UV DISINFECTION SEMINAR FOLLOW-UP

In April 2012, WIOA hosted a seminar in Melbourne entitled "Operation and Validation of UV Disinfection Systems for Water, Wastewater and Recycled Water". As more utilities consider the use of UV disinfection to provide an extra barrier to protozoan pathogens, common questions and problems arise. The aim of the workshop was to address these issues. As usual, time got away from us at the end. One of the closing segments I had wanted to run was to set a scenario and get each of the presenters to give their thoughts and advice. So instead of doing that in the seminar, we submitted a scenario to a number of the presenters so that we could publish their responses.

The seminar was a considerable success. Should members in states other than Victoria be interested in running a similar seminar, please contact WIOA.

Peter Mosse, Editor

Scenario

As operations manager for a water utility I have responsibility for the operation of a 10 ML/d DAFF WTP, which operates intermittently with as many as 12 stop-starts per day.

Raw water is sourced from a reservoir with turbidity typically 2 to 15 NTU and True Colour 25 to 70 Hz. There have been two significant dirty water events in the past, with turbidity going to 150 NTU and colour 300 Hz. Turbidity and colour do tend to come up after heavy rain.

There is no UVT or DOC data. There have been a number of Mn events where soluble Mn has gone as high as 1.1 mg/L. There are no problems with Fe. The water is treated with alum as the sole coagulant.

There are cattle in the catchment. Filter performance is OK, but definitely not down to 0.1 NTU consistently – it averages, say, 0.15 to 0.25 NTU. As the ops manager, I am aware of *Cryptosporidium* and my concern is mainly for an additional barrier for crypto. I am considering UV disinfection.

What additional information do I need to provide you with to allow you to provide good advice, and what system would you recommend and why?

The intention is to continue to post-chlorinate to maintain a distribution system residual. I have heard about validation but don't really know that much, however, the CEO and Board think we probably should have some sort of validation. I am prepared to wait a bit to collect some data if necessary to help ensure I get the most appropriate system.

Graham Smith from Berson/Hanovia replies:

Thank you for your enquiry. In order that we may correctly size the most suitable system for your needs, I have the following questions and comments regarding your application.

A UV disinfection system can only be correctly sized if we know the instantaneous maximum flow rate of the water to be treated. For this reason, can you please provide this flow rate? This is typically provided as litres per second, litres per minute or cubic metres (i.e. thousands of litres) per hour.

For example, if a 10 ML/d plant had a consistent flow over a 24-hour period, this would equate to an instantaneous flow of 116 l/sec or 417 m^3/hr. The maximum instantaneous flow rate is important as it governs the length of time the pathogens in the water are exposed to the UV radiation that will potentially inactivate them.

It is also important that we address the issue of 12 start-stop cycles per day. This is a large number of cycles and will need to be accounted for, not only with the selection of the most appropriate UV system, but also with the control philosophy of the plant. One way of accommodating this number of cycles would be to leave the UV system lamps constantly on. This would have the following advantages:

1. Lamp life would be extended as the more frequently UV lamps are power cycled, the lower their life expectancy. This, however, needs to be traded off against the lamp life being unnecessarily consumed when no water is flowing through the UV system.
2. The UV system would always be ready to disinfect as soon as water started flowing through it. If the UV system needed to be started prior to each of the 12 cycles, it would need to go through a warm-up period of approximately five minutes prior to peak disinfection performance being reached. This would need to be accommodated by either simply leaving the water "static" within the UV system during the warm-up period (in which case there may be a risk the system will overheat), or diverting (or circulating) water through the UV system during the warm-up period.

On the other hand, some of the challenges posed by leaving the UV system constantly "on" include:

3. Higher power usage. Power is wasted during the "no flow" period of the 12 cycles.
4. Depending on the number of lamps and/or if the UV system is using low- or medium-pressure lamps, the UV lamps may overheat the water during the "no flow" period, causing the UV system to automatically shutdown.

A further consideration that must be taken into account is the nature of the flow during the disinfection cycle. If the flow rate through the UV system rises gradually to a peak and then gradually falls to a stop, we recommend that the UV system operates at full power at all times. This is because if the UV system "flow paces" its power to match the flow, the UV system runs the risk of being unable to keep pace with the increasing rate of flow at the start of the cycle. As a result, it may "under-dose" as it fails to ramp the power quickly enough to accommodate the ever-increasing flow rate.

I see your water quality data refers to the true colour and turbidity of the water. While the ADWG makes reference to turbidity as a parameter to be considered when utilising UV disinfection, it is in fact the UV Transmissivity (UVT) of the water that is required to correctly size a UV system. UVT takes into account all water quality parameters (including colour and turbidity) that will affect the performance of a UV system.

Furthermore, it is important that the minimum UVT reading is determined in order that the UV system be sized according to a "worst case" situation. As such, UVT data over a prolonged period should be gathered in order that the minimum UVT be accurately ascertained. Should you not have a UVT monitor or analyser, they can be purchased from many UV suppliers. Indeed, on-line UVT monitors can be purchased along with your UV system so that a real-time UVT feed can be supplied to the UV system controller. This will facilitate an accurate calculation of UV dose.

It is important to supply water to the UV system that has no more than 20 mg/l of suspended solids. Any more than this will lead to a phenomenon known as "shielding", where pathogens are shielded from the UV light by the suspended solids in the water and inadequate disinfection may result. As such, particular attention should be paid to the filtration system prior to the UV.

The somewhat elevated levels of Manganese you have specified as being present in the water may (in time) result in a black deposit on the quartz sleeve of the UV system. There is no definitive level of Manganese in the water that will result in deposition, as it depends on a variety of both physical and chemical properties of the water being treated. Suffice to say that an auto wiper and UV intensity monitor should be fitted to the UV system.

While the wiper will keep the quartz sleeves from fouling, it will only have limited effectiveness in clearing the manganese deposit from the sleeves. The UV intensity monitor will alert you to any drop-off in UV intensity, at which time the quartz sleeves should be inspected and, if necessary, cleaned with a dilute citric acid solution.

If the sleeves are severely affected, thorough cleaning may be impossible and they may need to be replaced.

Pre-validation of UV systems is something that is increasingly being called for by water authorities both in Australia and throughout the world. While this provides surety to authorities that a UV system will achieve a particular disinfection result, it also potentially results in unintended drawbacks. Not only are pre-validated UV systems expensive, they also potentially lack the latest innovations. This is because the validation process requires a UV system to be delivered exactly as it was validated.

As new innovations are developed that improve the performance of UV systems, these same innovations potentially invalidate UV systems unless the UV system possessing them is once again validated.

Because the validation process itself is so expensive and time consuming, it is impossible for UV suppliers to be continually re-validating systems as every new innovation is introduced.

Perhaps in time this anomaly will be addressed by the validating authorities. Until then, a possible compromise may be for water authorities to utilise UV systems that have been fundamentally validated, while accepting that the innovations that have been included since validation improve rather than diminish the performance of the system.