The carcinogenic potential of chlorine disinfection byproducts and recent changes in water quality regulations in the United States have led to a greater emphasis on alternative disinfection mechanisms. More specifically, the promulgation of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) and the Stage 2 Disinfection and Disinfection Byproducts Rule (D/DBPR) may force water utilities to implement more aggressive treatment technologies to remain in full regulatory compliance. Photocatalysis, such as titanium dioxide (TiO\(_2\)) nanoparticles, have the ability to generate radical species, including hydroxyl (OH\(^-\)) and superoxide radicals (O\(_2^\cdot\)), which react with water to generate hydrogen peroxide and hydroxyl radicals, respectively. The synergistic effects of these reactive oxygen species (ROS) and UV light have the potential to destroy organic compounds and inactivate UV-resistant (adenoviruses) and chlorine-resistant (Cryptosporidium parvum) microbes. In this study, the efficacy of bench-scale and pilot-scale TiO\(_2\) photocatalytic disinfection was evaluated using four bacteriophages (PRD1, phi-X174, MS2, and f1) and four human viruses (adenovirus 4, coxsackievirus B6, echovirus 12, and poliovirus 1). The bench-scale and pilot-scale experiments were performed using a collimated beam and the Photo-Cat Lab\textsuperscript{®} reactor from Purifics\textsuperscript{®}, respectively.

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**Background and Experimental Design**

**Photocatalytic Inactivation of Viruses Using Titanium Dioxide Nanoparticles**

**Motivation and Objectives**

**Bench-Scale Collimated Beam Results**

**Pilot-Scale Photo-Cat Lab Results**

**Significant Observations**

- The annular reactor configuration and improved mixing in the Photo-Cat Lab significantly increased the inactivation of the bacteriophages on the TiO\(_2\) nanoparticles, thereby increasing the effectiveness of photocatalysis even at high TiO\(_2\) doses (400 – 1,000 mg/L).
- Ruviso, a UV resistant bacteriophage, achieves very low levels of inactivation due to increased quantum yields, light scattering, and absorption. This control indicates that photocatalysis is the dominant mechanism for high TiO\(_2\) doses.
- The "dynamic" membrane filter provides a higher level of bacteriophage removal in the presence of TiO\(_2\).