PhD Dissertation Defense

VIRUS REMOVAL AND INACTIVATION IN BATCH AND BY HYBRID PHOTOCATALYTIC UV-MEMBRANE FILTRATION SYSTEM: DISINFECTION MECHANISMS AND EFFECT OF WATER QUALITY

by

Bin Guo

Advisor: Volodymyr Tarabara

Friday, April 15 @ 1:00 p.m.

2527D Engineering Building

Abstract:
Waterborne diseases pose great health threat to humans and result in huge economic losses. One of the effective way to avoid the infections by waterborne microorganisms is water disinfection. Conventional disinfection methods include chlorination, chloramination and ozonation. However, the inevitable production of disinfection by-products (DBPs) and the inability to inactivate certain resistant microbial species are drawbacks of the conventional disinfection methods. In addition, with the transition to lower quality water sources and an increasing role of water reuse, conventional disinfection methods may no longer be sufficient. Alternative treatment methods with higher efficiency and smaller energy demand are urgently required.

Numerous studies have been conducted to explore the application of photocatalytic membrane reactors (PMRs) in water treatment. Most of these studies have focused on the removal of chemicals, often employing dyes as model pollutants. PMRs applications to water disinfection, however, are very limited. Only five studies employed concurrent filtration and photocatalytic disinfection. In four of the five publications, the same type of bacterium was used as the bacterial model.

In the present work, a novel hybrid photocatalytic UV-membrane filtration system was designed and applied for water disinfection. To the best of our knowledge, this is the first application of a PMR for virus removal and inactivation in water. Two types of viruses and two types of waters were used to test the performance of the hybrid system. The hybrid system is shown to retain the advantages of photocatalytic UV disinfection and membrane filtration and to synergistically mitigate drawbacks of each of these two processes. In addition, batch experiments were also conducted to understand the mechanism of photocatalytic inactivation of viruses in water and to examine the effect of water quality on the photocatalytic inactivation of viruses. Water quality affects the kinetics of photocatalytic inactivation, which fits Collins-Selleck model in DI water and a first-order reaction in pre-filtered surface water.