HOW CAN IUVA HELP SMALL WATER SYSTEMS?

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ABSTRACT

Often our attention is captured by very large environmental challenges such as providing billions of gallons per day of clean, safe drinking water for very large cities. However, the larger global public health challenge often lies with the small systems. Conservative estimates suggest that the lives of 2.5 billion people worldwide (the population of roughly 300 New York Cities) could be dramatically improved if organizations like the IUVA could provide technical knowledge and support to improve the applications of UV disinfection to small and very small water systems around the world.

The article provides an overview of the numbers and types of small systems including Point of Entry and Point of Use systems and reviews the challenges faced by small systems. A successful case study of using UV to improve small system water quality is also presented. The article closes with suggestions for how IUVA can proceed to help Small Systems worldwide with the long term goal of improving the lives of billions of people.

Ultraviolet (UV) disinfection has been applied to small systems for several decades and has attracted scores of small, medium and large companies supplying this market. This article is aimed at defining what is meant by a “small system”, how is this market addressed and regulated and where is it going.

SMALL SYSTEMS – WHERE HAVE WE BEEN?

The USEPA (2005) has defined size categories for drinking water treatment systems:

- Small Water Systems – serve 501 –3,300 people
- Medium Water Systems – serve 3,301 –10,000 people
- Large Water Systems – serve 10,001 – 100,000 people
- Very Large Water Systems – serve >100,000 people

Typical water flow rates for Small Water Systems are 2 – 700 gpm (8 – 2,650 L/min).

As Table 1 shows, Small and Very Small Water Systems affect the lives of about 2.5 billion people annually.

The biggest problem facing small drinking water systems is lack of resources (WHO 2005). There is a scarcity of knowledgeable personnel, time and money (USEPA 2003); furthermore:

- Small System information is plentiful and can be obtained from numerous sources, but the Small System has no personnel to collect or download that information and no time to make sense of it.
- There can be a very high degree of misinformation, ignorance and apathy in small systems (“nothing wrong with our water”; “leave us alone”; “requiring treatment is just a money making scheme and is no benefit”).
- Small System infrastructure is heterogeneous, often low quality when purchased and not maintained until total system failure.
- Finally, Small Systems often have severe space constraints for locating any treatment (Klevens 2005).

Figure 1 illustrates that often Small Systems also face space constraints.
WHY MIGHT ULTRAVIOLET TECHNOLOGY BE SO HELPFUL TO SMALL SYSTEMS?

Ultraviolet disinfection systems have many advantages for Small Water Systems:

- Compact
- Chemical free
- Essentially operator free (plug and play)
- Relatively easy to maintain
- Minimal moving parts
- Relatively easy to monitor lamp output
- Relatively inexpensive
- A well developed point-of-entry (POE) and point-of-use (POU) product

The only regulations concerning UV disinfection systems for Small Water Systems are those developed by the National Sanitation Foundation (NSF International) in their NSF Standard 55 (Lubitz 2005). In that standard, Point-of-entry (POE) systems are defined as (See Figure 2):

_A system used to treat all or part of the water for the facility at the point where drinking water comes into the facility. For Class A systems, a single family shall be considered a facility._

Point-of-use (POU) systems are defined as:

_A system used to treat water at a single tap or multi-taps but not for the entire facility._

SMALL SYSTEM UV PROBLEMS

UV disinfection systems are sometimes manufactured by small companies with little expertise. The buyers of these systems are often given few instructions on how to operate the units and do not understand the need for maintenance. Finally, there is the lack of regulations for small UV systems in most jurisdictions. This has led to many problems:

- Hundreds of small UV systems have been installed without any water quality information; for example, percent transmittances (UVT) values <10% and turbidities >NTU.
- Thousands of UV systems have been installed without any method to control flow; for example, a 2 gpm unit being operated at 10 gpm.
- UV systems have been operated with lamps down to 10% of their new output, completely burned out or just turned off!
- UV Systems have been installed without any sensor or even a means to determine if the UV lamp is on.
- UV reactors have been found operating filled with mud/sediments that are covering the lamps.
- UV sensors have been found reading 100% all the time, even when the lamp is removed from the reactor.

