MONTANA STATE UNIVERSITY
NORM ASBJORNSON College of ENGINEERING

PhD Defense in Civil Engineering

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"Assessing a novel approach to pharmaceutical removal from wastewater: Aerobic granular sludge"

11:00 a.m. Wednesday, April 17
Roberts 321 or via WEBEX
Montana State University

Abstract: Pharmaceutical concentrations in various environmental matrices are increasing across the globe. Effluent discharge from wastewater treatment plants is a major vector by which pharmaceuticals enter the environment, as many of these compounds are not biodegradable under conventional wastewater treatment conditions. Although concentrations are currently low (ng/L to µg/L levels), pharmaceutical contamination poses risks to both human and animal health, as many pharmaceuticals can have toxic effects on fish, birds, and small mammals, as well as contribute to the proliferation of antibiotic resistance genes in bacteria.

Aerobic granular sludge (AGS), an emerging biofilm-based wastewater treatment biotechnology and the subject of this dissertation, may be capable of enhancing pharmaceutical removal from wastewater. Scientific literature indicates that AGS uses a mixture of both biodegradation and adsorption to remove pharmaceuticals, but thus far, studies on this topic are limited. The research detailed herein investigated how AGS was affected by a mixture of three common, but relatively unstudied, pharmaceuticals: diclofenac (anti-inflammatory), erythromycin (antibiotic), and gemfibrozil (lipid regulator).

Studies described herein examined how AGS grown in two different environments—the lab versus a full-scale wastewater treatment plant—responded to pharmaceuticals. Pharmaceutical effects on wastewater treatment efficacy, active microbial populations, and biofilm structures were investigated. Pharmaceutical fates in both the aqueous and solid phases were also tracked.

In general, lab-grown AGS was more negatively impacted by pharmaceutical exposure, evidenced by reduced wastewater treatment efficacy, declines in key wastewater-treating microbial populations, and reductions in biofilm lipid content. Pharmaceuticals were also poorly removed by lab-grown granules. In contrast, key microbial populations and biofilm structures remained stable throughout dosing in environmentally-grown AGS, and gemfibrozil was completely biodegraded. An important caveat to comparison of the two studies, however, is that the pharmaceutical dose to lab-grown AGS was approximately double that to environmental granules.

Altogether, the research described herein demonstrates the promise of AGS as a dual wastewater and pharmaceutical treatment technology, but illustrates the importance of conducting experiments under conditions as environmentally relevant as possible.

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