

Appendix B. Advisory Memo Concerning the Cleaning of UV Quartz Sleeves

Memorandum

Date: November 1, 2004

To: Regional Water Quality Control Board's Executive Officers

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Subject: Cleaning of UV Quartz Sleeves

In recent years the use of ultraviolet (UV) radiation for disinfection of recycled water has increased significantly. As a relatively new technology for wastewater disinfection the Department of Health Services has been attempting to learn more about the operation of these UV facilities at recycled water plants. It has recently come to our attention that at some recycled water plants these UV facilities may be operated in a manner that could significantly compromise the disinfection treatment barrier. Specifically, we have been advised that these recycled water plants are following the practice of using the detection of coliform organisms in the treated effluent as a basis for determining how frequently to clean the quartz sleeves that protect the UV lamps. As the appropriate regulatory agency we are requesting that the Regional Water Quality Control Boards (RWQCB) look into this situation. In addition, we are recommending that the RWQCBs establish a more conservative set of requirements for all recycled water plants practicing UV disinfection to ensure that an appropriate disinfection treatment barrier is achieved. The following provides a brief discussion of the issue including background information, the problem that exists and our recommended requirements.

Background

Cleaning the quartz sleeves of a UV system is critical to ensuring the proper functioning of a UV system. Because the UV lamp is surrounded by a quartz sleeve, any coating on the surface of the quartz sleeve will reduce the transmission of UV into the wastewater thereby reducing the quantity of UV reaching or penetrating the wastewater for the purpose of disinfection. Unless this reduction in UV transmission is compensated for in the design and operation of the UV facility, the UV disinfection barrier can and will be reduced (compromised) concomitantly, i.e., the amount of disinfection being delivered will not be sufficient to meet minimum dose delivery requirement.

The National Water Research Institute (NWRI)/American Water Works Association Research Foundation (AWWARF) UV disinfection guidelines recognize this issue and recommend a 0.8 sleeve fouling factor be used in the design of UV systems. This increases the minimum dose delivery requirement in a linear manner, increasing the number of lamps required to achieve the minimum delivered dose during operation with the realization that quartz sleeve fouling is a never ending process.

Unless the UV system is operated using a sensor on the outside of a quartz sleeve for controlling the delivered dose, one does not know when or how much of an impact fouling has on UV dose delivery. Therefore, the delivered dose requirement is increased by the quartz sleeve-fouling factor to account for quartz sleeve fouling over time. While this accounts for quartz sleeve fouling in the design of the system, this approach assumes the quartz sleeve never exceeds a level of fouling that would reduce the UV dose delivery by 20 percent at any time. Such an approach is fine as long as the UV transmission through the quartz sleeve is not reduced by more than 20 percent. Unfortunately in actual operation, unless the quartz sleeve fouling rate has been established, one does not know when the limits of this fouling factor have been exceeded.

What the NWRI/AWWARF guidelines do not establish is the frequency with which the quartz sleeves should be cleaned to remove any scale or film that has been deposited on the sleeve. This is not a deficiency of the guidelines, but a reflection of inexact science and incomplete understanding of the nature of quartz sleeve fouling.

Problem

The problem that has resulted is that some water recycling plants may be using the presence of coliform organisms in the treated effluent as an indicator to determine when the quartz sleeves should be cleaned. In our opinion this is problematic. The recycled water coliform limit for filtered secondary effluent was established at a time when chlorination was used almost exclusively to provide disinfection. This limit along with requirements for total chlorine residual and contact time was established to ensure effective inactivation of viral pathogens. UV radiation, while very effective at inactivating coliform bacteria, is a much less effective viricide than chlorine. Therefore, the quantity of UV needed to meet the coliform discharge limits of less than 2.2/100mL is significantly less than the minimum dose delivery to inactivate viruses, as required in the NWRI/AWWARF UV Disinfection Guidelines.

The guidelines call for a minimum UV dose delivery requirement of 100 mJ/cm² for standard media filtered secondary effluents. Typical coliform concentrations in media filtered secondary effluents run about 10⁴-10⁶ MPN/100mL. The minimum UV delivered dose needed to achieve a 4 to 6 log reduction of coliforms is about 10-20 mJ/cm². Since 4 to 6 logs of inactivation should reduce the coliforms to nondetectable levels, this means that if coliforms are being detected the dose delivery in the system is probably around 10-20 mJ/cm² which is 5 to 10 times below the minimum dose delivery recommended by the UV guidelines as the minimum needed for an effective disinfection barrier.

Recommended Requirements

Based on the preceding discussion we are recommending the following requirements be established by the RWQCBs:

Include a provision in permits for water recycling treatment plants employing UV disinfection that requires the water recycling plant operator to establish quartz sleeve cleaning frequencies that ensure the minimum required UV dose delivery is consistently met.

Include a provision in water-recycling permits that requires water recycling plant operators use a fixed cleaning frequency to define the quartz sleeve cleaning intervals, and not use the presence of coliform organisms in the treated effluent as a factor to determine cleaning intervals. Because the water quality parameters for establishing fouling rates are not known and because of the site-to-site variability in wastewater quality, the Department further recommends that such cleaning frequencies be established on a site-specific basis.

Include a provision in water-recycling permits that specifies the minimum delivered UV dose that must be maintained (as recommended by the NWRI/AWWARF UV Disinfection Guidelines), in addition to the coliform standard.

If you have any questions concerning this matter, please contact Dr. Rick Sakaji with this Department at (510) 849-5050.