FAMU – FSU COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
2525 Pottsdamer Street
Tallahassee, Florida

Tag Meeting No. 2

Friday, April 8, 2016
12:30 am – 1:30 pm, Room Building A 127A

Project Title: Suspended Fiber Biofiltration for the Treatment of Landfill Leachate. Year II. Incorporation of Advanced Oxidation and Phosphorous Removal in a Single Unit
Tag Members: Peter Grasel, Owete Owete, John Hallas, Chen Lin, Hafiz Ahmad, Matthew Hendrix and Youneng Tang
Principle Investigators: Gang Chen and Kamal Tawfiq
In Attendance: Peter Grasel, Owete Owete, Chen Lin, Tim Vinson, Youneng Tang, Houzhen Wei, Boya Wang, Gang Chen, and Zhiming Zhang. Hafiz Ahmad and John Schert attended the meeting through Gotomeeting.

A website has been developed for this research (www.eng.fsu.edu/~gchen). All the information regarding this project has been uploaded to this site to facilitate the dissemination of the research discovery.

Agenda

1. Project Overview

Detailed information is available at http://www.eng.fsu.edu/~gchen

2. Reactor Design and Parameter Characterization

1. Experimental Design and Setup

The treatment system that integrates advanced oxidation with fiber biofiltration has been set up (Figure 1). Besides organic decomposition, this system is also designed to destruct xenobiotics and remove iron and phosphorus from the landfill leachate.

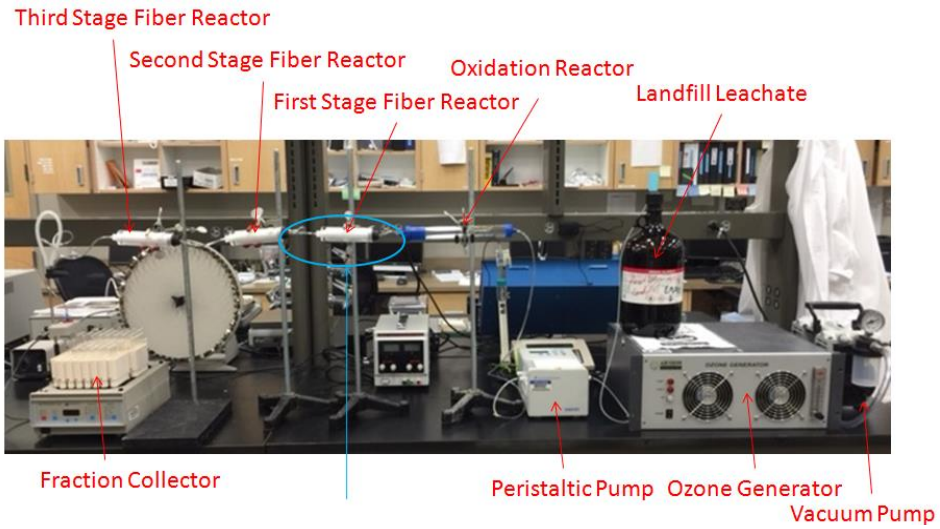

Figure 1. Experimental Setup

3. Reactor Operation

Hydrogen peroxide was first tested for this reporting period. Landfill leachate collected from Springhill Landfill was first reacted with hydrogen peroxide at different H_2O_2/COD mole ratios. NH_4^+ concentration was observed to increase with the increased H_2O_2 concentration owing to increased NH_4^+ release by the reaction of H_2O_2 with organic nitrogen. Hydrogen peroxide was further tested for COD removal. Landfill leachate collected from Springhill Landfill was reacted with hydrogen peroxide at different H_2O_2/COD mole ratios at pH 7.4 and 9.6. COD removal was found to increase with the increased H_2O_2 concentration for both pH levels. UV radiation in the range of 10 to 100 mJ/cm^2 (by varying the exposure time from 0 to 15 min) was also tested for Springhill Landfill leachate at pH 4.0, 7.4 and 9.6. The results demonstrated UV radiation had better COD removal effects at high and low pH values. However, the removal efficiency was low for all the tested pH levels. When H_2O_2 and UV radiation were combined, high COD removal efficiency was observed at low H_2O_2 dosage (H_2O_2: COD = 0.25:1), especially at low and high pH values. At low and high pH and H_2O_2 dosage of H_2O_2: COD = 0.25:1, COD removal increased with the increase of UV radiation, reaching 96% for pH 4.0 and 90% for pH 9.6. At pH of 7.4, around 75% of COD can be removed and variation of UV radiation showed minimal effect.

After advanced oxidation, big molecular organic compounds tended to be broken into simple and small molecules. Under conditions when there was no carbon or nitrogen limitation, different carbon sources (same nitrogen source) yielded different cell growth. The easiness of the carbon sources used in this research followed the following order: glucose, lactate and propionate. Based on the theoretical calculation, the stoichiometric yield was also different for three carbon sources.

4. Phosphorous Removal Consideration

Phosphorous was removed mainly in the first fiber reactor. After advanced oxidation, the fiber was coated with iron hydroxides by contact oxidation, which removed phosphorous by adsorption. It was a low pH is preferred for phosphorous adsorption in iron oxide-coated fiber. This process was also affected by alkalinity. Alkalinity of 100, 200, 300, 400, 500 and 600 mg/L as $CaCO_3$ (adjusted with lime) and pH of 5, 6, 7, 8, 9 and 10 (adjusted with hydrochloric acid or sodium hydroxide) were tested for iron coating and the subsequent phosphorous removal.

5. Xenobiotic Removal

To be investigated.

6. Dissemination Plan for this Project

7. Potential Funding Sources for the Continuation of Related Research

— NSF/CBET/Environmental Engineering
— EREF

8. Discussion

1. Relationship of loading rate and dissolved oxygen on iron and organic removal. The TAG members pointed out the inverse relationship of loading rate and dissolved oxygen level on iron and organic removal.

2. TAG members pointed that ozone concentration higher than 3 mg/L led to decreased COD removal. One possible explanation is that the leachate contained high levels of oxidizable inorganic materials which might interfere with the determination of COD such as chloride with a reaction with potassium dichromate following the equation:

$$6Cl^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 3Cl_2 + 2Cr^{3+} + 7H_2O$$

We will further test to see whether this is the reason. In addition, BOD instead of COD will be used. As suggested by the TAG members, synthetic leachate will also be used to quantify the ozonation and other oxidation processes.

3. It is recommended that synthetic leachate be used to study the mechanisms of ozone oxidation. Specific compounds will be used instead of COD to quantify the effect of ozone oxidation and destruction.

4. It is recommended leachate be collected from the discharge pipe instead of the pond. The leachate from the discharge pipe should contain more suspended solid and more accurately symbolize the leachate quality.

5. The solid waste managers think it is too complicated to operate the onsite treatment. Leachate is usually transported to the wastewater treatment plants for further treatment and is charged based on the leachate quantity. Since it is very difficult for onsite treatment to meet the direct discharge criteria, the landfill managers tend to like the idea of paying reduced charge for partially treated leachate that can be further treated in the wastewater treatment plants after onsite treatment processes that can be easily operated.

6. For some landfills, extended aeriation to blow off ammonia and oxidize ammonium to nitrate has been practiced as well as phytoremediation for nitrogen removal. In order to prevent percolation and groundwater contamination, sensors have been installed to detect nitrate in the subsurface soil. These operations also depend on the soil hydraulic conductivity and possible denitrification in the subsurface is also possible.

7. Landfill managers have concerns that leachate will not be accepted in wastewater treatments. Cost-effective onsite treatment process is therefore drawing more and more attention.