Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

Evaluation of Microbial Fuel Cells for Potential Implementation at Blue Plains Advanced Wastewater Treatment Plant

Wing-Mei Ko (wingmei.ko@gmail.com) (University of Maryland, College Park, MD, USA),
Mark Ramirez (DC Water, Washington, DC, USA)
Birthe Kjellerup (University of Maryland, College Park, MD, USA)

Background/Objectives. Wastewater treatment is an energy-intense process. The Blue Plains Advanced Wastewater Treatment Plant (Blue Plains) requires an average of 20 MW of energy to treat 384 million gallons of wastewater each day. Several projects have been implemented to reduce energy costs and carbon footprint, such as a thermophilic hydrolysis process that subjects the wastewater to high temperature and high pressure to enhance methane production during anaerobic digestion. Blue Plains is also evaluating implementation of Microbial Fuel Cells (MFC) to reduce the oxygen demand during treatment, while recovering energy, as the influent to the plant contains at minimum an estimated 13-14 kJ of caloric energy. MFCs have been found to convert chemical energy in the organic matter to electric energy as a result of exoelectrogenic microbial processes, but more research is needed for the scale-up of an MFC for Blue Plains. The objective of this study is to determine the optimal location for energy recovery and COD removal at Blue Plains for the implementation of an MFC and to evaluate if exoelectrogenic bacteria required for MFC operation are naturally present in at Blue Plains.

Approach/Activities. Samples were collected from the Blue Plains site for laboratory-scale experiments. Four locations in the wastewater treatment plant were tested based on prior experiments demonstrating differences among their levels of oxygen demand and amounts of solids: anaerobic digesters (digestate), belt press filters (filtrate), gravity thickened/dissolved air flotation dewatering process (centrate), and the effluent from primary clarifiers (primary effluent). Experiments were conducted with four single-chamber batch reactors to observe electric potential over time as well as initial and final oxygen demand and solids. Chemical oxygen demand (COD) tests were run to measure the oxygen required to oxidize all organic matter in the water. biochemical oxygen demand (BOD) tests were run to measure the amount of oxygen that microorganisms use to break down the organic material. Total suspended solids (TSS) was another parameter tested to examine the quality of the water. DNA extraction and sequencing was also performed to examine the composition of the bacterial community in the wastewater as well as the biofilms on the anodes of the MFCs.

Results/Lessons Learned. The results show that the samples consisting of filtrate and digestate are most effective for energy recovery. Centrate and Primary Effluent had low levels of electric potential, and thus are not ideal for MFC treatment for energy recovery. Treating digestate and Filtrate for 44 days in the laboratory-scale batch reactors resulted in 93.88% and 97.82% COD removal, respectively. BOD removal levels for digestate and filtrate were 80.02% and 75.36%, respectively. There was an increase in TSS in filtrate and centrate, which may be due to microbial growth and an increase in biomass within these samples. DNA was extracted from each of the wastewater samples before and after MFC treatment together with biofilms from the anodes. DNA sequencing results revealed that multiple groups of bacteria were present in the wastewater that form biofilms on the anodes of the MFC. The results show a high potential for energy recovery using MFCs and that the required exoelectrogenic bacteria are present in the system thus providing the basis for the microbial populations at the anodes.