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The Investigation of UV-C LED Arrangement on the Sterilization of *Escherichia Coli* in Flow Reactors

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Extended Abstract

In this study, a planar UV reactor with distinct UV-C LED arrangements was proposed to treat potable water. The particle tracing method combined with computational fluid dynamics were used to simulate water velocity field, microbial trajectory and exposure time. The ray tracing method was used to determine the irradiance distribution in water. The simulated variables were integrated to determine the distribution of fluence in water.

UV light has been widely used in water sterilization processes because it is safe and simple and does not produce any unwanted by-products [1]. UV-C LEDs have been used instead of mercury lamps in water disinfection processes because of their numerous advantages, such as their long lifespan, mercury-free design, tunable wavelength, and high design flexibility [2,3]. The arrangement of UV-C LEDs substantially affects the light distribution and UV fluence to which microbes are subjected. However, if the distribution of light is not optimized, the performance of reactors employing UV LEDs may be lower than that of reactors employing traditional mercury lamps [4]. According to studies on the application of UV-C LEDs in water disinfection in flow reactors, positively correlating the flow field with the irradiation distribution can aid in the design of highly efficient UV reactors. In this study, the effects of LED arrangement on the efficacy of a planar UV LED reactor for E. coli disinfection under various flow rates were investigated. In this experiment, *E. coli* IFO 3301 was used to validate the water disinfection performance of the reactor. The bacteria were cultured on NZCYM broth supplemented with deionized water and grown in an incubator. To determine the reactor's sterilization performance, plate counting was used with irradiated and nonirradiated water. The inactivation kinetic was defined using the first linear model [5].

Both experimental and theoretical results among the distinct UV light modules used in this study, turn-enhanced emission exhibited the highest efficiency in sterilizing *E. coli* owning to the synergic effect of hydrodynamics and UV radiation. Turn-enhanced emission combined with turn-induced secondary flow effectively improved the reactor performance. At a flow rate of 300 mL/min, turn-enhanced emission resulted in an inactivation value of 4.6 log, which was approximately 21.9%, 19.3%, 19.9%, and 111.2% higher than the values obtained with top, staggered, lined, and side emission, respectively. According to the particle count and cumulative count of the fluid particles, turn-enhanced emission effectively enhanced the UV fluence to which microbes in water were subjected. In conclusion, optimal combinations of LED arrangements and channel configurations effectively improve the sterilization efficiency of UV reactors.

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