

ABSTRACT

Wait, Isaac William. Ph.D., Purdue University, August, 2005. Fouling of Quartz Surfaces in Potable Water Ultraviolet Disinfection Systems. Major Professor: Ernest R. Blatchley III.

Although ultraviolet (UV) disinfection of drinking water has been shown to be effective and cost efficient, one barrier to more widespread adoption is uncertainty surrounding the possible accumulation of fouling materials on quartz surfaces within UV reactors. These quartz surfaces serve as protection for the delicate UV lamps that are immersed in the water being treated, and in many cases they can become coated with precipitated minerals and impacted particles that limit the transmission of germicidal UV radiation from the lamp into the water that is to be treated. While past research has investigated the formation of foulants in reactors treating wastewater, differences in reactor geometry, lamp type, and water chemistry between wastewater and drinking water treatment applications are cause for further investigation of sleeve fouling mechanisms, rates, and foulant composition.

Laboratory and field experiments were conducted at several locations to investigate the relationship between water chemistry and foulant composition, formation, and UV absorbance characteristics. Low Pressure High Output (LPHO) lamp sleeves in a parallel flow configuration were examined for metals accumulation, UV transmittance, and rate of accumulation, and models of solution chemistry were used to understand the formation of mineral species. Zero order kinetics for foulant accumulation were demonstrated. Medium Pressure (MP) lamp sleeves were utilized in a perpendicular flow reactor configuration disinfecting a surface water to determine variations in fouling that can occur when reactor geometry and higher UV intensities are used. Regression modeling was utilized to develop an understanding of the absorbance characteristics of foulant components, and iron and calcium were found to be primary contributors to radiation absorption in fouled lamp sleeves. Comparisons of foulant buildup and fouling effects between multiple locations within a groundwater treatment process highlighted the impact of treatment steps that cause changes in oxidation reduction potential, mineral solubility, and fouling rate. Depending on water oxidation state, phosphate addition was found to have either a protective or detrimental effects as related to fouling formation.