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

Tag Meeting No. 1

Friday, January 16, 2015
11:30 am – 1:30 pm, Room Building A 127A

Minutes

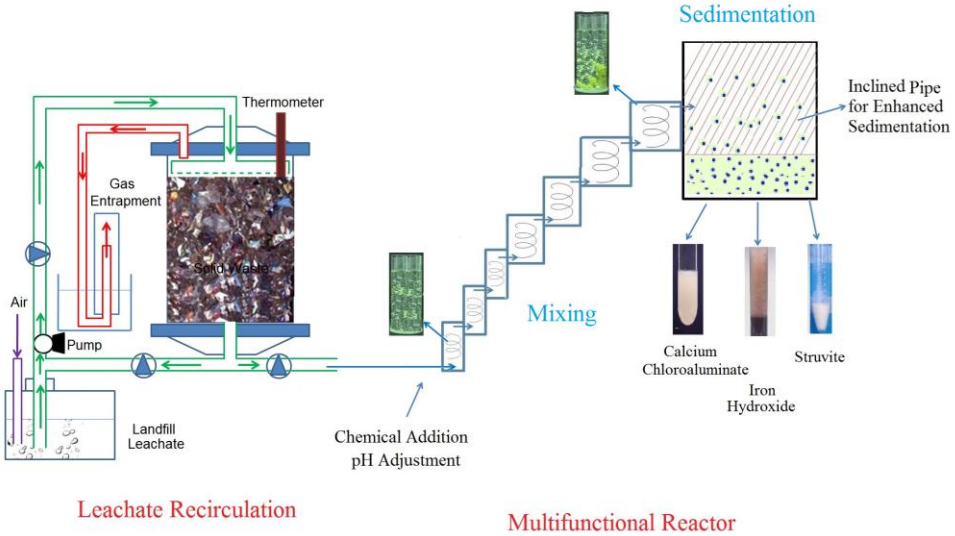
Project Title: Design and Testing of a Multifunctional Energy and Space-Saving Reactor for the Treatment of Landfill Leachate
Tag Members: Peter Grasel, Gary Millington, John Hallas, Chen Lin and Hafiz Ahmad
Principle Investigators: Gang Chen and Kamal Tawfiq
In Attendance: Peter Grasel, Gary Millington, John Hallas, Chen Lin, Cory D. Dilmore (on behalf of Richard Tedder), Tim Vinson, Kien Vu, Boya Wang, Gang Chen and Hafiz Ahmad (through Gotomeeting)
Principle Investigators: Gang Chen and Kamal Tawfiq

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. Experimental Setup



3. Aerated Leachate Recirculation Investigation

Through aerated leachate recirculation, organic contents can be significantly reduced. During this process, solid components can be significantly reduced. The leachate recirculation not only improves the leachate quality, but also shortens the time required for landfill stabilization. For this research, aerated recirculation reactor will be set up with a dimension of 15 cm ID × 150 cm Length (Right Image). The solid waste collected from the Leon County Landfill will be ground and sieved before introduced into the laboratory reactors. Landfill leachate collected from the Leon County Landfill will first be treated through aerated recirculation for organic removal. Specifically, after aeration, landfill leachate will be pumped to the bioreactor from the storage reservoir using a peristaltic pump at a flow rate of 100 ml/min. Leachate aeration will be achieved in the storage reservoir with air supply at flow rates of 0.2 l/min, 0.5 l/min, 1 l/min and 5 l/min for 15 min 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. The same amount of fresh leachate equivalent to that introduced to the next treatment step will be added to maintain the same liquid volume of the recirculation bioreactor. Recirculation ratio of 80%, 75%, 50%, 25% and 0% will be tested in this research. For this part of the research, dissolved oxygen (DO), pH, oxidation/reduction potential (ORP), BOD_5, and ammonium, nitrate, chloride, phosphorous and iron concentrations will be monitored for the leachate before recirculated into the bioreactor and after getting out of the bioreactor.

4. Multifunctional Reactor Design, Setup and Parameter Characterization

For chloride, iron, phosphorous removal and struvite recovery through precipitation, chemical addition is required. After chemical addition, mixing is the most important process to facilitate a quick reaction. During this process, a more homogenous mixing is desired. Well-mixing operations tend to decrease the chemical demand for an efficient chloride, iron and phosphorous removal as well as struvite recovery. For the multifunctional reactor, a series of continuous-mixing tube reactors will be utilized (Figure 9). The design of the multifunctional reactor will fully utilize the energy that transports the fluid into the reactor. As shown in Figure 9 (Reactor Plan View), 7 tube-reactors will be arranged in series surrounding the sedimentation tank. To fully utilize the imparted energy, the 7 tube-reactors will be arranged in variable elevations with the first tube-reactor at the lowest elevation and last one at the highest elevation (Figure 9, Reactor Profile View). During operation, the aliquot of treated landfill leachate from aerated recirculation will be applied with a rate 600 ml/min to the multifunctional reactor. The leachate will be introduced to the bottom of the first tube-reactor at the lowest elevation. Flow will leave the first tube-reactor from the top and then enter the second reactor at the bottom and so on. Therefore, flow in the tube-reactors will spiral upwards, creating the maximum mixing for the

chemical reactions. The length of the tube-reactors will be kept the same, i.e., 10 cm. However, the diameters of the tube-reactors will increase incrementally, i.e., the first three reactors will have a diameter of 5 cm, the fourth and fifth ones of 8 cm, and the sixed and seventh of 10 cm. Different chemicals will be added before leachate is introduced to the multifunction reactor. The chemical type and dosage will be discussed below for different removal functions.

5. Dissemination Plan for this Project

This research will be presented at 2015 South Carolina Environmental Conference that will be held between 3/14/2015 to 3/17/2015.

6. Potential Funding Sources for the Continuation of Related Research

— NSF/CBET/Environmental Engineering
— EREF

7. Discussion

Following are the issues raised in this TAG meeting:

a. Energy requirements for the flow to enter the multi-functional reactors and subsequent sedimentation reactor
   The current design is to fully utilize the energy that is used to transport the flow to the multi-functional reactors. Therefore, the leachate will be pumped to the reactors. Based on Chen's comments, energy may be imparted if the mixing energy is not sufficient within the system.

b. The choice between inclined plane vs. inclined pipe
   Gary discussed the differences between inclined plane and inclined pipe that will be used in the sedimentation tank. Inclined pipe may have the advantage of avoiding interference with particle settling by possible lateral flow.

c. Leachate recirculation and the content of solid waste in the recirculation reactor
   Ammonia evaporation during leachate recirculation will be considered based on Chen's suggestion.
   Chlorinated organic compound removal consideration will be included in the research.
   The recirculation reactor will be packed with inoculated silica sand first to avoid the complex situation of contaminant release from the solid waste as suggested by Chen and Tim before the introduction of municipal solid waste.

d. Coagulant selection
   As suggested by Gary, aluminum and iron coagulants will be tested and the efficient and cost-saving ones will be selected for further investigation.

e. Competition between different contaminants
   As suggested by John, contaminant removal will be studied first in batch reactors to evaluate their competitions to provide guidelines for the continuous flow tests.