QUARTERLY PROGRESS REPORT

December 1, 2010 to February 28, 2011

PROJECT TITLE: Comparison of Onsite Biological and Physicochemical Systems for the Treatment of Landfill Leachate with High Ammonium Content

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One of the challenges to be confronted during landfill operations is to handle the landfill leachate with high ammonium content. Current biological ammonium removal processes either are complicated and hard to manage, or require major investments. Low cost and low maintenance onsite systems for the treatment of landfill leachate with high ammonium content are in urgent need, especially for landfills located in low population areas where landfills are smaller and often at a distance from sewage systems and lack trained personnel. The objective of this study is to compare onsite biological and physicochemical systems for the treatment of landfill leachate with high ammonium content. Laboratory scale anaerobic ammonium oxidation (Anammox) and magnesium ammonium phosphate (MAP) precipitation systems are set up for this research. Organic and ammonium removal efficiency as well as treatment cost for landfill leachate collected from landfills in Northwest Florida is compared for the Anammox and MAP precipitation processes.

WORK ACCOMPLISHED DURING THIS REPORTING PERIOD:

Anammox Experiments

The laboratory scale anaerobic-partial nitrification-Anammox reactor consisted of three sequencing CSTR batch reactors with a working volume of 500 ml each. The first reactor was an anaerobic reactor equipped with a gas capturing device for the removal of produced CO_2 and CH_4. The second reactor was a partial nitrification reactor with a controlled oxygen supply device. These two reactors were continuously stirred by a single mechanical blade. The last reactor was an Anammox reactor and was operated at 37 ~ 42°C using a temperature-controlled water bath. The key step for Anammox was to achieve partial nitrification and obtain stable nitrite accumulation. Depending on the available oxygen content, it is possible to convert a fraction or even the whole load of ammonium into nitrite.

For this research period, we cultured microbial consortia that were responsible for partial nitrification using the inocula from our prior research. Specifically, 1 liter regurgitant sludge was inoculated into the reactor. The dissolve oxygen concentration of the bulk liquor in the reactor was maintained at 0.15 mg/l and the ammonium concentration in the reactor was maintained at 100 mg/l NH_4^+-N. After around one month's adaptation, the inocula were able to function with a bulk liquor suspended solid maintained at ~ 1,000 mg/l. With the partial nitrification consortia, we performed leachate partial nitrification experiments. The sequential reactor system was operated at dissolve oxygen (DO) concentrations of 0.03, 0.07, 0.13, 0.15, 0.19, 0.30, 0.40, 0.50 and 0.60 mg/l, respectively.

As shown in Figure 1, with a DO value of 0.60 mg/l, almost all ammonium can be converted within 5 hours. With decreasing DO values, the time requirements increased accordingly. For the DO value of 0.03 mg/l, it took almost 25 hours in order for all the ammonium to be converted.

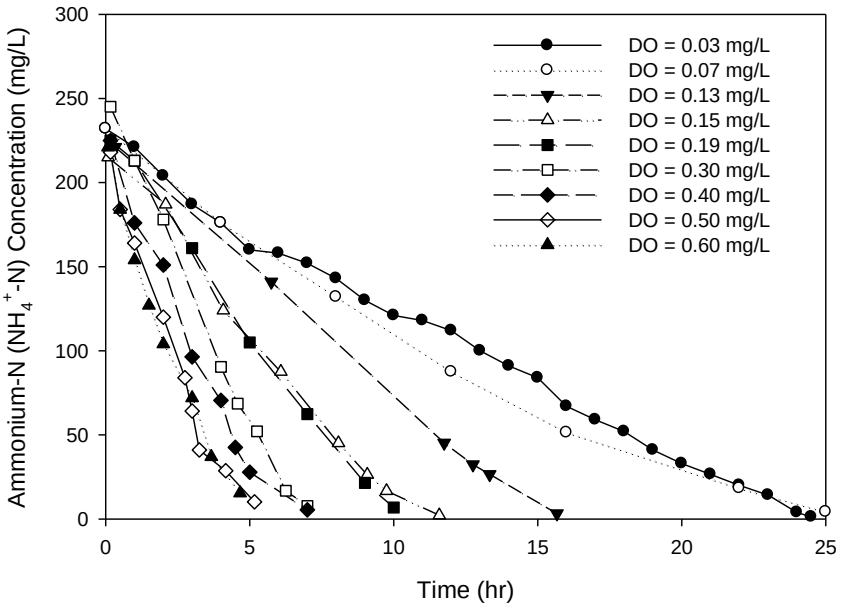

Figure 1. Ammonium Conversion as a Function of DO and Time

We would like to see that the ammonium was converted to nitrite instead of nitrate. Therefore, we monitored the nitrite and nitrate concentrations with the ongoing of the experiments. As shown in Figure 2, most of the converted ammonium had turned into nitrite. Overall, the nitrate formation was minimal (<10 mg/l) within 25 hours (Figure 3). The stable conversion of ammonium to nitrite was a pre-requisite for a successful following-up Anammox.