Then there is outright fraud and rip-offs:

**Figure 1**: Illustration of the tight quarters in a Small Water System in New Hampshire (photo courtesy of Cynthia Klevens, New Hampshire Department of Environmental Services).

**Figure 2**: Example of a Point-of-Entry UV systems (diagram courtesy of Melissa Lubitz of R-Can Environmental, Inc. Guelph, ON, Canada).
HOW CAN IUVA HELP SMALL SYSTEMS?

IUVA has the key resource – dedicated volunteer personnel with large amounts of UV technology experience. IUVA has the ability to provide outreach and help with the education and to answer questions posed by small system personnel. It is true that “no one has the time”, but when dedicated volunteers decide the cause is worth doing they make the time.

WHERE DOES IUVA GO FROM HERE?

Plans began in 2004 to establish the “IUVA Small Systems Topical Group”. In the past year the group has provided:

- educational seminars to three rural water associations in the US
- an educational seminar at the Water Quality Association (WQA) Annual Meeting in March-April 2005.

The goal should be to double the Group’s Activities during this next year. IUVA experts can help Small Systems with the selection, design, and operation of UV disinfection units.

ONE EXAMPLE OF HELPING A SMALL SYSTEM

As reported in a study by Protasowicki and Malley (2002), the town of Norfolk is a semi-rural suburban community located on an upper valley of the Charles River about 20 miles southwest of Boston, MA. Norfolk is supplied by groundwater pumped from two wells – the Gold Street Well and the Spruce Road Well. Both wells draw from the Charles River watershed. Spruce Road is Norfolk’s primary water supply and is typically operated at 500 gpm with a maximum flow of 600 gpm and the total annual water production in 2003 was 197 million gallons (~2,800 people served).

High copper levels in 1999-2000 prompted Massachusetts Department of Environmental Protection (MADEP) to issue a State Administrative Consent Order requiring Norfolk to optimize its corrosion control measures. Norfolk hired Dufresne-Henry to evaluate alternatives and recommend optimization for the Spruce Road Well. Dufresne-Henry recommended venturi aeration to drive off CO₂ and augment the existing KOH feed system. Since aeration represents a break in the hydraulics and potential for microbial contamination, it was also recommended that UV disinfection be implemented following the venturi system.

The MADEP indicated that both venturi aeration and UV disinfection represented innovative technologies and required a pilot study prior to approval to proceed with full scale design. Dufresne-Henry performed the venturi aeration pilot work and worked with the University of New Hampshire (UNH) to perform the UV disinfection pilot study simultaneously. Figure 4 shows the setup for the UNH pilot study.

Pilot Testing

The pilot testing was conducted at 2 to 10 gpm. In the parallel venturi pilot study, the aeration system was monitored for changes in pH and dissolved oxygen of the water as well as mechanical and operational reliability.

The UV system was run at a delivered UV Dose of 60 mJ/cm² to be consistent with another state approved groundwater UV disinfection system (Westford, MA). The UV system was monitored for:

- Changes in groundwater quality tastes and odors (TAO), UVT.
- Sensor window and sleeve fouling rate
- UV lamp sensor response
- Bacterial inactivation
- Mechanical and operational reliability
- Delivered UV Dose

The venturi aeration system provided reliable and cost effective removal of CO₂ raising the pH to neutral values while attaining dissolved oxygen saturation of the water. The UV pilot demonstrated:

- Reliable operation with no detectable changes in the taste, odor and color of the water;
- Consistent and stable power and UV lamp output;
- Minimal UV sleeve and quartz window fouling rate;
- Consistently high influent UVT values;
- UV effluent bacterial counts of 0/100 mL throughout;
assisting small and very small systems in North American and in most of what is commonly referred to as the developed nations is very, very different than addressing issues in third world countries. Here are just a few initial ideas on how IUVA can proceed:

- A Small Systems Hotline or Website?
- Dedicated and motivated volunteers from IUVA to assist small systems directly
- Outreach to colleagues in academia and in businesses in third world nations to promote the development and use of UV systems at the local level
- We have established the beginning of a Small System Topical Group which is open to all IUVA Members – everyone can play if you are interested, and can make the time please contact Jim Malley at jim.malley@unh.edu.
- 2.5 billion people are waiting for your help!

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REFERENCES


