

UV—Moving into the Mainstream

Terms & Conditions of Use

UV disinfection technology helps small community water systems meet stringent regulations

- by Michael Sarchese

The majority of community water systems (CWSs) in North America provide drinking water to communities of less than 10,000 people; variously, these are defined as small water systems. Referring to terminology used within the U.S. Safe Drinking Water Act, a CWS provides drinking water to at least 15 service connections or at least 25 individuals, and essentially serves the same population year-round. For the purposes of this article, providing year-round service to the same population is an important distinction from water systems that might serve schools, health care facilities, campgrounds, etc.

In both the U.S. and Canada, the push to protect the public from new waterborne health issues is certainly having an impact on small CWS operators. Drinking water regulations in both countries have undergone recent revisions to address certain pathogenic microbes that are resistant to traditional chlorine disinfection, specifically *Cryptosporidium parvum* and *Giardia lamblia*, while at the same time reducing the formation of the harmful disinfection byproducts often associated with chlorination.

Even though UV has a long-established history in wastewater and drinking water disinfection, and also industrial contaminant reduction, it is only within the last 10 years that UV's effectiveness against chlorine-resistant organisms has been proven.

Regulations & UV Technology

In very brief summary, new regulatory requirements to address *Cryptosporidium* and *Giardia* are being imposed on water systems using surface water or groundwater under the direct influence of surface water. In the U.S., this comes in the form of the Long Term 2 Enhanced Surface Water Treatment Rule, which was published in the U.S. federal register on Jan. 5, 2006.

Of course, new regulatory requirements mean additional expenditures at many CWSs. Given that more than 90% of systems are serving small communities, and supported by a relatively small portion of the population (less than 20%), there isn't the financial viability for the high level of individual site engineering studies that the larger centers such as New York City can undertake.

Here's where UV disinfection technology fits in nicely: UV has been accepted both in the U.S. and Canada as an alternative primary disinfectant, and further identified as a cost-effective technology to provide reliable inactivation of *Cryptosporidium* and *Giardia* (as well as many other microbial pathogens). In addition, UV has been found to be benign with respect to the formation of disinfection byproducts. In many cases, compliance to the disinfection byproduct regulations can be achieved by implementing UV as the primary disinfectant, while still using low-level chlorination to maintain the downstream distribution system and provide optimum virus protection—a prime example of a multi-barrier approach.

UV System Validation

Before any UV system can be considered for a CWS, both U.S. and Canadian regulations require it to undergo critically important validation testing to ensure that sufficient disinfection performance (dose) is achieved under given flow rate and water quality conditions. Typically, state or provincial regulatory bodies dictate what forms of validation testing are deemed acceptable, but all accepted validation protocols share some common elements:

- a) All rely on empirical biosimetry tests, in which a UV reactor is subject to a given flow rate while a non-pathogenic surrogate microorganism is injected/mixed into the water upstream of the reactor inlet.
- b) The tests all consider a very critical water-quality parameter, UV transmittance (UVT), which is how

well the UV light penetrates through the water.

c) During reactor testing, the reactor UV sensor reading is monitored.

d) Samples from before and after the UV reactor are processed by an accredited microbiology lab to determine the reduction of the surrogate organism (typically measured as log reduction, where 99.9% inactivation is equivalent to 3-log reduction).

e) The reactor log-reduction results are then compared to a concurrent lab analysis of the surrogate organism's response to UV exposure time X intensity (dose), thereby allowing the reactor performance to be expressed in terms of dose at a specific flow rate, sensor reading and UVT.

f) The UV monitoring system must provide a means of generating an alarm if the disinfection dose falls below the required level.

g) All must be done under the direction of an acknowledged third-party expert.

UV System Design

Fortunately, a variety of UV systems are currently available to suit small water systems with the necessary validation testing already completed, covering a broad range of flow rates and water qualities. Often, UV equipment is selected to provide a dose of 40 mJ/sq cm to provide 3-log inactivation of *Cryptosporidium* at the maximum design flow rate and worst-case UVT, but of course, the specific requirements will depend on the individual CWS objectives and local regulations. Therefore, it is important that the CWS evaluate prospective UV equipment within that context.

Figure 1 shows an installation using two Sterilight SUVAM-6C/4 reactors, with one duty reactor and one standby, with flow controlled by electrically actuated valves. This particular site is designed for remote operation, with automatic or manual control of water flow via electrically actuated valves at the inlet and outlet of each reactor. Remote operation entails considerably more automation and wiring, but this is certainly common for many small CWSs.

