

QUARTERLY PROGRESS REPORT

November 1, 2013 to January 31, 2014

PROJECT TITLE: Aerated Recirculation and Pressurized Suspended Fiber Biofiltration for the Treatment of Landfill Leachate

PRINCIPAL INVESTIGATOR(S): Gang Chen and Kamal Tawfiq

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

COMPLETION DATE: November 1, 2013 to January 31, 2014

PHONE NUMBER: 850-4106303

PROJECT WEBSITE ADDRESS (URL):

<http://www.eng.fsu.edu/~gchen>

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

In this research, leachate from landfills in Northwest Florida will be treated by aerated recirculation, MAP precipitation, ultra-high lime with aluminum process, and suspended fiber biofiltration. The suspended fiber biofilter will be designed and operated under pressurized aeration to achieve biological contact oxidation, which can remove organic compounds and iron more efficiently. The pressurized suspended fiber biofiltration, a cost- and space-saving technology, combined with aerated leachate recirculation, MAP precipitation, and ultra-high lime with aluminum process, will provide a new alternative means for the treatment of landfill leachate with high organic, ammonium, chloride and iron contents. The specific objectives of this research project include:

- Aerated Leachate Recirculation. A laboratory scale experiment apparatus will be set up to simulate aerated landfill leachate recirculation. Organic compound decomposition and heavy metal removal will be investigated and recirculation ratio and aeration level will be tested.
- MAP Precipitation and the Ultra-High Lime with Aluminum Process. A precipitation reaction tank and a sedimentation tank will be arranged in between aerated leachate recirculation and pressurized suspended fiber biofiltration. Ammonium and chloride removal will be examined by means of MAP precipitation and ultra-high lime with aluminum process.
- Pressurized Suspended Fiber Biofiltration. A custom-made pressurized suspended fiber biofilter will be set up and tested for organic and iron removal by biological contact oxidation. Factors that may impact this process such as pH and alkalinity will be explored for this part of research.
- System Optimization and Cost Analysis. The best operation parameters will be identified for aerated leachate recirculation, MAP precipitation, ultra-high lime with aluminum process, and pressurized suspended fiber biofiltration. Cost and space saving will be

analyzed and compared with that of conventional treatment processes and reported in this research.

WORK ACCOMPLISHED DURING THIS REPORTING PERIOD:

Experimental Setup and Test Running

The experimental setup is illustrated in Figure 1. After aeration, landfill leachate collected from the Leon County Landfill will be pumped to the bioreactor from the storage reservoir. Leachate aeration will be achieved in the storage reservoir with air supply controlled by a mass-flow controller (with targeted dissolved oxygen levels of 2 mg/l to 6 mg/l). Considering the possible organic leaching from the solid waste in the bioreactor, the leachate may be recirculated for a couple of months until obvious decrease of organic contents can be observed. Then, an aliquot will be introduced to the next treatment step and the other aliquot will be aerated and recirculated. For this part of the research, dissolved oxygen (DO), pH, oxidation/reduction potential (ORP), BOD₅, and ammonium, nitrate and iron concentrations will be monitored for the leachate before recirculated into the bioreactor and after getting out of the bioreactor.

