

ABSTRACT

Mbonimpa, Eric Gentil. Ph.D., Purdue University, December 2010. Title: Disinfection of drinking water using solar UV: A low cost system applicable in developing countries. Major Professor: E. R. Blatchley III.

Potable drinking water is a scarce resource in many parts of developing countries, especially rural areas. The WHO/UNICEF (2006) estimated that around 1.1 billion people do not have access to potable water and 2 million a year die due to diseases caused by pathogens in water. Due to limited financial means of these countries, low cost point-of-use systems are thought to be appropriate technology to treat water. Systems using solar ultraviolet (UV) radiation could be successful since many vulnerable countries are located where solar radiation is intense and abundant throughout the year. The goal of this study is to develop a simple and low cost point-of-use solar UV reactor to disinfect water.

In this study wavelength-dependent microbial dose-response behavior was investigated using surrogates to pathogenic microbes. A solar radiation prediction method based on the SMARTS model was used to predict solar UV intensity as function of geographic location and time. A numerical modeling procedure using the discrete ordinate (DO) model and CFD software (FLUENT) was used to simulate UV dose (distribution) delivery to microorganisms. Then, the dose distribution was combined with the dose-response behavior using a segregated-flow model to predict microbial inactivation by the reactor.

A prototype was produced and tested to validate the numerical modeling procedure. The inactivation results from the prototype were in agreement with numerical inactivation prediction. The modeling procedure permits parameters such as reactor dimensions and material properties to be varied to meet a treatment goal. For future study, other potential materials should be investigated and prototype tests should be carried out in regions where the system is to be applied.