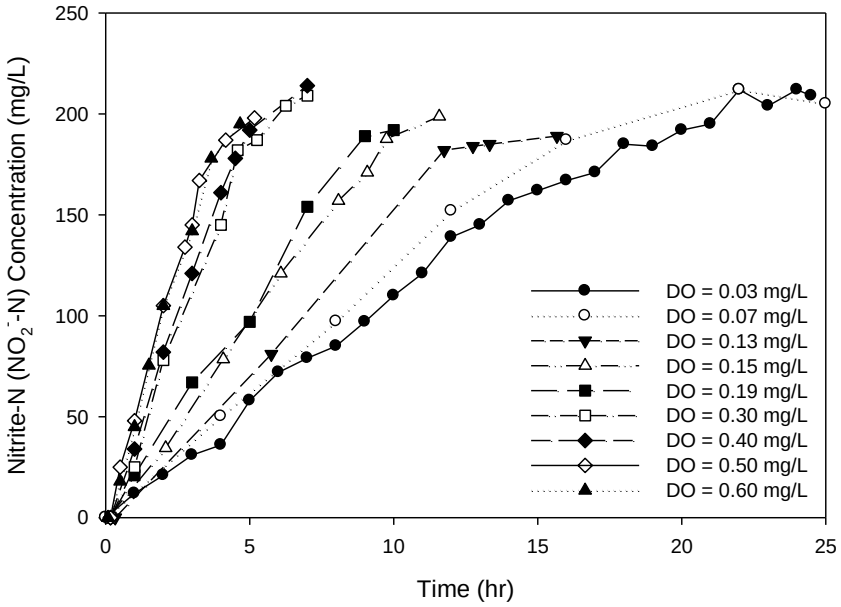

Figure 2. Nitrite Accumulation as a Function of DO and Time

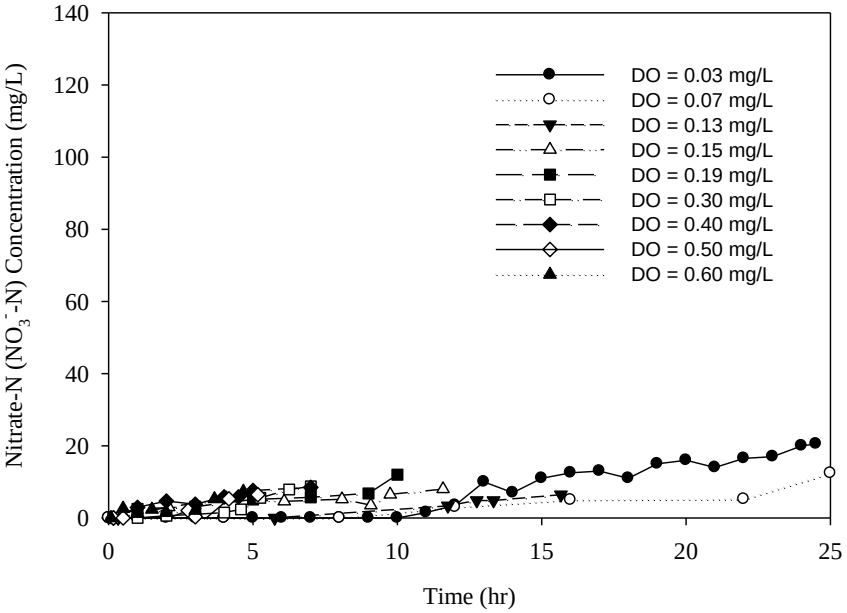

Figure 3. Nitrate Accumulation as a Function of DO and Time

INFORMATION DISSEMINATION ACTIVITIES:
TAG members: Lee Martin, Peter Grasel, Michael Watts, Daniel Kuncicky and Michell Smith

TAG meetings: First TAG meeting was held on February 18, 2010 at FAMU-FSU College of Engineering. The meeting minute was available at www.eng.fsu.edu/~gchen.

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

CONFERENCE PRESENTATION:
Subramaniam, P. K. and Chen, G., Ammonium Removal from Landfill Leachate through Anammox, 97th Annual ASM Southeastern Branch Conference, November, 2011.