ABSTRACT

Shen, Chengyue Ph.D., Purdue University, December 2004. Characterization of UV Irradiance Field in UV Disinfection Systems by Local Actinometry. Major Professor: Ernest R. Blatchley III

Field-scale UV systems deliver spatially non-uniform UV irradiance fields. Locations characterized by relatively high velocity and low irradiance are critical to the overall performance of UV systems in that they are responsible for delivery of relatively low UV doses. In this study, an experimental method, "local actinometry" was developed to monitor the UV irradiance at a location that approached the size of a point in the system.

The actinometer used in this study was (E)-5-[2-(methoxy-carbonyl)ethenyl]cytidine (*S*), which is photo-transformed to 3-β-D-ribofuranosyl-2,7-dioxopyrido[2,3-d]pyrimidine (*P*) when subjected to UV radiation. The photoproduct, *P*, is strongly fluorescent. Quantum yields for *P* from *S* were estimated for germicidal UV radiation at wavelengths of 254 nm, 282 nm, and 222 nm, respectively. Capillary quartz tubes were utilized as actinometer solution conduit, and were placed at well-defined critical positions inside UV systems. The photoproduct yields were quantified by HPLC, or monitored continuously by a continuous-flow fluorometer. The measured photoproduct yields were translated to the local irradiance at the location corresponding to the capillary tube. A numerical model was developed to accurately represent the photochemical and optical behavior of the actinometer in the quartz capillary tube. A SSS model was developed to estimate UV irradiance in close proximity to UV lamps. Conjunction of these numerical models was used to accomplish the interpretation from

photoproduct yields to the local UV irradiance. As such, local actinometry can be used for experimental validation of UV irradiance field models, as well as correlation with dose delivery in a continuous-flow system.