

APPLICATION OF UV DISINFECTION TO ACHIEVE ENTEROCOCCI REMOVAL AT A TRICKLING FILTER PLANT

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ABSTRACT

The City of Leavenworth, KS operates a wastewater treatment plant with an average daily capacity of 16.54 MLD (4.38 MGD) with a peak flow rate of 104.98 MLD (27.50 MGD). The plant currently uses trickling filters to remove organics (BOD) and suspended solids. In 2010 the State of Kansas (KDHE) issued a discharge permit that required disinfection be incorporated into the plant and that a plan be developed to provide nutrient removal. Collimated beam testing was conducted during the month of October 2010. Results of the testing indicated that a fluence (UV dose) of 600 J/m² would be needed to achieve compliance with either the *E. coli* permit compliance or future enterococci limits. To confirm the transmittance data, measurements were collected using an on-line HACH UVAS transmittance sensor. This data indicated values more in line with typical values observed from trickling filter plants. Design transmittance values were developed that resulted in a UVT of 38 percent. Chemical testing was examined as a potential for increasing the transmittance resulting in a reduction in the cost and size of the UV system. The results of these preliminary tests indicated, with chemical addition, that a higher UVT could be used for design.

Keywords: UV-C; UV Disinfection, Collimated Beam, Trickling Filter

INTRODUCTION

The use of UV disinfection for trickling filter effluent is traditionally difficult and often results in periods of non-compliance. The City of Leavenworth, KS operates a wastewater treatment plant (WWTP) with an average daily capacity of 16.54 MLD (4.38 MGD) with a peak flow rate of 104.98 MLD (27.50 MGD). The Leavenworth WWTP consists of the following facilities: influent screening and pumping, aerated grit removal, primary clarification, intermediate pumping (settled sewage), trickling filters, final clarification, and sludge dewatering (belt filter press) as shown in

Figure 1.

BACKGROUND

In 2010 the State of Kansas Department of Health and Environment (KDHE) issued a discharge permit requiring that disinfection be incorporated into the plant and that a plan be developed to provide varying levels of nutrient removal. The KDHE has established two sets of disinfection requirements at



Figure 1: City of Leavenworth, KS wastewater treatment plant.

the WWTP, a monthly geometric mean limit of 160 cfu/100 mL *E. coli* from April through October and a 2,358 cfu/100 mL *E. coli* limit from November through March. The permit requires the final limits for *E. coli* for the current WWTP be achieved by December 31, 2012.

The Leavenworth WWTP has an existing chlorine contact basin and a building for storage of chlorine gas cylinders. The basin has not been used since its construction, and the building is now being used for storage. A review of future regional and federal regulations pertaining to disinfection was made to ensure flexibility of the disinfection system to be installed at the plant. Currently, the permit lists a monthly geometric mean for the final *E. coli* limits, based on the schedule of compliance for both winter and summer seasons. Regionally, the USEPA is requiring that States establish either weekly maximum or maximum not to exceed limits. In addition, the EPA is requesting that States examine (i.e., lower) the risk values that have been used to establish bacterial permit limits.

Nationally, the EPA will be proposing new guidance for the establishment of bacterial limits in the wastewater discharge permits in 2012. Early indications are that limits will be established for *enterococci* (instead of *E. coli*), partly due to

the fact that the EPA proposed enterococci in 1986, and the States did not adopt this guidance.

TRANSMITTANCE TESTING

Early testing of the percent transmittance at 254 nm indicated values around 65%. This is extremely high for trickling filter effluent, which typically ranges from 35% to 45%. To confirm the transmittance, measurements were collected using an on-line HACH UVAS transmittance sensor. One of the key items in using the sensor was that, to ensure that correct measurements were collected, it needed to be cleaned on a weekly basis because of biological fouling. A number of items may have resulted in higher values however, it was observed that transmittance values collected by the sensor would match the transmittance values collected as part of the bench-scale testing. Therefore a practice of weekly cleaning was implemented. Design transmittance values were developed using all the data collected, which resulted in a UVT of 38%. **Figure 2** provides a historical plot of the transmittance data collected by the online sensor and **Figure 3** provides a summary of the T10 analysis.

