Low Wavelength Medium-Pressure UV Disinfection – Communication Update

This article was submitted by Kati Bell (CDM Smith) and Oliver Lawal (Aquionics) who serve on the joint IUVA/ AWWA Communications Subgroup of the Low Wavelength UV Disinfection Working Group.

BACKGROUND

Use of ultraviolet (UV) light to disinfect drinking water has become a cost-effective treatment technology to address regulatory requirements for reducing microbial contaminants. In addition to the fact that UV light can inactivate pathogenic microorganisms without forming regulated disinfection byproducts (DBPs), it is also effective against some pathogens, such as Cryptosporidium, that are resistant to commonly used disinfectants like chlorine or ozone (EPA, 1999).

Research in the late 1990s demonstrated that UV light inactivates Cryptosporidium and Giardia at low UV doses (Bukhari *et al.*, 1998), and this research resulted in the development of the United States Environmental Protection Agency's (USEPA) Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), which lists UV disinfection as a viable technology for achieving Cryptosporidium, Giardia, and virus credit, resulting in greater acceptance of UV disinfection by state and provincial regulators throughout North America. Today, hundreds of surface water treatment plants (WTPs) in the U.S. and Canada have either installed UV disinfection or are planning to install UV disinfection for applications ranging from 0.5 to 2,200 million gallons per day (mgd). Approximately 75 percent of those systems use polychromatic medium-pressure (MP) mercury vapor lamps (Wright et al., 2012) due to their smaller footprint requirement and a potential for more effectiveness against adenovirus (Linden 2009). MP lamps generate germicidal UV light at wavelengths from 200 to 320 nm.

In the U.S., the LT2ESWTR specifies that UV systems receive disinfection credit based on a biodosimetry validation. With UV validation, the inactivation of a non-pathogenic surrogate microbe, like MS2 phage, is measured as a function of flow through the reactor, UV transmittance of the water at 254nm, and lamp power settings. Results are analyzed with respect to a reference dose-response curve, to define a UV dose monitoring algorithm that is programmed into the UV reactor's controller. Recent validation testing and computational fluid dynamics (CFD) modeling has raised the awareness that the validation process used to characterize some MP UV systems may not account for disinfection from low wavelength (i.e., less than 240 nm) UV light. The discrepancy is between the dose proven in full-scale testing with surrogate organisms and the level necessary for targeted organisms (e.g., Cryptosporidium). Some surrogates (e.g., MS2 phage) are inactivated more easily than target pathogens (e.g., Cryptosporidium) by the light in the low wavelength UV spectra. This development is important to both current and future design and operation of medium-pressure UV systems. Low-pressure lamps that emit monochromatic light primarily at 253.7nm and MP UV systems that block wavelengths below 240nm are not impacted.

PROCESS TO RESOLVE

To address this issue, technical experts, including academicians, water utilities, consulting engineers, manufacturers and validators, have held a series of working meetings to share information, better define this issue and develop an interim solution for existing MP UV facilities while a more detailed protocol is developed to assure appropriate inactivation levels are achieved by current and future MP UV disinfection systems. The first meeting was held at the May 2011 IUVA Biennial Conference in Paris, France, where the issue was initially presented to the UV industry. Since that meeting, North American stakeholders have developed and begun to implement a plan to collect data to address the issue. While critical research is ongoing, the working group also understood the need to provide information that could be communicated to utilities, regulators, design engineers and other stakeholders about the issue and options for resolution.

In August 2012, the working group released this communication brief that provided a brief description of the issue, interim options for utilities that have already installed MP UV systems, as well as a summary of the ongoing research being conducted to bring the issue to resolution. Additional information will be provided in future issues of the IUVA News as the Working Group continues to make progress. It is also of note that since the release of the August 2012 communication, WaterRF Project 4478 has been initiated. The goal of this project is to develop a set of action spectra correction factors, using specific medium-pressure (MP) UV reactors and their associated validation conditions, which will allow utilities to continue to use these UV systems to confidently achieve regulatory credit for pathogen disinfection. Additional information on the project can be obtained at: http://www.waterrf.org/Pages/Projects.aspx?PID=4478

REFERENCES:

EPA. (1999). Wastewater Technology fact Sheet: Ultraviolet Disinfection. Retrieved on December 2012 from http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_uv.pdf

Linden, K.G., Shin, G.A., Lee, J.K., Scheible, K., Shen, C.Y., and Posy, P. (2009). Demonstrating 4-log adenovirus inactivation in a medium-pressure UV disinfection reactor. Journal American Water Works Association, 101(4): 90-+.

Bukhari, Z., T.M. Hargy, J.R. Bolton, B. Dussert, and J.L. Clancy. 1998. Inactivation of Cryptosporidium Parvum Oocysts Using Medium-Pressure Ultraviolet Light. In Proc. of the *Annual AWWA Conference and Exposition . Denver, Colo: AWWA.*

Wright, H.W., Gaithuma, D., Heath, M., Schulz, C.,Bogan, T., Cabaj, A., Schmalweiser, A., Schmelzer, M., and Finegan-Kelly, J. (2012). UV Disinfection Knowledge Base. Water Research Foundation, Denver, CO.