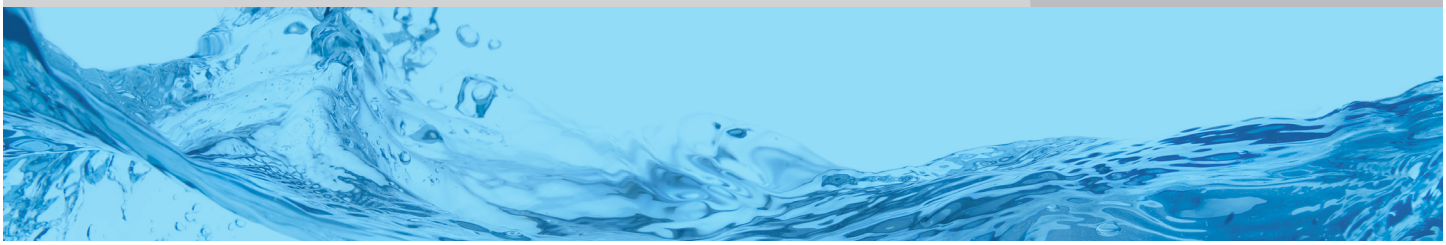

Utilize Ultraviolet Lamps for Disinfection

Principle

Ultraviolet (UV) radiation has become a common method for final disinfection during the wastewater treatment process in municipal plants with up to 20% of US plants utilizing it[1]. Specific wavelengths of UV light damage the genetic information (e.g., DNA and RNA) of microorganisms leaving them unable to reproduce. When applied to a flow of wastewater, UV light can provide disinfection without the addition of any chemicals. Advantages (and cost savings) related to utilizing UV disinfection compared to typical chemical disinfection processes like chlorination include reduced lifecycle costs, reduced need for technically trained chemical handling professionals, and reduction in storage and handling of potentially hazardous chemicals.

Compared to chemical disinfection, UV disinfection has the following benefits:

- Inactivates most viruses, spores, and cysts;
- Eliminates need to generate, handle, transport, or store toxic and hazardous chemicals;
- Leaves no residual environmental effects that can be harmful to human or aquatic life, including disinfection by-products;
- Is user-friendly for operators;
- Has shorter contact time compared to other disinfectants (seconds compared to ~30 minutes);
- Allows for a smaller physical footprint due to elimination of chlorine storage tanks or chlorine contact chambers; and
- Is cost competitive when considering the auxiliary needs of chlorination (storage, handling, transport, specialized operators, etc.).

Suggested Actions

- Consider utilizing ultraviolet disinfection to replace other disinfection processes.

[1] US EPA. 2016. "Clean Watersheds Needs Survey 2012." United States Environmental Protection Agency 53 (9): 1689–99.

Drawbacks to UV disinfection include:

- Increases facility energy consumption due to UV lamps' electricity consumption;
- Requires preventive maintenance program to control fouling of UV tubes (see Wastewater Tipsheet #6 for more information);
- Requires pre-filter to remove excess suspended solids or larger organisms that may interfere with or be shielded from UV light; and
- Requires consistent flow rate – too high and water will pass without proper exposure; too low and UV lamps will build up heat and become damaged.

Example

Although there are unlikely to be direct energy savings from switching to a UV disinfection system, there are many ancillary cost savings. Chlorine is a hazardous chemical and, as a result, has higher associated costs, including the cost of chemicals and delivery, storage equipment, specialized trainings and staff, emergency preparedness planning, and general maintenance. The much simpler and safer UV disinfection system's operations and maintenance (O&M) costs include only electricity supplied to the lamps, lamp cleaning, and lamp replacement. Other considerations when selecting a disinfection process may include non-economic factors such as "operator and community safety, ease of operation, process reliability, constructability and space requirements, and sustainability/environmental impact[2]."

It is estimated that wastewater treatment plants that use low-pressure UV lamps consume 100-250 kWh per million gallons (MG) of treated water; while medium-pressure systems use 460-560 kWh/MG. Compare this to chlorinated disinfection systems which use 60-250 kWh/MG[3]. Therefore, this technology is not proposed as an energy-saving measure, but is intended to reduce the direct cost and environmental and health impacts in addition to lifecycle costs related to chlorine disinfection.

Comparing UV disinfection and chlorine disinfection, a 2008 Water Environment Research Foundation paper stated that for a 15 MGD wastewater treatment plant with UV disinfection typical annual O&M costs would be between $44,000 – $116,000 depending on whether low or medium pressure lamps were utilized. Whereas a similar-sized 16.5 MGD plant utilizing chlorine disinfection spent $958,000 on O&M costs[4]. Of course, dramatic differences can exist in O&M costs depending on facility size, location, and effluent flow; this is just one example of the operational cost savings that can be realized by utilizing UV disinfection.

Resources

See the Sustainable Wastewater Infrastructure of the Future (SWIFt) website for more information on wastewater energy solutions at betterbuildingssolutioncenter.energy.gov/accelerators/wastewater-infrastructure

To view more Energy Tip Sheets visit energy.gov/eere/amo/tip-sheets-system

To access these and many other industrial efficiency resources and information on training, visit the Advanced Manufacturing Office Website at manufacturing.energy.gov

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[2] Newberry, Mike. "The Big Question – UV Technology." WaterWorld Magazine, March 19th, 2014. Accessed September 3, 2021. https://www.waterworld.com/international/desalination/article/16200979/the-big-question.

[3] "Water Disinfectant: Ultraviolet vs. Chemical or Ozone." Ultraviolet Disinfection of Water and Wastewater. Washington State University - Energy Program. Accessed September 3, 2021. http://e3tnw.org/ItemDetail.aspx?id=13#:~:text=WWTFs%20using%20low%2Dpressure%20UV,on%20the%20chlori.

[4] Leong, Lawrence, et al. 2008. "Disinfection of Wastewater Effluent – Comparison of Alternative Technologies." Water Environment Research Foundation.