QUARTERLY PROGRESS REPORT

March 1, 2010 to May 31, 2010

PROJECT TITLE: Usage of Microbial Fuel Cell Technology to Prevent Iron Release nearby Landfills in Northwest Florida

PRINCIPAL INVESTIGATOR(S): Gang Chen, Amy Chan Hilton and Kamal Tawfiq

AFFILIATION: Department of Civil and Environmental Engineering, FAMU-FSU College of Engineering

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PHONE NUMBER: 850-4106303

PROJECT WEBSITE ADDRESS (URL): www.eng.fsu.edu/~gchen

EMAIL ADDRESS: gchen@eng.fsu.edu; abchan@eng.fsu.edu; tawfiq@eng.fsu.edu

WORK ACCOMPLISHED DURING THIS REPORTING PERIOD:

Impact of pH on Power Generation

Using the two dual-chamber MFC setups (one batch MFC and one continuous MFC), we tested the impact of pH on power generation from landfill leachate collected from Leon County. For these processes, O_2 served as the electron acceptor in the cathode chamber, and the anodes and cathodes were connected through a digital multi-meter.

Impact of pH on power generation is illustrated in Figure 1 and Figure 2. High pH (i.e., pH 8) generated more power as compared to low pH (i.e., pH 6) for both batch MFC (Figure 1) and continuous MFC (Figure 2). It should be noted that the pH control was achieved at the anode chamber where organic compounds (glucose or landfill leachate) were decomposed. According to the following equation, raising the pH should favor electron release:

$$C_{12}H_{22}O_{11} + 13H_2O \rightarrow 12CO_2 + 48H^+ + 48e^-$$

However, when free electrons are picked up by oxygen in the cathode chamber, lowering the pH should favor the reaction:

$$1/4O_2 + H^+ + e^- \rightarrow 1/2H_2O$$

Since the cathode chamber is totally separated from the anode chamber, for above experiments, we only examined pH variations at the anode chamber. In addition, we only focused on typical pH ranges of the soils nearby landfill, i.e., pH 6 to pH 8. We will investigate the power generation under acidic and basic conditions in the next quarter of this project. In addition, we will also examine the impact of pH variations in the cathode chamber on power generation.