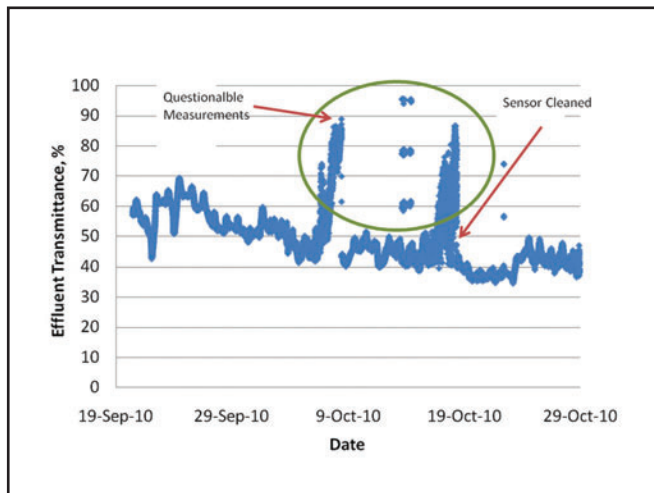


Figure 2. Leavenworth secondary effluent transmittance data

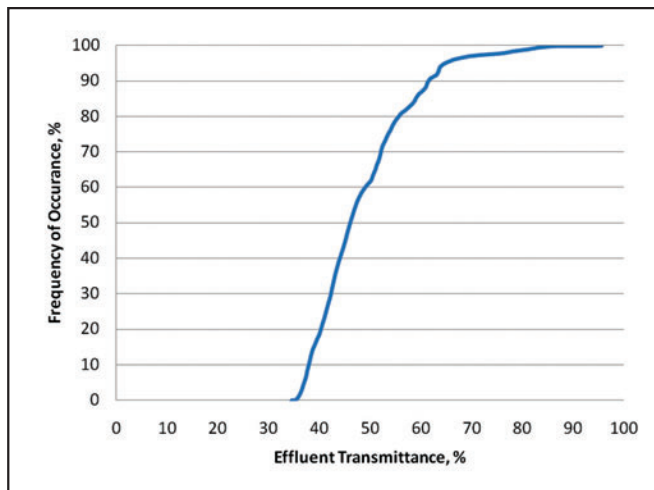


Figure 3. Transmittance frequency analysis from the on-line sensor data

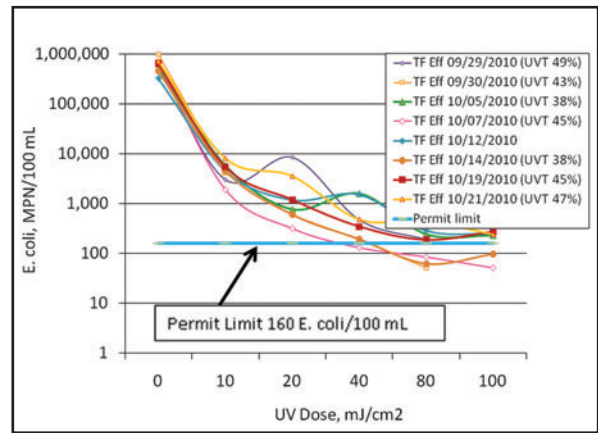


Figure 4. E. coli concentration in the UV treated samples

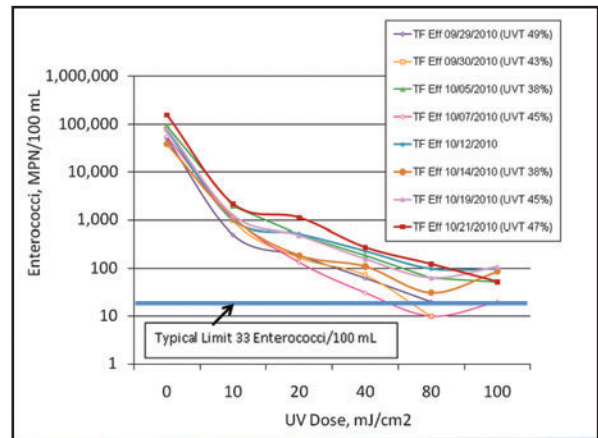


Figure 5. Enterococci concentration in the UV treated samples

BENCH SCALE TESTING

A series of bench-scale chlorine and UV disinfection tests were carried out at the B&V research facility between September 29 and October 21, 2010 to determine the optimum disinfectant dose required. Bench scale testing prior to design is important, since the design dose is highly dependent on effluent water quality, which varies from plant to plant. Two sets of bench-scale tests were performed to collect data for the design of the UV disinfection system. Collimated beam testing was conducted during the month of October 2010. Results of the testing (**Figures 4 and 5**) indicated that a UV dose of 60 mJ/cm² would be needed to achieve compliance with either the *E. coli* permit compliance or the future enterococci limit. In 1986, the USEPA recommended the establishment of water quality standards using enterococci. The USEPA is anticipating reposing the use of enterococci in 2012. State regulatory agencies, who have not already adopted these new water quality standards, will need to develop an implementation schedule.

RESULTS AND DISCUSSION

In order to reduce the project costs, additional tests were conducted. These tests examined both filtration and chemical addition to determine if either of these alternatives could result in a reduction in the cost and size of the UV system.

