] Indeed, typical UV systems will inactivate more than 99.99 percent of these cysts. Previously, it had been believed that these organisms were among the most resistant to UV.

The UV dose required for an application depends on the quality of the raw water. For private water supplies, a dose of 30 mJ/cm2 is sometimes considered acceptable, however many areas have regulations that specify a UV dose of 40 mJ/cm2. Municipal water may require a dose of only 16 mJ/cm2.

Typically, UV is installed in conjunction with pretreatment equipment to soften and/or filter the water, which enhances the performance of the UV. For example, most manufacturers recommend a 5-micron filter as a prerequisite.

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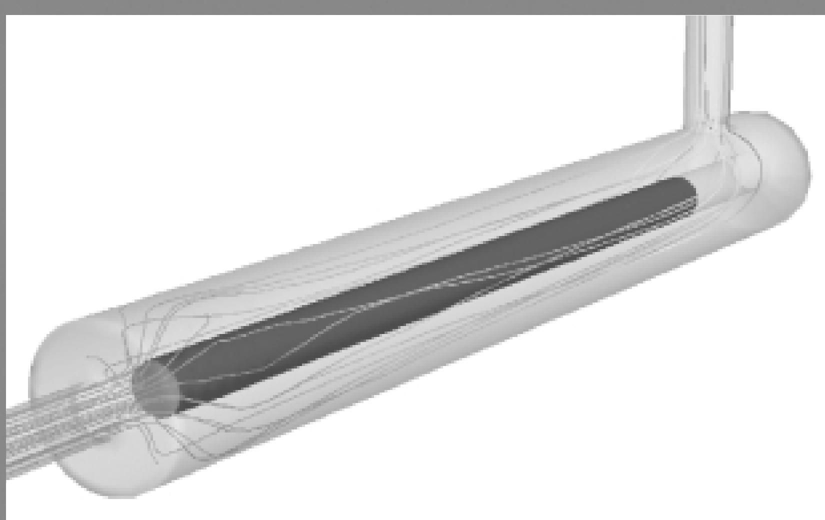
About the Author

Bruce Laing is the manager of residential markets with Trojan Technologies, Inc. Laing has provided education on UV technology over the past three years at the Water Quality Association (WQA) convention and other regional WQA educational seminars in addition to publishing numerous articles on UV technology and applications for residential use. For further information contact blaing@trojanuv.com.

Figure 1. CDF Modeling Used to Optimize Reactor Design



microbiologically unsafe water that meets all other drinking water criteria. The dose requirement is 40 mJ/cm^2 for a municipality. Until very recently, there were not UV systems with Class A certification.

- **Class B** is for UV equipment that is used to provide supplemental treatment of treated and disinfected public drinking water. The dose requirement is 16 mJ/cm^2.

Regulators generally are interested in Class A certification because of the health effect claims that can be made by products receiving this certification. This includes 99.99 percent inactivation of Rotavirus. Whether viral, bacteriological or protozoan (such as *Cryptosporidium parvum* and *Giardia* or beaver fever) Class A certification assures that dangerous microorganisms are eliminated.

Systems that are certified and listed by NSF are the only systems that have been tested and have passed the Standard 55 Class A protocol. Do not be misled by statements that

Class A certification assures that dangerous microorganisms are eliminated.

indicate the product "meets Standard 55 requirements." If a product is certified it will be listed on the NSF website (www.nsf.org/certified) under "Drinking Water Treatment Units," "Reduction Claims for UV Microbiological Water Treatment Systems" and "Disinfection Performance, Class A."

UV disinfection for residential use is growing rapidly in popularity. POE systems provide chemical-free disinfection, easy installation, minimal maintenance and proven protection against waterborne illnesses. There have been many advances in UV technology for the residential market. Water chamber and lamp efficiency, automatic timers, UV intensity monitors and NSF certification are some of the key features to consider when selecting the appropriate product for you and your customers. WQP

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