UNIVERSITY OF SOUTH FLORIDA

Clean Drinking Water using Advanced Solar Energy Technologies

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Description: Availability of fresh water is one of the biggest problems facing the world and Florida is one of the most vulnerable to fresh water shortages. Moreover, Florida ground water is contaminated in many locations from leaky underground tanks, agricultural pesticides, and other chemicals. Although it is possible to desalinate abundant seawater, conventional systems are too energy intensive. Solar energy can provide the needed energy, and innovative new solar vacuum (USF) and humidification/dehumidification (UF) desalination systems can provide adequate fresh water for the state's needs. Systems are being developed for both bulk water desalination and small community needs/disaster response. We will also develop photocatalytic disinfection to remove contaminants and integrate these technologies with solar PV for complete water supply systems.

Photocatalysis is a promising water treatment technology capable of utilizing solar light. However, the construction of an effective photocatalytic disinfection system for water purification is currently limited by the lack of reliable models to aid in the design and testing of these systems. Simplified models have been proposed, but most are inadequate because they rely on traditional disinfection theories which are not applicable to photocatalysis. Therefore, the major goal of this research is to develop a model for photocatalytic disinfection based on fundamental processes which may then be used to design water treatment systems in the state of Florida.

Budget: $326,756
Universities: USF

Project Summary

A comprehensive mechanistic model for photocatalytic disinfection was proposed to optimize the design of treatment systems. A major benefit of a mechanistic model is the significant cost reduction associated with performing fewer preliminary experiments to determine the effectiveness of various combinations of catalyst concentration and light intensity for a given organism. The model simulates the effect of light intensity and catalyst concentration on the disinfection process and shows good agreement with the experimental data for stable colloidal suspensions, that is, suspensions in which rapid aggregation of cells and TiO_2 do not occur.

The following summarizes the main findings of the study:

- Most efficient disinfection achieved at high light intensity and lowest catalyst concentration
- Model predicted disinfection rate constants (k_{dis}) within 2 orders of magnitude, with less variation at lower TiO_2 concentration (within an order of magnitude)
- Disinfection has log-linear relationship with light intensity within the range in our research
- Small variation in disinfection efficiency for 0.10-0.50 g L^{-1}, especially at low and medium light intensity

- Generation rate per mass of catalyst reduces exponentially with catalyst concentration
- Colloidal interactions play a significant role in the disinfection process
- TiO_2 appears to be strongly and specifically adsorbed to cells
- Model shows disinfection does not vary significantly from pH 6-8

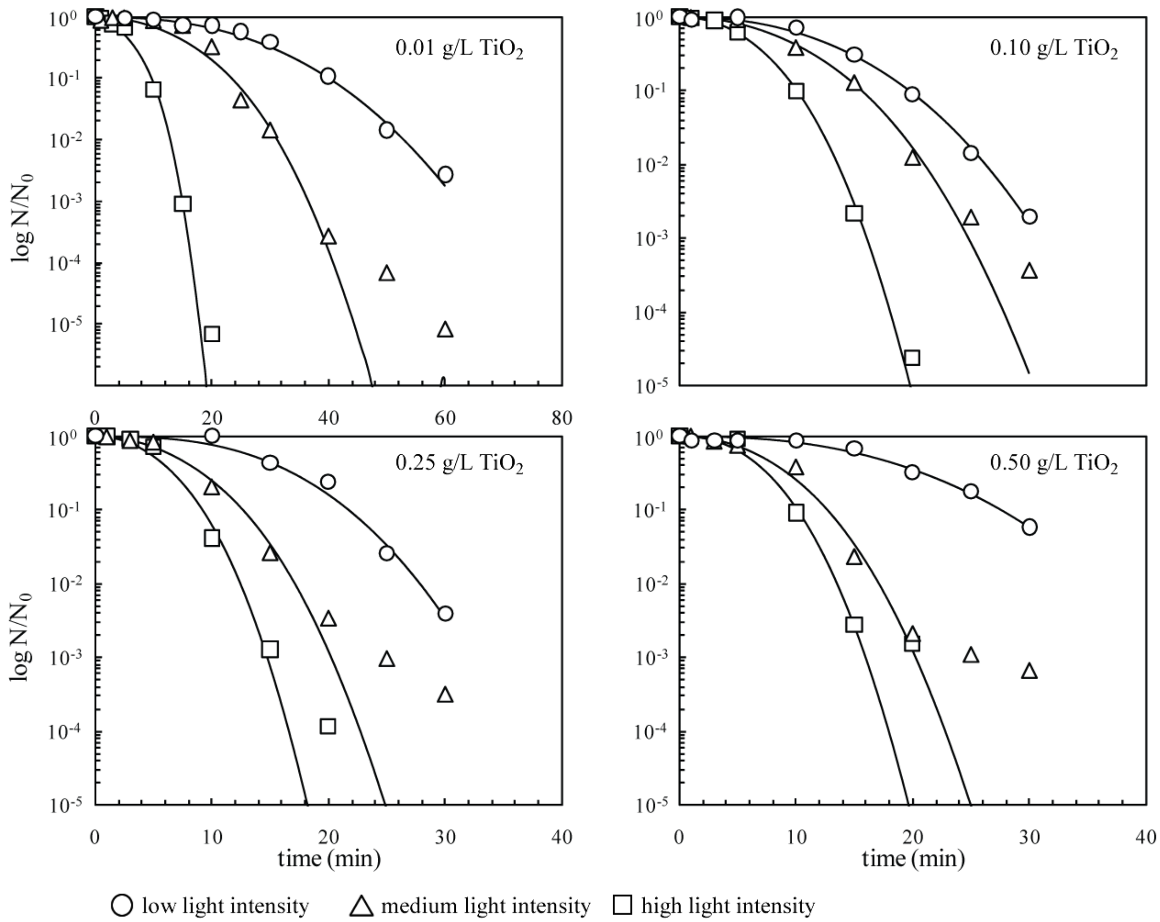

Figure 1 Disinfection curves showing the reduction in *E. coli* with time after photocatalytic exposure to different combinations of light intensity and TiO_2 concentration. The continuous lines are the results of the model simulation matching the data (geometric shapes).