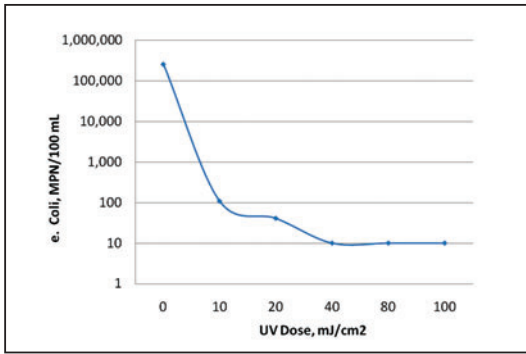


Figure 6. Results of Bench Scale Testing with Chemical Addition *E. coli*.

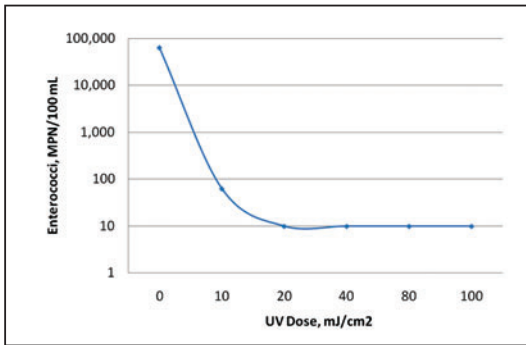


Figure 7. Results of Bench Scale Testing with Chemical Addition *Enterococci*

The results of collimated beam tests demonstrated that a UV system could be installed to comply with current regulatory limits. In the future, after nutrient limits are written into the discharge permit resulting in an improved effluent water quality, the UV system should be able to disinfect effectively the future design flows. Therefore, by adding the polymer, the design value for the UVT could be increased to 50% allowing for the installation of a UV system at this facility.

Results of Polymer Testing				
Polymer	Dose, mg/L	Molecular Weight	Charge	Increase in UV Transmittance, %
1 (dry)	2	High	High	15
2	10	High	Medium	4
3	8	High	High	2
4	8	High	Low	4
5	4	High	High	4

Table 1. Polymer Testing For Transmittance Improvement

CONCLUSIONS

The use of polymer at the Leavenworth WWTP was found to be a cost effective alternative to increase solids capture. Colloidal solids in the effluent could be flocculated into larger solids, which would then settle. With increased solids capture, the UVT increased to levels that allowed for UV to be implemented in a cost-effective manner at the treatment plant. Other utilities may find polymer addition as a means to allow UV to be implemented with poor-water quality effluents.

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