# Inactivation of Opportunistic Pathogens and Prevention of Biofilms in Drinking Water Systems using UV LEDs

## Background

The quality of drinking water may change as it travels from the treatment plant through the drinking water distribution system (DWDS) to consumers' taps. A large area of concern is the growth of bacteria within these systems. Although many bacteria that grow within DWDSs are not harmful to human health, opportunistic pathogens (OPs), such as *Legionella pneumophila*, *Pseudomonas aeruginosa*, and *Mycobacterium avium*, can inhabit DWDSs and premise plumbing and cause infection in drinking water consumers. These OPs are the leading cause of waterborne disease outbreaks in higher income countries[1]. The United States currently requires drinking water suppliers to maintain a chemical disinfectant residual, such as chlorine or chloramine, throughout DWDSs to prevent bacterial regrowth. However, these disinfectants are not effective against these OPs, especially when the bacteria adhere to each other and surfaces to form biofilms. Therefore, another method to prevent biofilm-bound OPs within DWDSs is necessary.

[1]Beer et al. 2015. *CDC*.

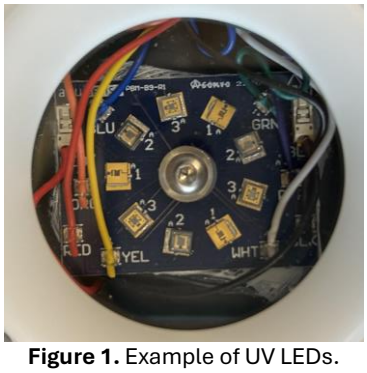

**Figure 1.** Example of UV LEDs.

UV light at wavelengths between 200 to 290 nm can inactivate all classes of microorganisms, including viruses, protozoa, and bacteria. A newer, emerging UV technology is light emitting diodes (LEDs), which have advantages including instantaneous powering on, long life spans, small size, and high power density. These LEDs create promising opportunities for new treatment methods within DWDSs.

## Research

To evaluate UV LED-based strategies for reducing biofilm formation by OPs, two bench scale experimental systems are utilized: one testing the impact of in-line UV disinfection of planktonic cells prior to biofilm formation conditions, and one testing the impact of direct UV irradiation in disrupting biofilm formation.

**Figure 2.** UV LED reactor used in bench scale system testing the efficacy of inactivating planktonic cells prior to biofilm formation.

**Figure 3.** Bench scale experimental system testing the impact of constant, direct UV irradiation in disrupting biofilm formation.

## Impact

The outcome of this research is to establish if and how UV LEDs can be used within DWDSs to reduce biofilm formation, therefore reducing infections by OPs. The cost effectiveness and flexibility of these technologies may make them ideal for small-scale decentralized treatment systems within rural areas. Additionally, the extra layer of protection against OPs UV could provide may be ideal for households or hospitals with immunocompromised individuals.

## Related Publications


- Ma et al. 2022. *Water Research*. https://doi.org/10.1016/j.watres.2022.118379
- Linden et al. 2019. *Accounts of Chemical Research*. https://doi.org/10.1021/acs.accounts.9b00060



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