Validation of Large-Scale, Monochromatic UV Disinfection Systems for Drinking Water Using Dyed Microspheres [Project #3139] [Web-only]

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ABSTRACT:
Dyed microspheres have been developed as a new method for validation of ultraviolet (UV) reactor systems. When properly applied, dyed microspheres allow measurement of the UV dose distribution delivered by a photochemical reactor for a given operating condition. Prior to this research, dyed microspheres had only been applied to a bench-scale UV reactor. The goal of this research was to extend the application of dyed microspheres to large-scale reactors.

Dyed microsphere tests were conducted on two prototype large-scale UV reactors at the UV Validation and Research Center of New York (UV Center) in Johnstown, NY. All microsphere tests were conducted under conditions that had been used previously in biodosimetry experiments involving two challenge bacteriophage: MS2 and Qb. Numerical simulations based on computational fluid dynamics and irradiance field modeling were also performed for the same set of operating conditions used in the microspheres assays. Microsphere tests on the first reactor illustrated difficulties in sample collection and discrimination of microspheres against ambient particles. Changes in sample collection and work were implemented in tests conducted on the second reactor that allowed for improvements in microsphere capture and discrimination against the background. Under these conditions, estimates of the UV dose distribution from the microspheres assay were consistent with numerical simulations and the results of biodosimetry, using both challenge organisms.

The combined application of dyed microspheres, biodosimetry, and numerical simulation offers the potential to provide a more in-depth description of reactor performance than any of these methods individually, or in combination. This approach also has the potential to substantially reduce uncertainties in reactor validation, thereby leading to better understanding of reactor performance, improvements in reactor design, and decreases in reactor capital and operating costs.


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