Water Resources Center
Department of Civil and Environmental Engineering

Annual Technical Report
2018

General Information

Products

Elkhatib, D. Oyanedel-Craver,V. (2019) A critical review of techniques used for detection, characterization and quantification of microplastics in wastewater and drinking water. Water Research (in preparation)

Elkhatib, D., Carissimi, E., Oyanedel-Craver,V. (2019) Removal of microplastics using electrocoagulation. Environmental Science and Technology (in preparation)

Elkhatib, D., Andreu, I.., Oyanedel-Craver,V. (2019) Fate of microplastics in urban water system. Environmental Science and Technology (in preparation)

Addison, E., Gerlach, K., Dudle, J., and Goodwill, J. “The physico-chemical impacts of ferrate and cyanobacteria” Target Journal: Environ. Sci. Water Research and Tech.

Erika Addison, Kyle Gerlach, Aly Fairbrother, Joseph Goodwill, Jeanine Dudle Poster, UMass Amherst, AEESP Distinguished Lecture Series, Amherst, MA, October 24, 2018

Kyle Gerlach, Erika Addison, Joseph Goodwill, Jeanine Dudle, Poster, New England Water Works Association, NEWWA Spring Conference, Worcester, MA, April 3, 2019

Kyle Gerlach, Erika Addison, Joseph Goodwill, Jeanine Dudle, Poster, Worcester Polytechnic Institute, Graduate Research Innovation Exchange Worcester, MA, April 6, 2019

Kyle Gerlach, Erika Addison, Joseph Goodwill, Jeanine Dudle, Poster, Worcester Polytechnic Institute, Sustainability Project Competition, Worcester, MA, April 10, 2019

Erika Addison, Joseph Goodwill, PowerPoint Presentation, University of Rhode Island, Graduate Student Seminar, Kingston, RI, May 1, 2019

Erika Addison, Kyle Gerlach, Joseph Goodwill, Jeanine Dudle, PowerPoint Presentation, American Water Works Association, 2019 AWWA Annual Conference and Exposition (ACE19), Denver, CO, June 10, 2019

Kyle Gerlach, Erika Addison, Joseph Goodwill, Jeanine Dudle, Poster, UMass Amherst New England Graduate Student Water Symposium, Amherst, MA, September 7, 2019

Information Transfer Program

The goal of the information transfer project was to deliver a one-week summer camp to expose high school students to clean water concepts through 8 science presentations, four experiments, field trips to a water treatment and a wastewater treatment facility. We worked with 10 students from the Providence School District.

Activities for the students involved numerous presentations, various laboratory exercises, and two major field trips. Among the presentations were those on of the water cycle, chemistry of water, water quality and treatment, sewage treatment and biological technology, runoff and storm water, industrial water pollution, pollution prevention. Laboratory exercises included water quality sampling and testing, settling, and filtration experimentation. Field work included the collection of samples from various locations, including 30 Acre Pond at URI, where students were allowed, with guidance and observation, to enter into the shallow areas of the pond to sample for macro-invertebrate life in the pond. This was definitely one of their favorite activities. Field trips were taken to the Holton Water Purification Facility at the Scituate Reservoir and the Warwick Advanced Wastewater Treatment Facility, with a final trip to the Boston Science Museum.

Dr. Hunter, from URI, was responsible for most of the presentations and establishing the activities, while he was assisted with a current URI engineering student and former Clean Water Summer Engineering and Science participant, Jeffery Francisco.

Student Support

2 Ph.D Graduate Students
1 MS Graduate Student
3 Undergraduate Students

Notable Achievements and Awards

Dounia Elkhatb won best paper on the North Atlantic Society of Environmental Toxicology and Chemistry in 2018.

Joseph Goodwill nominated as Emerging Investigator by Royal Society of Chemistry (RSC) Environmental Science: Water Research and Technology Journal.

Projects

Assessing Microplastic and Microfibers Contamination in Small Water Utilities and Private Wells

Project Type: Annual Base Grant **Project ID:** 2018RI134B

Project Impact: Our main goal is to perform an extensive review of peer review publications reporting of microplastics presence in wastewater and drinking water in the United States and worldwide. This review compares methodologies used to collect, quantify and identify microplastics in both wastewater and drinking water. Using the information collected we identified research limitations and knowledge gaps as well as proposed research needs. The compilation of the results shows that concentration of microplastics discharged from wastewater treatment facilities effluents vary between 8.0x10-1 to 8.1x104 particles/m3; while concentrations in wastewater influent, reported only by 28% of the studies, varied between 1.51x104 to 9.1x105 particles/m3. The majority of the microplastics sizes reported were between 100 to 500 µm. Microplastic concentrations in single use bottled water, tap water and drinking water treatment plant effluent were between 0 to 5.51x106 MP/m3, 0 to 6.1x104 MP/m3, and 0 to 6.56x105 MP/m3, respectively. This review identified scientific information regarding techniques used for MP assessment in both wastewater and drinking water studies, while recognizing the work deficits and needs. Finally, recommendations for the most appropriate methods are discussed in this review to enlighten work priorities to generate standard methods. We assessed the removal of MP using both synthetic and real wastewater effluent collected from a local utility. The experiments were performed in batch reactors, and parameters such as current density, pH, and electrolysis time were varied to determine the most effective operational conditions. Removal efficiencies in synthetic wastewater obtained ranged between 98% and 99% using initial pH between 4 and 7 and applying current densities of 2.88 mA/cm2 and 8.07 mA/cm2, respectively. However, the lowest operating costs were obtained using the current density of 2.88 mA/cm2 with initial pH of 4 since it requires low energy use. When real wastewater effluent was used, the EC process removed 96.5% of MPs, 92.2% of COD, and 88.8% of fecal coliform colonies using the best conditions found for synthetic wastewater. In conclusion, the applicability of EC process proves to efficiently remove MPs from the effluent at municipal WWTPs, reducing the impacts of theses discharges in the receiving natural waters, and consequently fewer negative impacts on the ecosystem and public health.

Treatment with Ferrate via Oxidation and Coagulation Mechanisms

Project Type: Annual Base Grant **Project ID:** 2018RI135B

Project Impact: The increase in the occurrence of harmful algal blooms (HABs) has negatively impacted many surface water utilities across Rhode Island. To control these HABs, many companies implement pre-oxidation treatments. However, pre-oxidation has both positive and negative water quality outcomes. This study investigated ferrate (Fe(VI)) as an alternative to other oxidants by measuring its effect on cell lysing, coagulation, and oxidation in waters containing the cyanobacteria Microcystis aeruginosa. Bench scale studies were conducted to examine the complex combination of processes in a Fe(VI)-algae system. These processes were characterized by fluorescence index, surface charge, coagulation efficiency tests, and particle counts. Results showed that Fe(VI) lysed algal cells, but further oxidation of released organic matter is possible. Additionally, coagulation is likely not occurring to a great extent, even though particle size increases. In general, the results indicated that Fe(VI) may be a viable alternative to other strong oxidants for water utilities struggling with HABs, but the final fate of the resulting organic matter must be further studied.