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

Tag Meeting No. 2

Friday, October 16, 2015
12:30 am – 2:00 pm, Room Building A 127A

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, Hafiz Ahmad and Matthew Hendrix
Principle Investigators: Gang Chen and Kamal Tawfiq
In Attendance: John Hallas, Chen Lin, Matthew Hendrix, Tim Vinson, Youneng Tang, Houzhen Wei, Boya Wang, Gang Chen and Hafiz Ahmad (through Gotomeeting)

This TAG meeting presentation has been presented at Leon County Landfill on Sep. 17, 2015 and Springhill Regional Landfill on Oct. 5, 2015. Leon County Solid Waste Management Director Robert Mills, Solid Waste Superintendent Shawn Abbott as well as two other staff members attended the Leon County Landfill presentation. David Steiner, District Manager of Waste Management Springhill, Brian Dolihite, Market Area Engineer of Waste Management, Inc., Michele Lersch, Environmental Protection Manager of Waste Management, Inc. and two more staff members attended the Springhill Regional Landfill presentation. Comments and questions from these two presentations are included in the discussion section.

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.

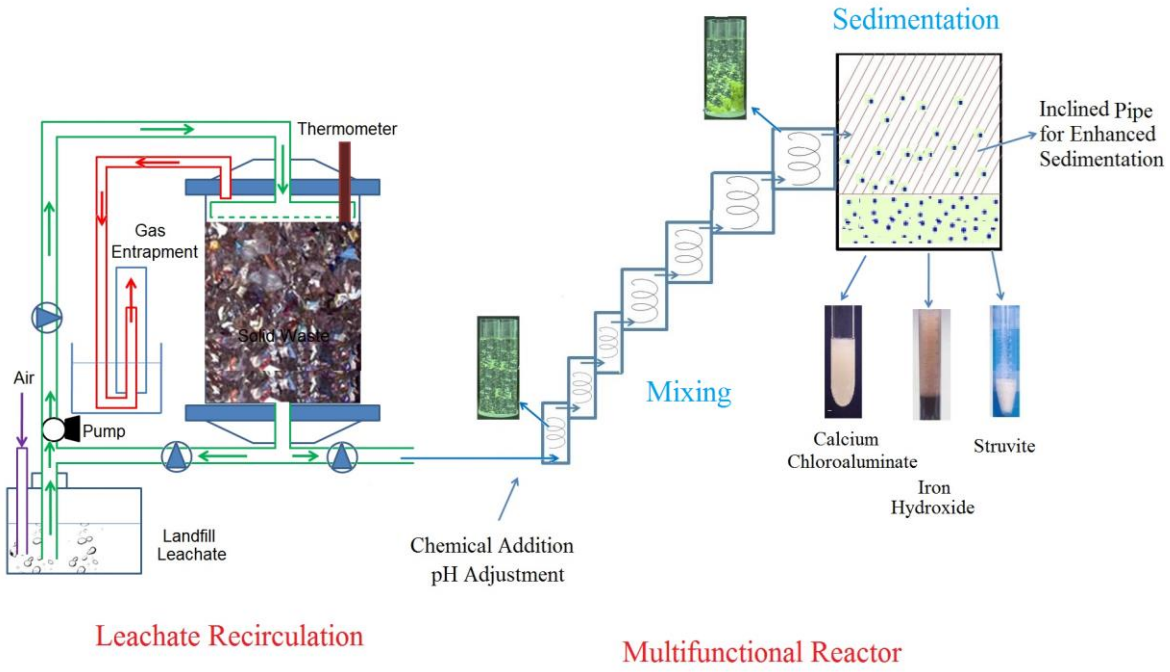
Agenda

1. Project Overview

A website has been developed for this project. Detailed information is available at http://www.eng.fsu.edu/~gchen.

2. Experimental Setup

A laboratory scale recirculation bioreactor followed by a multifunctional reactor has been set up for this research. Through leachate recirculation, most organics and solid components can be removed. The following multifunctional reactor is designed for the removal of chloride, ammonia, phosphorous and iron.