Electrical panels that house ballasts for the UV lamps are typically mounted on walls or brackets in the vicinity of the reactors. Depending on the manufacturer, the operator interface control may be integrated within the ballast panel or housed in a separate panel that provides the advantages of remote mounting and electrical lockout separated from the main ballast panel. To give an indication of panel size, the ballast panel for a 1.4-mgd reactor can be as small as 24 X 24 X 9 in.

As UV systems are electrically operated, consideration must be given to the occurrence of power failure. Because many small CWS sites require pumps, the flow of water—and hence the need for the UV lamps to be on—disappears when the power goes off. If the site is required to run on backup such as a diesel generator, the demands of the UV equipment will have to be included.

Selecting UV Equipment

The following are some of the key characteristics to consider when evaluating prospective UV equipment:

CWS disinfection objectives. Match UV system capacity in terms of dose vs. flow rate vs. UVT against the regulatory requirements. The key pieces of information required from the CWS are the maximum anticipated flow rate (including any projected expansion) and the water UV transmittance. With this information, sizing of the UV equipment is simply based on the independent validation testing, with required sizing charts and supporting reports available from the UV equipment manufacturer.

Lamp warm-up. It is a fact that UV lamps require some time to warm up before they will give adequate output for disinfection. An effective control strategy can be easily implemented by having the "demand for water" command connected to start the UV system rather than the pump. A proper UV system will have a "reactor ready" or similar dry contact that closes when its lamps are sufficiently warmed up; this signal can then be used to start pumps or open flow valves. Note that the warm-up characteristics depend on

specific equipment design details, and may vary significantly. In fact, some systems even require time to cool down before they can be restarted. It is important that the UV equipment manufacturer supply these details to allow the CWS to implement a workable strategy.

On/off cycling. Many small CWS installations operate such that there are extended periods of zero water flow, whether due to reservoir/water tower fill cycle, lack of demand during certain periods or a combination of both. Therefore, in operating the water plant, a decision must be made whether to keep the UV lamps on during periods of zero flow or turn them off.

Consider that most UV reactors for small systems will operate for at least one hour without water flow until they shut down based on a temperature switch. If the plant operating strategy is to leave the lamps on for extended periods of zero flow, then it is prudent to provide some cooling water, the amount of which will depend on the type of equipment. This needn't be too scary, as the SUVAM-6C/4 reactors described previously will stay cool indefinitely with water flow of less than 1/4 gpm.

Alternatively, cycling the UV lamps on and off in response to demand is a viable strategy, provided that there is a sufficient water supply reserve (3 minutes) to accommodate the lamp warm-up time described previously. Cycling the lamps more than four or five times per day will likely reduce the useful lamp life, but the increase in lamp replacement costs may very well be offset by the savings in electricity.

Remote operation and monitoring. This doesn't have to be complicated, as full remote operation is quite feasible with just the following signals for each reactor:

- a) Minor alarm dry contact—a condition that doesn't require immediate attention, such as lamp life expired.
- b) Major alarms—a fault condition that requires immediate attention, such as low UV dose.
- c) Reactor ready dry contact signaling that it is okay to allow flow through the reactor.
- d) Low voltage input to turn reactor on.
- e) If required, a 4-20 mA output signal to remotely monitor the UV disinfection level.

Of course, remote operation can be much more complicated if desired, all the way up to having all UV operating details and control functions accessible through a central SCADA system via Ethernet or some other network, but there's certainly a cost associated with that.

Maintenance and operating costs. Again, this will vary between equipment manufacturer and model. At the very least, suppliers should be asked to provide details regarding lamp replacement, sleeve cleaning, UV sensor cleaning and calibration, pressure drop vs. flow rate and electrical power consumption.

UV disinfection systems are becoming more mainstream, as they are accepted in both the U.S. and Canada for primary disinfection for surface waters and groundwater under the direct influence of surface water, providing compliance with increasingly stringent regulations. UV technology definitely has a place in the wide world of small CWSs.

Michael Sarchese is manager of the Municipal Projects Group for R-Can Environmental, Inc., Guelph, ON, Canada. He can be reached at 519.763.1032 ext. 240, or by e-mail at sarchese@r-can.com.

Source: *Water Quality Products* October 2006 Volume: 11 Number: 10
Copyright © 2006 Scranton Gillette Communications