DISINFECTION EFFICACY OF COMMERCIAL FAR UV-C FIXTURES USING THE CONTINUOUS CHALLENGE AGENT INTRODUCTION AND DECAY METHODS

by

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ABSTRACT

Airborne disease outbreaks, whether epidemic or pandemic, pose serious threats to public health and societal function. The COVID-19 pandemic clearly showed the urgent need for effective air disinfection technologies that can reduce the spread of aerosolized pathogens. With the ongoing risk of future outbreaks, interest in germicidal ultraviolet (GUV) systems is growing, especially those that use Far-UV-C (222 nm) radiation for safe and continuous disinfection in occupied indoor spaces. Chamber-based testing provides a controlled setting to assess the performance of these technologies and to measure bioaerosol inactivation under specific mixing and irradiation conditions.

This study evaluated the disinfection effectiveness of commercial Far-UV-C (222 nm) and conventional UV-C (254 nm) fixtures using two exposure methods: the traditional decay approach and a different continuous challenge agent introduction method. Tests were performed in a well-controlled Indoor Air Quality (IAQ) chamber. Bacteriophages T1 and MS2 were used as surrogate airborne viruses, and their infective concentrations were measured using the samples collected by impinger and BioSpot samplers. A mass balance model helped estimate first-order inactivation constants and calculate the UV-equivalent air changes per hour ($eACH_{UV}$).

The results showed that the continuous introduction method provided more reliable and interpretable data than the decay method, especially when challenge agent concentrations dropped to detection limits. Among the challenge agents tested, T1 showed better performance due to its UV sensitivity and consistent detectability. Additional modeling and collimated beam experiments further supported the determination of $eACH_{UV}$ reinforcing confidence in the performance assessments.

Overall, the findings highlight the importance of achieving nearly uniform mixing, choosing suitable surrogate organisms, and thoroughly characterizing fluence rate fields in chamber studies. These practices are crucial for accurately evaluating and applying UV-C disinfection technologies, contributing to the creation of best practices for large-scale testing and public health readiness.