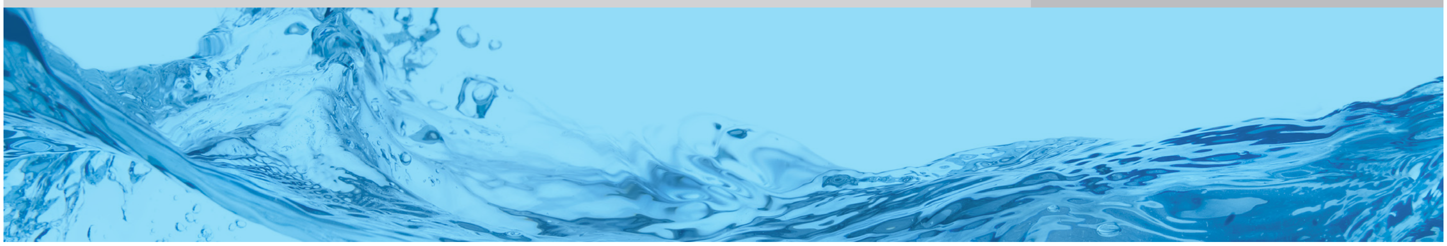

Clean Ultraviolet Lamp Sleeves Regularly to Enhance Transfer Efficiency

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.

While UV disinfection systems have much lower operations and maintenance activities and costs compared to chlorine disinfection systems, they still require critical maintenance to ensure proper functioning of the UV system. These include routine lamp sleeve cleaning to ensure consistent UV radiation transfer efficiency. UV lamps are enveloped in a quartz sleeve to protect the lamp from touching the water directly and more effectively transmit UV light through the water. The UV lamps also warm the water, accelerating precipitation of inorganic minerals in the water. Over time, mineral deposits from the water build up on and foul this sleeve, making it appear cloudy. Hard water is particularly prone to fouling[2].

As a lamp sleeve becomes fouled, less UV light is transferred to the water thereby requiring more energy to deliver the same dose of UV disinfection.

Suggested Actions

- Monitor the energy consumption of the UV lamps and the microbial removal efficiency of the process.
- If energy consumption increases without an increase in disinfection, it may be time to clean the UV lamps.
- Consult UV lamp directions on how to properly clean sleeves.

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

[2] NYSERDA. 2004. "Evaluation of Ultraviolet (UV) Radiation Disinfection Technologies for Wastewater Treatment Plant Effluent." New York State Energy Research and Development Authority 04 (07): 2-9.

Since fouling varies dramatically based on quality of water, surface area of the lamps, and the temperature change induced by the lamps' radiation output, a typical maintenance schedule is facility-dependent. A common best practice is to monitor the energy consumption of the lamps and microbial removal efficiency of the process. If energy consumption increases but microbial removal does not, fouling is beginning to occur. Over time, a facility can establish a threshold for the increase in energy consumption that should trigger cleaning activities for their operating conditions. If energy consumption cannot be tracked, then a simple weekly visual inspection for fouling is recommended.

Example

Common estimates for UV system energy usage put low-pressure lamp systems at 100-250 kWh per million gallons of wastewater treated and medium-pressure lamp systems at 460-560 kWh per million gallons[3].

According to Wisconsin's Energy Office, "[s]leeve cleaning alone can save up to 15% of UV system energy costs." As an example, let's consider a 15 million gallons per day (MGD) wastewater treatment plant utilizes a low-pressure UV lamp system for disinfection. Utilizing the median estimated energy consumption of a low-pressure UV system and the Wisconsin Energy Office's estimate of 15%, the annual energy savings with a proper UV sleeve cleaning maintenance routine would be:

Resources

For more information on UV System Maintenance, access Wisconsin Energy Office's Water & Wastewater Energy Best Practices Guide by visiting https://www.focusonenergy.com/business/ee-best-practice-guides

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

Annual Energy Savings =

UV System Energy Usage (kWh/MG) × Average Flow (MGD) × Operating Days × % Savings

$$175 \frac{\text{kWh}}{\text{MG}} \times 15 \frac{\text{MG}}{\text{day}} \times 365 \frac{\text{days}}{\text{year}} \times 15\% = \mathbf{143{,}719} \frac{\textbf{kWh}}{\textbf{year}}$$

Which, at an estimated $0.10 per kWh, would provide annual savings of about $14,372.

[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.