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Ultraviolet System Design

Understanding Residential and Commerical UV

In the last issue, we reviewed ultraviolet (UV) disinfection as a suitable technology for treating biologically unsafe water supplies. In this article, we will focus on system design and understanding the many available options for residential and commercial applications.

As with most water applications, selecting the proper unit will depend on the required flow rate. Once determined, you then will have to look for situations that inhibit UV light from penetrating the water. Turbidity—the state of water when it is cloudy from having sediment stirred up—will interfere with the transmission of UV energy and decrease the disinfection efficiency. In cases where the water has high iron or manganese content, is cloudy or has other organic impurities, it may be necessary to pretreatthe water through softening, reverse osmosis or carbon before it enters the UV disinfection stage.

Table 1 outlines the recommended maximum concentration levels.

A basic unit should be sized to treat the specific flow rate and provide the necessary UV dosage measured in mWs/cm² (microwatts).

Table 1: Recommended Maximum Concentration Levels

Turbidity	5 NTU
Color	None
Iron	0.3 PPM
Suspended Solids	10 mg/l
Manganese	0.05 mg/l
pH	6.5–9.5
Hardness	7 grains

While the U.S. government mandated systems to produce 16,000 microwatts in the 1960s, many local authorities are designing their own protocols and requiring systems to produce between 30,000 and 90,000 microwatts. In addition to requiring higher UV doses, they also are requiring additional safety features.

What to Look for in a UV System

The actual UV device should be constructed of 304 stainless steel that has been electro-polished and is rated for at least 100 psig. The electro-polishing process provides a high purity finish and will inhibit rust. This provides the end user with a system that will last for years.

The chamber's diameter also is an important consideration. The ideal diameter is between 3 and 4.5 inches. If the diameter is too small or too large, the system will not deliver the proper dose. This is because a small chamber will lower the retention time and a larger chamber will allow microorganisms to escape without receiving a lethal dose.

The electronics that run the system either will incorporate magnetic or electronic ballasts. Electronic ballasts run more efficiently and will allow the system to produce a higher UV dose.

The electronics either will be remote or attached to the chamber. The advantages to the remote ballasts are that they are away from the water supply and also are easier to service in case of a failure.

The UV lamp should have a rated life of one year (8,760 hours). It may be of interest to know that the average residential system uses only a 40-watt lamp. This provides a very energy-efficient solution.

A system can be designed to provide the proper dosage and have many important bells and whistles, but if it is not easy to install, the service technicians will be unhappy.

Safety Features

UV systems are equipped with many standard and optional features.

The most basic warning device is an LED that indicates that the lamp is on. In addition to the LED, many systems come equipped with audible lamp-out alarms.

While these warning features are extremely effective, they indicate the problem only when the lamp goes out. If the unit is in a remote place, the homeowner may not know the system is not working.

This is why many water specialists and health authorities are installing more sophisticated systems.

A solenoid valve (brass or reinforced nylon) can be installed to work with the lamp out alarms. In the event of lamp failure or a power outage, the solenoid valve will shut off the water flow. While this may be an excellent way to insure that the water always is biologically safe, it does stop the water for the whole house. This should be taken into consideration.

A precision flow control device is an option for most systems. This insures that the proper flow rate is maintained. Since the unit is sized to deliver a dose at a given flow rate, this is a vital feature.

For a more sophisticated approach, the system can incorporate a UV monitoring system. This monitor reads the UV output of the system. If the dose falls below a certain point, the UV monitor can signal an alarm or trigger a solenoid valve. When evaluating this option, it is important to know that there are systems that monitor "light" and those that actually monitor "UV intensity." Since the lamp may stay lit for a long period of time and not produce any UV, a true UV monitor is recommended.

It is important to have the lamp replaced on a yearly basis and have the quartz sleeve cleaned during routine maintenance.

Keeping the Installers Happy

A system can be designed to provide the proper dosage and have many important bells and whistles, but if it is not easy to install, the service technicians will be unhappy, and it is important to keep the field personnel smiling.

An UV device should be designed to be installed vertically or horizontally. Flexibility will allow for quick installations.

It also should be designed to allow the techs to easily replace the lamp or swap out the electronics. As mentioned, a remote power supply allows for much easier installation and service.

Lamp replacement is the most unnerving aspect of any purchasing agent's and installer's job. Since there are so many different types of lamps on the market, many water professionals are looking to consolidate. Before selecting a system, make sure that the lamp is standard and is easily replaceable.

System Maintenance

As indicated, it is important to check to see if the lamp is on. It also is important to have the lamp replaced on a yearly basis and have the quartz sleeve cleaned during routine service.

In situations where the water is turbid or has a high iron count, it may be important to clean the quartz sleeve on a more frequent basis. There are two ways to accomplish this task.

The first is shutting down the system and removing the quartz sleeve for manual cleaning. The second is using a quartz wiping system.

A quartz wiper is a plunger that is swiped back and forth to remove debris that may have settled on the sleeve. This is the easiest and most efficient way to perform the maintenance tasks. For larger systems, an automatic air-driven wiper may be employed.

Test Results

There are two basic tests that determine the UV system dosage.
The first is based on the EPA Point Source Summation Method. This method mathematically calculates the UV dose based on UV watts, chamber dimensions, turbulence, absorption coefficients, quartz transmission and other technical information. Most companies have had engineering firms conduct these tests.

The second is based on a biological test called a bioassay. In this test, microorganisms are flowed through the disinfection chamber and samples are taken before and after exposure to UV. The results provide dosage.

Recap

The checklist in Table 2 will help you design your system.

In the next article, we will focus on the various applications for UV technology. The overview will include and analysis of the available UV technologies—low output, high output, amalgam and medium pressure as well as how they are being applied to TOC reduction, ozone destruction, chlorine reduction, photochemical and other industrial applications.

About the Author
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For more information on this subject, write in 1014 on the reader service card.

Table 2: System Design Checklist

Chamber material	Electro-polished 304 stainless steel
Diameter	Between 3 and 4.5 inches
Technology	Magnetic or Electronic
Electronics	Remote or Attached
Mounting	Horizontal and/or Vertical
Alarm	Visual and/or Audible
UV monitor	Light meter or UV meter
Quartz wiper	Manual or Automatic
Solenoid valve	Brass or Nylon
Solenoid valve	Activated from Monitor or Alarm
Flow control	Internal or External
Tests	EPA and/or Bioassay