QUARTERLY PROGRESS REPORT

May 1, 2015 to July 31, 2015

PROJECT TITLE: Design and Testing of a Multifunctional Energy and Space-Saving Reactor for the Treatment of Landfill Leachate

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COMPLETION DATE: May 1, 2015 to July 31, 2015

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

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In this research, a multifunctional energy- and space-saving reactor was designed and tested for the treatment of landfill leachate with high ammonium, chloride, phosphorous and heavy metal contents. This approach provides an efficient and energy- and space-saving means of on-site management of landfill leachate. This reactor can also be configured for potential valuable commodity recovery from landfill leachate treatment.

Work Accomplished During This Reporting Period:

1. Chloride Removal in the Multifunctional Reactor

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. However, lime addition makes the pH of the sludge greater than 12.5. Subsequently, the sludge is classified as corrosive and can only be deposited in hazardous landfills. Sustainable management of the alum sludge thus becomes an increasing concern in water industry. Its beneficial reuse is therefore highly desirable and has attracted considerable research efforts. For this part of research, we used the alum sludge collected from Atlanta-Fulton Water Treatment Plant for the removal of chloride from the landfill leachate. This sludge contained approximately 39% aluminum by weight. After addition of lime and dewatering, the cake-shaped alum sludge had a pH in the range of 12 to 13 (Figure 1). 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

Compared to 87% of chloride removal with the usage of aluminum sulfate, around 75% of chloride can be removal with the usage of the alum sludge. Although the removal efficiency was not as good as aluminum sulfate, alum sludge is a great substitute for aluminum sulfate because it costs nothing. In addition, this treatment proves also provides a means of alum sludge disposal. Typically, 20 mg/l (aluminum equivalent) should be able to achieve the chloride removal goal (Figure 2).

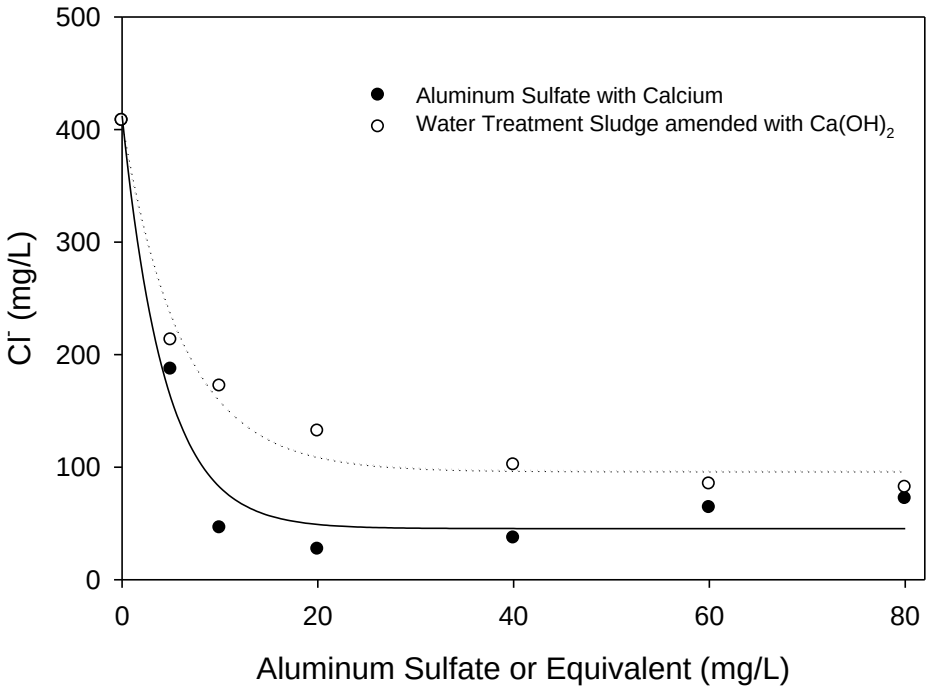

Figure 2. Chloride Removal as a Function of Alum Concentration

For this part of research, we tested the phosphorous removal in the multifunctional reactor by using commercial metal salt coagulants, including aluminum sulfate ($Al_2(SO_4)_3 \cdot 18H_2O$) and ferric chloride ($FeCl_3 \cdot 6H_2O$). With the addition of the coagulants, solution pH decreased according. The decrease of solution pH was attributed to the alkalinity consumption during coagulant hydration. Compared to Al^{3+}, Fe^{3+} reacted slowly with the natural alkalinity, and consequently, iron salt coagulants encountered less pH decrease. It was demonstrated that aluminum sulfate had better removal efficiency than that of ferric chloride (Figure 3). The removal percentage was in the range from 92 to 95% for aluminum sulfate at a concentration of 20 to 80 mg/l and 65% to 70% for ferric chloride at a concentration of 30 to 80 mg/l.

