Bristol Water AMP5 UV Schemes

the use of ultraviolet light for the treatment of Cryptosporidium

by Bill Irvine

The application of ultraviolet technology in the UK in water treatment has a history of over 20 years, but with new guidance on its use in the treatment of Cryptosporidium, its prevalence is set to increase markedly. Bristol Water has selected UV treatment as a solution to manage Cryptosporidium risk at four of its major supply sites with new process plants to be constructed during the AMP5 period. The use of UV to render Cryptosporidium non-viable is covered by new guidance issued by the Drinking Water Inspectorate in February 2010. Bristol Water's four UV schemes are some of the first in the UK to be designed specifically to meet the requirements of the new guidance criteria. In this article we will describe the considerations given during the design and procurement phases of these projects, with a planned article next year for the construction phase of the first and second plants.

Trojan Medium Pressure Reactors at a different location — *Courtesy of Trojan UV Technologies*

The use of ultraviolet light for treatment of Cryptosporidium

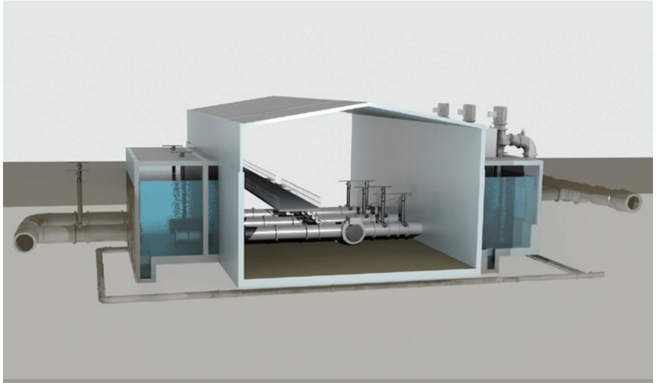
Cryptosporidium oocycts have historically been removed from water supplies using a multiple barrier approach or by membrane technology, which, while robust, involves significant pressure loss, large plant footprints, and high chemical demand associated with membrane cleaning. The use of UV has been recognised as an alternative treatment in the US and Canada for some time, along with applications in the leisure industry for swimming pools.

UV technology for water treatment in the UK has historically been applied for primary disinfection, and was only really considered economically viable for relatively small plants. But with the new application as treatment for Cryptosporidium, its use on larger plants is now likely to become more common place.

The DNA disrupting properties of UV renders the oocysts non-infective rather than removing the organisms from the water, and whereas traditional chemical disinfection techniques use independent measurement of dose to ensure that the correct conditions have been achieved, there are no easily measureable downstream parameters to ensure correct operation. Hence, in order to ensure effective treatment, the correct operation of the UV reactors must be verified and recorded.

This constraint has led the DWI to consider the application in the UK for potable water supplies, culminating in the publication of *"Guidance on the use of Ultraviolet (UV) irradiation for the Disinfection of Public Water Supplies"* in February 2010. This document sets out required arrangements to ensure confidence in rendering


UV Plant during construction at Purton WTW *Courtesy of Atkins*


3D Model of new UV plant *Courtesy of Atkins*

Cryptosporidia non-viable, and has formed the basis for the design challenges that the team faced in developing a solution for the four sites for Bristol Water. The conditions set out in the document include:

1. UV reactors must be validated with a recognised validation house (in accordance with US EPA, Austrian ONORM or German DVGW) and the operating envelope defined.
2. Minimum UV dose must be guaranteed, hence particular consideration is to be given during start up and restart when the lamps must reach working temperature prior to being brought online.
3. Various critical conditions ensuring operation within the validated envelope shall be verified, including flow, lamp status, UV lamp intensity, water quality (UV transmittance, turbidity etc).
4. Flow through individual reactors will be monitored and, in accordance with DWI recommendations, the US EPA requirement has been followed to ensure equal flows are passed through reactors where more than one stream is in service.
5. No bypass of operational streams whereby there could be a possible route for untreated water to pass or contaminate treated water.
6. A plan is to be in place for identifying and responding to lamp breakage.

This last condition sets out to ensure that due thought is given to the potential for mercury (mercury vapour is used to provide the correct germicidal wavelength of UV light) and glass to enter into supply in the event that a lamp or its surrounding sleeve breaks.

Design approach

The conditions above set the initial constraints for the development of the solution for the four sites. Bristol Water took a cautious view on how lamp breakage should be dealt with, specifying that measures should be put in place to guarantee that no glass or mercury could pass onto the downstream processes and that the requirements of the new guidance were adhered to. Several key and common features were developed during the design to address these requirements leading to a "UV train" concept that incorporates a similar arrangement for each site.

- ***Inlet tank:*** This tank provides hydraulic balancing across the streams promoting equalised flows when more than one stream is running, and permits release of air and stilling of heavy objects.
- ***Isolation valve:*** This valve isolates flows from offline, or standby streams, and provides isolation for maintenance of equipment in the UV train.
- ***Flow meter:*** This equipment provides crucial data for verification of the UV dose.
- ***UV reactor:*** The reactor is sized to treat flows in accordance with its conditions of validation and on the basis of several years of water quality data specific to each site. The reactors will achieve Cryptosporidium treatment at all four sites and will in the future, additionally provide primary disinfection at three of the sites.
- ***Tell tale:*** A double isolation valve arrangement with integral drain facility to guarantee an air gap between treated flows and untreated flows when a stream is taken offline.
- ***Reactor catchment chamber:*** Each stream has a dedicated wet well to complete the train which acts as a catchment sump in the event of lamp breakage. Flows are pumped from the chamber via vertical turbine pumps, which will provide fast reacting isolation on a stop signal generated in the event of reactor failure.

This standard module was applied to each of the four sites, and tailored to suit the particular site constraints and requirements, including options for recirculation or draining 'out of specification' flows. Such flows include waters reaching the plant that are below the minimum UV transmittance threshold of the reactor's validation range; waters that have passed through the reactor where an appropriate dose has not been applied - for example in the instance of power failure or through lamp failure. These waters will be un-contaminated and can be recovered and returned to the head of the treatment works.

Undertakings

Atkins completed outline design of the four plants in 6 months and assisted Bristol Water with the preparation of Contract Documents, enabling the award of contract to Enpure in February 2011. Enpure have completed the design of Purton WTW and have commenced the design of the second plant at Littleton WTW. Construction is underway at Purton, with Dean and Dyball as the civils sub-contractor progressing well with ground works and reinforced concrete works.

Trojan UV Technologies have been selected as UV supplier and orders have been placed for a total of 9 (No.) Swift 10L30 UV reactors to provide standardisation throughout the four sites; these reactors utilise high output medium pressure lamps.

A medium pressure lamps system was selected to reduce the number of reactors required, to minimise both process footprint and capital expenditure. While low pressure lamp systems have lower energy demands, the footprint of systems meeting DWI validation requirements at the time were either not available or did not meet with the process footprint restrictions.

All parties are working together closely with a focus on achieving excellent treatment facilities at these critical sites, whilst meeting the tough programming target dates imposed by the regulator.

The Editor & Publishers wish to thank Bill Irvine, Principal Engineer with Atkins, for preparing the above article for publication.