CIWEM Chartered Institution of Water and Environmental Management

Policy Position Statement

Ultraviolet (UV) Disinfection of Drinking Water Supplies in the UK

Purpose

Ultraviolet (UV) disinfection involves the application of germicidal UV wavelengths to water, which damages microbial cell components (DNA and RNA) and thereby prevents cell replication and renders pathogens harmless.

There is already considerable operational experience with the UV disinfection of drinking water globally and in the UK. This policy position statement (PPS) sets out CIWEM's position on the UV disinfection of water supplies in light of the recent amendment to *The Water Supply (Water Quality) Regulations 2016* and makes recommendations for consideration in the UK water industry context.

CIWEM's Position on UV Disinfection

UV disinfection is now an established primary disinfection process that is recognised to be an effective treatment against a range of waterborne pathogens, including certain chlorine-resistant pathogens (e.g. *Cryptosporidium*), although it is less effective than chlorine against some viruses at the doses most commonly applied in drinking water treatment. Properly implemented in conjunction with a catchment risk assessment or other treatment processes as part of an overall multi-barrier treatment strategy, UV disinfection can serve as an effective treatment for the control of microbial pathogens and may be the most appropriate treatment in some situations. It is widespread practice in the UK to add chlorine afterwards to provide additional disinfection and/ or provide a disinfectant residual for the distribution network.

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Key recommendations for the UK water industry

The Drinking Water Inspectorate (DWI) have provided guidance to complement *The Water Supply (Water Quality) Regulations 2016*, to describe the proper design, operation and monitoring of UV irradiation as a process for the disinfection of public water supplies: "*Guidance on the use of Ultraviolet (UV) irradiation for the Disinfection of Public Water Supplies"*.

1. Proper dose monitoring and regular system maintenance are crucial for effective UV disinfection performance. UV disinfection systems installed in the UK should be properly validated, using standardised procedures, within their intended normal operating ranges (e.g. flow rate, UV transmittance) to ensure a consistently achieved adequate UV dose with a justified margin of safety. It is the responsibility of the UV system manufacturer to provide validation documentation as well as instructions for the ongoing maintenance of the system (e.g. lamp replacement and sensor calibration).
2. A recent UKWIR report estimates that appropriately designed UV disinfection systems typically use less than 20 kWh/Ml of energy, versus 250-500 kWh/Ml typically for high lift pumping. Energy use by UV disinfection is comparable with, or less than, that for alternative treatment options of ozonation or membrane filtration for *Cryptosporidium* control (Camm *et al*. 2008). While overall energy consumption by water treatment facilities is certainly an important consideration in the UK water industry, energy usage on its own should typically not be a justification for ruling out UV disinfection as a viable treatment process option for a given treatment works.
3. UV disinfection could be considered as one component in an overall multi-barrier treatment strategy as well as being a primary treatment process. For example, UV disinfection is most effective when turbidity is low and the transmissivity of the water is high. This can be achieved either by the use of a good quality groundwater source or by treatment, such as conventional coagulation, flocculation, sedimentation, and/or filtration, of a surface water. This prevents suspended particles or organic material from blocking the pathway between the UV light and target pathogens. It is widespread practice in the UK to add chlorine, post-UV disinfection, to provide additional disinfection and/or provide a disinfectant residual for the distribution network.
4. Selection of UV disinfection for a particular treatment works needs to be considered on a site-specific basis, taking into account water quality, associated treatment and the nature and magnitude of the microbial challenge.

Discussion

UV disinfection has been proven to inactivate certain chlorine-resistant pathogens such as *Cryptosporidium* as well as a range of other waterborne pathogens. Applied at conventional UV doses, there is little to no known formation of regulated disinfection by-products associated with UV disinfection under most circumstances, which is an advantage over chemical disinfectants (e.g. chlorine, ozone).

The increasing number of applications of UV disinfection in several countries throughout the world over the past decade (especially in North America and Europe) has led to the development of cost-competitive, optimised UV disinfection system designs that can be applied to a range of treatment plant sizes, from small groundwater systems up to water supplies for major cities (e.g. New York City).

Other countries have developed UV disinfection regulations and guidance manuals (ÖNORM 2001 and 2003; EPA Ireland 2011; NWRI-AWWARF 2003; DVGW 2006; USEPA 2006) and several industry organisations have produced survey reports (e.g. UKWIR, AWWA) that provide detailed recommendations for the proper installation, maintenance, and operation of UV

disinfection systems as well as cost summaries (Cotton *et al*. 2005; Bolton and Cotton 2008; Camm *et al*. 2008).

An amendment to the Water Supply (Water Quality) Regulations for England and Wales then came into force (specifically, section 26(5)) which defines an "adequate treatment process" to now include any "process of blending or purification treatment which removes or renders harmless the value of concentration of any property of, organism or substance in, water, so that supplies do not constitute a potential danger to human health". The inclusion of the words "or renders harmless" meant that UV can be practiced as general disinfection as UV inactivates microorganisms without physically removing them.

UV inactivation is also an accepted process for the disinfection of private water supplies in the UK (Dillon *et al*. 2016). A survey of practice found that, broadly, application follows the same principles as for public water supplies. The review, however, identified that often UV devices were not operated and maintained to the same standard as those used for public water supplies. Guidance intended for householders and local authorities was provided in the report on the requirements for effective UV treatment.

It is particularly important that the quartz sleeve that surrounds the lamp is kept clean. For UV plant serving public supplies it is common to have a wiper mechanism and a monitor to measure the intensity of UV dosed. These features are not always present on small UV plant used for private supplies and in the absence of regular cleaning fouling of the quartz sleeve could soon compromise the efficacy of a UV plant.

References / Further reading

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Note: CIWEM Policy Position Statements (PPS) represents the Institution's views on issues at a particular point in time. It is accepted that situations change as research provides new evidence. It should be understood, therefore, that CIWEM PPS's are under constant review, that previously held views may alter and lead to revised PPS's. PPSs are produced as a consensus report and do not represent the view of individual members of CIWEM.