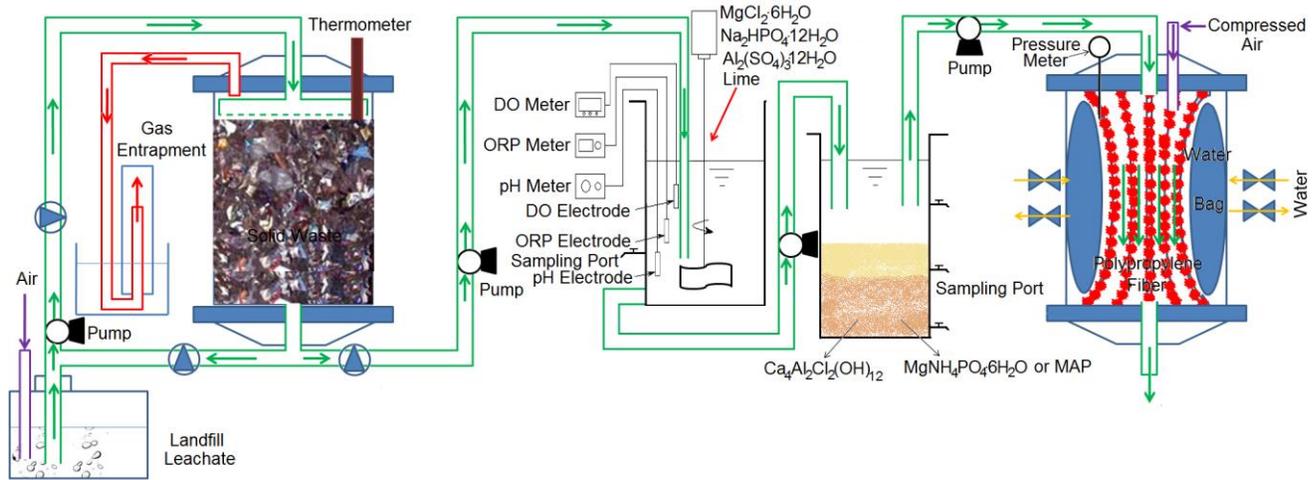


Figure 1. Experimental Setup

The precipitation reaction tank is equipped with pH, DO and ORP probes and is continuously stirred by a single mechanical blade. Magnesium and phosphate will be added as $MgCl_2 \cdot 6H_2O$ and $Na_2HPO_4 \cdot 12H_2O$ and pH will be adjusted with lime. For chloride removal in the form of calcium chloroaluminate [$Ca_4Al_2Cl_2(OH)_{12}$], $Al_2(SO_4)_3 \cdot 12H_2O$ will be added. For chloride removal research purposes, if the chloride content of the leachate sample collected from Leon County Landfill is less than 600 mg/l, leachate collected from Quincy-Byrd Landfill (Gadsden County), Baker Landfill (Okaloosa County), Santa Rosa Central Landfill (Santa Rosa County), and Santa Rosa Holley Landfill (Santa Rosa County) will be tested and used in this research.

The custom-made pressurized suspended fiber biofilter will have a volume of 35 L with a height to diameter ratio of 1:1.66 (height = 50 cm and diameter = 30 cm). In the pressurized suspended fiber biofilter, polypropylene fibers will be arranged to be suspended in the column. Two water rubber bags will be arranged on two side of the column, each with a capacity of 8 L. During the operation, the water bags will first be filled with water and compressed air will be supplied to the

biofilter, which can be controlled by a mass-flow controller. A DO probe will be installed to monitor oxygen concentration in the biofilter. With the ongoing of the biofiltration and building up of the pressure, water will be withdrawn decrementally from the water bags to release the pore space and reduce the pressure. Organic decomposition and iron oxidizing will be monitored in the biofilter.

Currently, the recirculation reactor and the fiber reactor are circulated with leachate collected from Leon County Landfill to stimulate the microbial growth on the fiber (Figure 2). We monitored the organic decomposition and iron removal during the recirculation and have observed both organic and iron removal from above processes (Figure 3).



Figure 2. Recirculation Reactor and Fiber Reactor

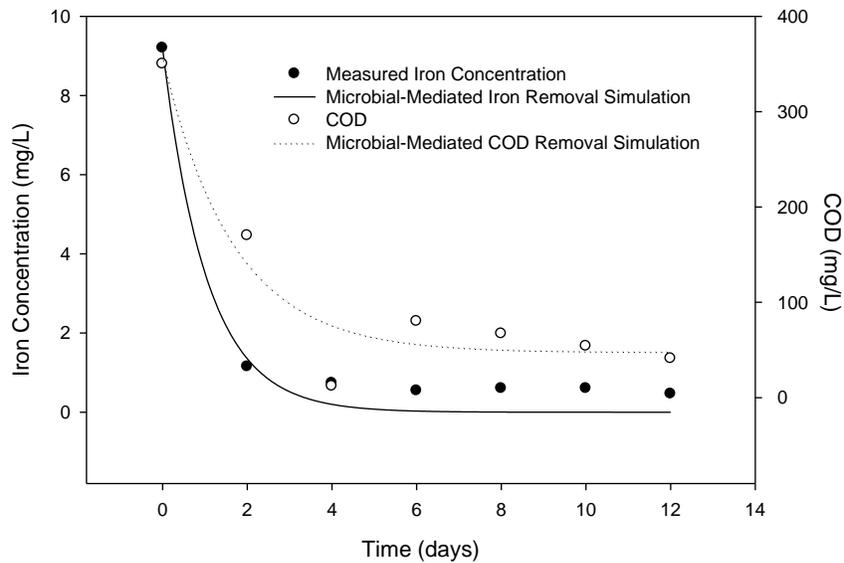


Figure 3. COD and Iron Removal by Recirculation and Fiber Filtration

INFORMATION DISSEMINATION ACTIVITIES:

TAG members: Peter Grasel, Lee Martin, John Hallas, Brian Lee Moody, Tarek Abichou and Hafiz Ahmad

TAG meetings: First TAG meeting was held on January 24, 2014 at FAMU-FSU College of Engineering. The meeting minute will be available at www.eng.fsu.edu/~gchen.

A website has been created for this project (URL): www.eng.fsu.edu/~gchen (Biofilter)