WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2003MA8B

Title: Copper Removal by Biofilms

Project Type: Research

Focus Categories: Treatment, Waste Water, Water Quality

Keywords: biofilms, extracellular polymeric substances, copper

Start Date: 03/01/2003

End Date: 02/28/2005

Federal Funds: $25,155

Non-Federal Matching Funds: $31,562

Congressional District: 5th

Principal Investigator:
Xiaoqi (Jackie) Zhang

Abstract

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Statement of Critical Water Problem
Heavy metal contamination is of growing concern nationwide because of the numerous health risks to animals and humans (Costley and Wallis, 2001). Among the five pollutants of primary concern to MWRA's Toxic Reduction and Control division in Massachusetts, three are heavy metals (i.e. Hg, Cu, and Pb, http://www.mwra.state.ma.us/sewer/html/regs2.htm). Some of the heavy metal contamination comes from agriculture and sewage disposal, although most comes from industrial sources, including electroplating plants, mining, nuclear and electronics industries, metal finishing operations, tanneries, and industrial processes utilizing metals as catalysts (Costly and Wallis, 2001). Since most of the heavy metal laden effluent will ultimately reach sewerage systems via direct discharge or urban runoff, it is important to remove heavy metals during wastewater treatment processes to reduce the potential harmful effects to ecosystems and public health. In Massachusetts, The Clean Water Act requires that businesses and industries that discharge into the sewerage treatment plants be regulated through an industrial pretreatment program and the discharge limit is set by the local wastewater treatment plant (WWTP). For copper, the state average local limit is

2.187mg/l (with the maximum being 27.6mg/l). This program has greatly reduced the burden of local sewerage treatment plants that usually do not have the capability of handling high concentration industrial pollutants. Wastewater treated by municipal/industrial wastewater treatment plants is usually discharged into local surface water. Although many municipal/industrial wastewater treatment plants can meet the discharge limit set by DEP/EPA, some still have difficulty in meeting the copper discharge limit, such as the Wastewater Treatment Plant in Clinton. There is a critical need for an effective treatment technology to remove copper during the wastewater treatment process to meet the ever more stringent discharge limit (6.2 mg/l for copper discharge to Nashua River).

Dr. Zhang proposes to use biofilm systems to remove copper. Biofilm systems offer significant advantages over suspended systems; however, their potential in heavy metal removal has yet to be discovered. The project would train one graduate student and one undergraduate student with a potential of impacting 15 graduates and 30 undergraduates. The success of this proposal will help Dr. Zhang conduct long-term research: understanding the mechanisms and functions of biofilms in biological water and wastewater treatment.

Statement of Expected Results or Benefits

The project will evaluate a biofilm system in treating copper containing wastewater, and develop a fundamental understanding of cellular response to copper contamination and the effects of substrate concentration on cellular response and copper removal. Knowledge gained form this research can be used to improve the performance of fixed film systems and enhance the efficiency of copper removal. This research will contribute to developing an effective treatment technology to remove copper and other heavy metals of primary concern during the wastewater treatment processes. Results can also be used to develop a more effective remediation technology to remove heavy metals from Superfund sites. With experimental results, efforts will be made to contact local wastewater treatment plants to set up a pilot scale study. Full-scale operation is the final goal of this project.