CEE@UCI Environmental ENGINEERING Ph.D. DEFENSE Announcement

MICROBIAL PATHOGEN DETECTION AND REMOVAL IN WATER REUSE PRACTICES

By:

Xiao Huang

Doctor of Philosophy in Engineering
With a Concentration in Environmental Engineering
University of California, Irvine, 2015
Professor Sunny Jiang, Chair

Date: Monday, September 14, 2015
Time: 1:00 PM
Room: CEE Conference Rm, EG 4171

Abstract:

Population growth, rapid urbanization, and climate change have been straining our traditional water resources and leading to a global water crisis. Wastewater reclamation and reuse offer an effective means of conserving our limited freshwater resources and improving water productivity. The advances of water treatment technologies have provided options for treating wastewater to the quality required for any intended uses. The efficiency and sustainability of water reuse practices, however, rely on matching the water treatment process with specific end uses.

The primary concern associated with water reuse practices is the public health risk caused by the potential exposure to microbial contaminants. The detection and removal of microbial pathogens is therefore of great importance to ensure the reclaimed water is "safe" for the intended end uses. This research studied the microbial pathogen removal in three different water reuse schemes. In the first study, a rapid direct virus detection method based on Accuri C6 flow cytometry was developed to quantify the virus removal rate in a water reclamation plant using microfiltration-reverse osmosis (RO) process for indirect potable reuse water production. This new method, in combination with online total organic carbon and nanoparticle analysis, has shown to be a viable option for online monitoring of high-pressure RO membrane integrity. In the second study, the effectiveness of microbial pathogen removal by constructed stormwater wetlands (CSW) was investigated using digital droplet PCR (ddPCR) and 454-pyrosequcing techniques. The results showed that the two CSW in the US and one of the three CSW in Australia had good performance in terms of indicator bacteria removal during dry weather flow condition. The treated stormwater can meet the recreational water quality criteria. No *Cryptosporidium* was detected in any of the CSW, while Adenovirus were present at all sites. Human specific HF183 *Bacteroides* were only found in Australian sites indicating the potential contamination from sewage ingression. Microbial community analysis showed a clear increase of *Cyanobacteria* in the outflow of CSW with better performance. The water residence time was determined as a critical factor affecting the efficacy of microbial pathogen removal or inactivation. In the last study, pathogen removal efficiency was investigated in a solar-powered wastewater electrolysis cell for decentralized wastewater treatment. The results showed 5 $\log_{10}$ reductions of bacteria (*E. coli* and *Enterococcus*) and viruses (coliphage MS2 and adenovirus) were achieved within 1 h reaction at applied cell voltage of 4V. The dominating role of free reactive chlorine generated *in situ* during EC reaction was verified using laboratory model waters. The formation of organic disinfection byproducts trihalomethanes (THMs) and haloacetic acids (HAA_5) during EC disinfection were found to increase with the rise of applied cell voltage. The EC treated toilet wastewater is suitable for many non-potable reuse applications (e.g., toilet flushing and irrigation) with significantly reduced microbial infection risk.