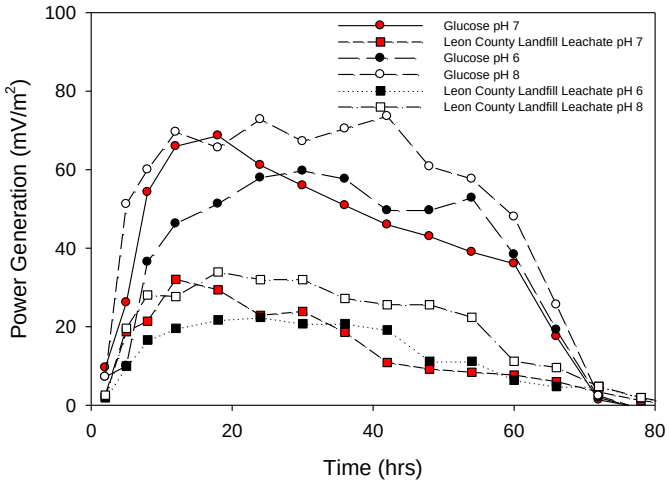

Figure 1. Impact of pH on Power Generation from Batch MFC

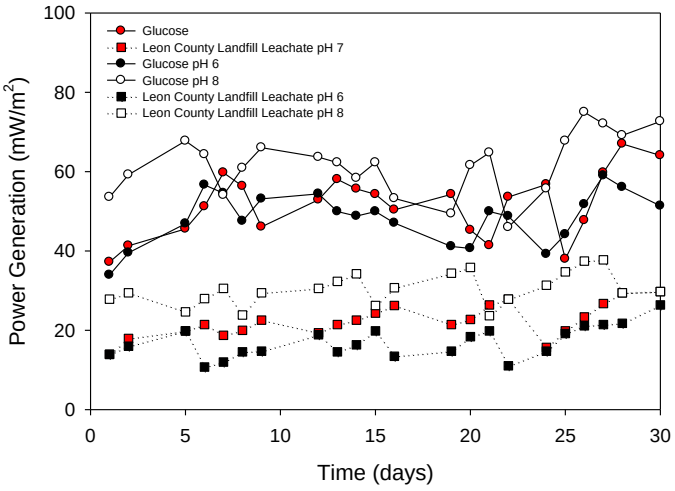

Figure 2. Impact of pH on Power Generation from Continuous MFC

Applications of MCF Technology in Preventing Iron Release nearby Landfills

As a control, landfill leachate collected from Santa Rosa County landfill was sprayed to the soil samples collected from Santa Rosa County Landfill (Figure 3). After 5 days, iron started to be released from the soil. Within two weeks, iron can be released as high as 150 mg/l (Figure 4). In a parallel setup, MCF technology was applied. Specifically, a Nafion membrane was used to create an anode region where landfill leachate was applied. Outside this region, a cathode region was created with wires connected to an oxygen source (armed Erlenmeyer flask in Figure 3). Within the anode region, *Shewanella putrefaciens* was inoculated. As evidenced by Figure 4, much less iron was released when MFC technology was applied. This part of research will continue to investigate the impact of pH variations in both the anode region and cathode region on iron release protection. In addition, landfill leachate and soil samples collected from other landfills will also be tested.

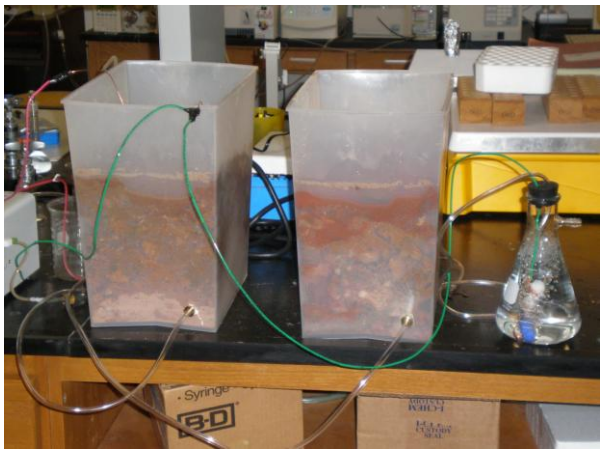

Figure 3. Iron Release Prevention Experimental Setup

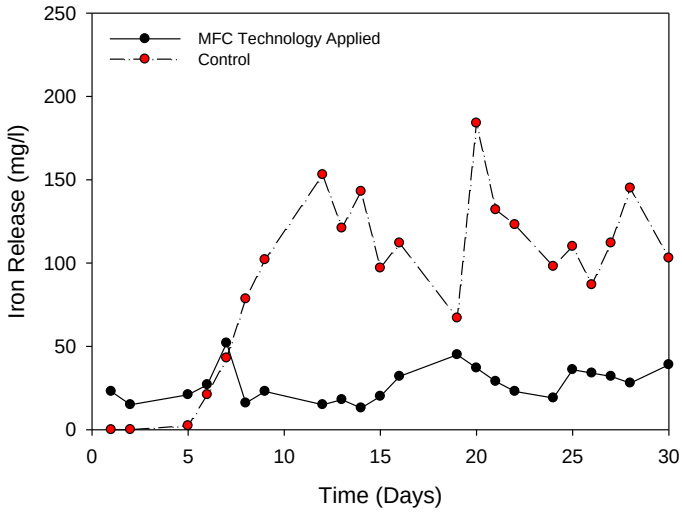

Figure 4. Iron Release Prevention Experimental Results

FUTURE WORK

Power generation under acidic and basic conditions will be investigated. In addition, pH variations in the cathode chamber on power generation will also be examined. For iron release protection, the impact of pH variations will be evaluated. Landfill leachate and soil samples collected from other landfills will also be tested.

INFORMATION DISSEMINATION ACTIVITIES:

TAG members: Lee Martin, Peter Grasel, Casey Taylor, Jim Langenbach, Subramanian Ramakrishnan, Michael Watts, and Clayton Clark

TAG meetings: First TAG meeting was held on August 20, 2009 in RM B202 at FAMU-FSU College of Engineering. The meeting minute is available at www.eng.fsu.edu/~gchen.

TAG meetings: Second TAG meeting will be held in late June at FAMU-FSU College of Engineering.

CONFERENCE PRESENTATION:

Subramaniam, P. K. and Chen, G., Usage of microbial fuel cell technology to prevent iron release nearby landfills in Northwest Florida, 95th Annual SAM Southeastern Branch Conference, Savannah, GA, November 6 - 7, 2009.

JOURNAL PUBLICATION:

Subramaniam, P. K. and Chen, G., Microbial fuel cell technology in landfill applications, Bioresource Technology, to be submitted.