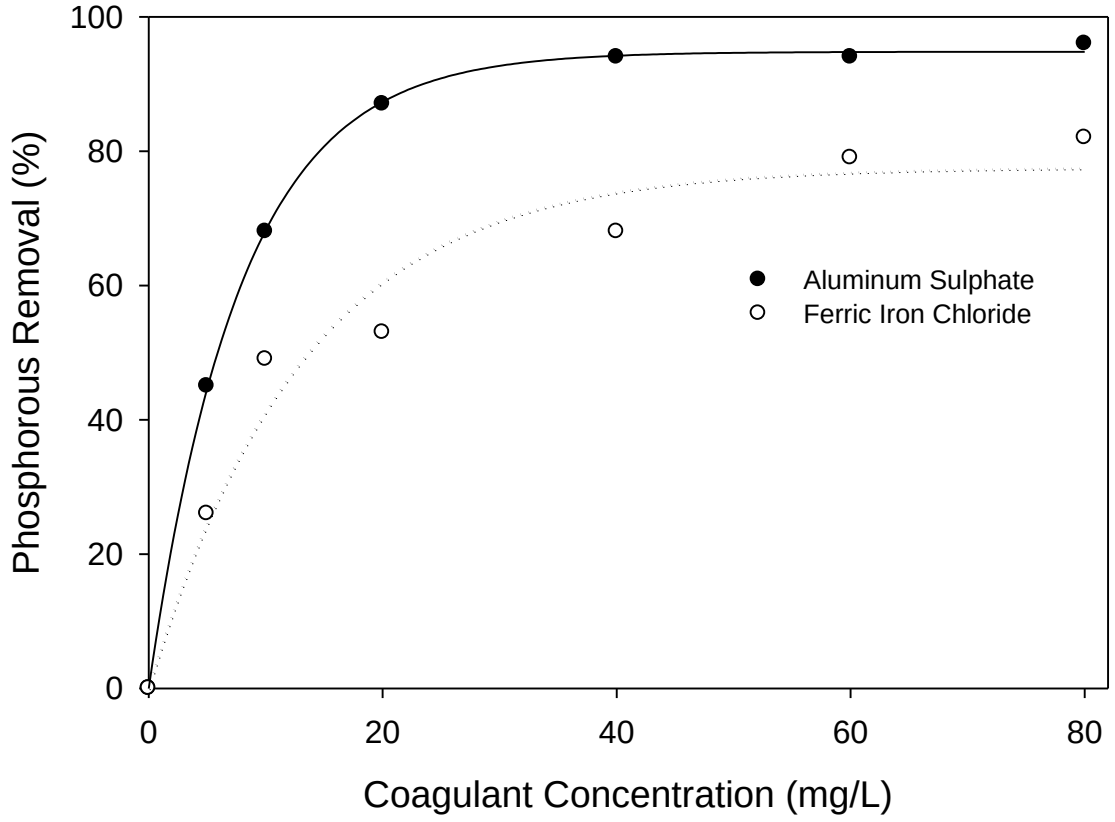

Figure 3. Phosphorous Removal as a Function of Coagulant Concentration

Information Dissemination Activities:

Metrics:

1. List graduate or postdoctoral researchers funded by this Hinkley Center project

Last name, first name	Rank	Department	Professor	Institution
Boya Wang	M.S.	Civil and Environmental Engineering	Gang Chen	Florida State University
Kien Vu	Ph.D.	Civil and Environmental Engineering	Gang Chen	Florida State University
Houzhen Wei	Visiting Scientist	Civil and Environmental Engineering	Gang Chen	Florida State University

2. List undergraduate researchers working on this Hinkley Center project

Last name, first name	Department	Professor	Institution
Dean Van	Civil and Environmental Engineering	Gang Chen	Florida State University

3. List research publications resulting from this Hinkley Center project

Wang, B., Tawfiq, K. and Chen, G. "A Multifunctional Energy and Space-Saving Reactor for the Treatment of Landfill Leachate", to be submitted.

Wang, B., Tawfiq, K. and Chen, G. "Landfill Leachate Treatment by Aerated Recirculation and Pressurized Suspended Fiber Biofiltration", Frontier in Environmental Engineering, accepted (2015).

4. List research presentations resulting from this Hinkley Center project

Chen, G., Wang, B. and Tawfiq, K. "Design and Testing of a Multifunctional Energy and Space-Saving Reactor for the Treatment of Landfill Leachate", South Carolina Environmental Conference, Myrtle Beach, SC, March 14 to March 17, 2015.

5. List who has referenced or cited your publications from this project?

Current research is in process and has not been published yet. Following is the information of citation of recently finished projects:

Power generation and nitrogen removal of landfill leachate using microbial fuel cell technology

Y Lee, L Martin, P Grasel, K Tawfiq… - Environmental …, 2013 - Taylor & Francis

Microbial fuel cell (MFC) technology has been practiced in the treatment of landfill leachate. However, it is a big challenge for the usage of MFCs to treat landfill leachate with high ammonium content. The purpose of this study was to design and test two MFC reactors, ...

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6. How have the research results from this Hinkley Center project been leveraged to secure additional research funding?

A proposal of "Nitrous Oxide Emission from Landfills under Different Operation Conditions" by Gang Chen has been submitted to Environmental Research and Education Foundation in response to Request for Proposals – Research in Sustainable Solid Waste Management.

7. What new collaborations were initiated based on this Hinkley Center project?

We have initiated collaboration with John Hallas from Talquin Electric Cooperative, Inc. and Hafiz Ahmad from Florida State University at Panama City Campus from this research.

8. How have the results from this Hinkley Center funded project been used (not will be used) by the FDEP or other stakeholders? (1 paragraph maximum).

We shared our research results of iron and chloride removal with Patrick Johnson, Solid Waste Director and Brent Schneider of Escambia County Solid Waste Management. In addition, we discussed the results with FDEP Solid Waste Section through TAG members of Gary Millington and Peter Grasel. We also consulted the results with Talquin Electric Cooperative, Inc., which operates seven wastewater treatment plants as well as Leon County Division of Solid Waste. At the South Carolina Environmental Conference, Craig Sherwood from Ni America showed interests in our research work and discussed possible future collaboration with us. Fred Sims, Jr., VP of Water Care Division for Florida Chemical Supply also contacted us with respect to the usage of our research discovery.

TAG members: Peter Grasel, Gary Millington, John Hallas, Chen Lin and Hafiz Ahmad

TAG meetings: First TAG meeting was held at FAMU-FSU College of Engineering on January 16, 2015. The meeting minutes and presentation and discussion were available at www.eng.fsu.edu/~gchen. The second TAG meeting will be held in August.