CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S1120

Project Title

The Effect of Nano-scale Zinc Oxide on the Filtration Rate of Membrane Biological Reactors in Wastewater Treatment

Abstract

Objectives/Goals

The objective of this project was to prove that a correlation exists between the presence of manufactured nanoparticles in wastewater influent and membrane fouling in Membrane Biological Reactors (MBRs).

Methods/Materials

Polypropylene membranes with a nominal pore size of 200 nm were used for all runs. Three types of manufactured zinc oxide particles (termed ZnO-A, ZnO-B, and ZnO-C) were used in the experiment. Deionized water, tap water, and secondary effluent wastewater were filtered at a pressure of 12.5 in/Hg with nanoparticle concentrations of 2 mg/L. MBR effluent was weighed in grams every 3/7 second by a computer, and a zetasizer was used to analyze particle size distributions.

Results

There was no significant change in the flux of deionized water or secondary effluent wastewater with the addition of zinc oxide nanoparticles. When added to tap water, ZnO-A and ZnO-C both resulted in flux that was 20% below that of tap water. The addition of ZnO-B resulted in the mitigation of some of the fouling effects of tap water and at some points, flux was 20% above that of tap water.

Conclusions/Discussion

My hypothesis was proven to be mostly incorrect. Although I was correct in inferring that ZnO-A's relatively small particle size would clog the membrane, resulting in a flux decrease, I incorrectly concluded that ZnO-B and ZnO-C would both consistently result in flux decreases. ZnO-C yielded inconsistent results, with a tendency to reduce flux in tap water. ZnO-B, however, reduced fouling. This result, in conjunction with zetasizer analyses showing that smaller ZnO-B particles remained behind after filtration, may indicate that, while ZnO-B particles were small enough passing through membrane pores, they aggregated with other particles in doing so, reducing the number of particles capable of fouling the membrane. These data show that MBR yields in wastewater treatment might be significantly improved through the utilization of pretreatment to remove manufactured nanoparticles in wastewater influent prior to filtration.

Summary Statement

This project is about the effect of manufactured nanoparticles on microfiltration membranes in wastewater treatment.

Help Received

Used lab equipment at Professor Diego Rosso's Environmental Process Laboratory at the University of California, Irvine under the supervision of Joshua Smeraldi