3. Chloride Removal

For the multifunctional reactor, chloride, iron, phosphorous removal and struvite recovery were investigated separately. For chloride removal, chloride was removed as calcium chloroaluminate [$Ca_4Al_2Cl_2(OH)_{12}$] through precipitation in the presence of calcium and aluminum at high pH. Considering reducing the chemical costs for the treatment, we tested chloride removal using the alum sludge, a waste of surface water treatment. Alum is commonly utilized to remove color, turbidity, and other impurities during treatment of drinking water. For conditioning and dewatering, lime addition is usually practiced resulting pH > 12.5 and making the sludge classified as corrosive and can only be deposited in hazardous landfills. Sustainable managing the alum sludge becomes an increasing concern in water industry. Its beneficial reuse is therefore highly desirable and has attracted considerable research efforts. This sludge contains approximately 39% aluminum by weight. We used alum sludge collected from Atlanta-Fulton Water Treatment Plant (Figure 1). After addition of lime and dewatering, the cake-shaped alum sludge had a pH in the range of 12 to 13. The high pH and calcium content of alum sludge made it possible for chloride to be removed by calcium chloroaluminate precipitation.

Figure 1. Alum Sludge Collected from Atlanta-Fulton Water Treatment Plant

The dried and powder format alum sludge was flash-added in the first chamber. The spiral mixer provided the rapid mixing necessary for uniform application and dispersion. After alum sludge addition, chloride interacted with alum and precipitated in the sedimentation tank. The inclined pipes ensured that the micro-particles settled in the sedimentation tank.

4. Struvite Recovery

For struvite recovery, pH plays an import role since pH affects the solubility and the kinetics of the reaction. In our research, we investigated the impact of pH, alkalinity, stoichiometry of precipitating ions, and reaction and settling time on struvite recovery. Among these factors, pH was found to be the most important factor. pH also affected the mechanism and the extent of interference of some cations such as calcium and iron. It also should be noted that the transformation of ammonium to ammonia at high pH would prevent struvite precipitation since ammonium might react with OH^- to release ammonia and deteriorate the formation of struvite. Stoichiometry of magnesium, phosphate and ammonium was important from the standpoint of struvite solubility. It was discovered that $NH_4^+/Mg^{2+}/PO_4^{3-}$ molar ratio of 1:0.75:0.75 would result in the optimum precipitating ion concentration for which struvite precipitation could be maximized. For this research, phosphorous was added in the form of $Na_2HPO_4 \cdot 12H_2O$ and magnesium was added as $MgCl_2 \cdot 6H_2O$. The pH adjustment was achieved by the addition of lime to 10. We discovered that the low struvite recovery for low ammonium-content leachate was owing to the poor settling of micro-sized struvite. In the laboratory test at pH 7.6, only leachate with ammonium content greater than 100 mg/l had obvious struvite precipitation observations. For this research, we therefore raised the pH to 10 for better struvite formation. In addition, in order for the micro-sized struvite to precipitate, inclined tubes in the sedimentation tank would enhance struvite recovery.

5. Organic and Phosphorous Removal

Currently, there is ongoing research to investigate removal of organic contents associated with the suspended solid from the leachate. Phosphorous removal by coagulation is also under investigation.

6. Dissemination Plan for this Project

Two research presentations have been made to Leon County Landfill and Springhill Regional Landfill respectively.

7. Potential Funding Sources for the Continuation of Related Research

— NSF/CBET/Environmental Engineering
— EREF

8. Discussion

During the presentation at Leon County presentation, the managers are more interested in the operation costs of the treatment system of this research. They recommend cost analysis be conducted for this research.

Springhill Regional Landfill has concerns about the high ammonium and arsenic concentrations in their leachate.

For the usage of slum sludge for chloride removal, the sludge is suggested to be treated to separate the clay minerals to enhance chloride removal.

The difference effects $FeCl_3$ and alum on phosphorous removal may be owing to the different molecular weight of the coagulant. The difference of the effects should be compared in terms of molecular weight of Fe^{3+} and Al^{3+} directly.

Iron release and regulation has been discussed. Iron release from landfill operation and removal from leachate treatment will be included in this research.

Enough reaction and retention time is required for the precipitation. The micro-sized particles that cannot be settled will be removed with the aid of coagulant applications.