QUARTERLY PROGRESS REPORT

September 1 to November 31, 2010

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:

MAP Experiments

The laboratory scale MAP precipitation experiments were conducted. Landfill leachate was added with magnesium ($MgCl_2$ $6H_2O$) and phosphate (NaH_2PO_4 $2H_2O$). The chemical addition was made under flash-mixing conditions and was continuously stirred by a single mechanical blade for 5 minutes. After mixing, the leachate was transformed to the settling tank for MAP precipitation for 20 minutes. Suspended solids and heavy metals like iron were co-precipitated at this stage. In most cases, to remove all available nutrients such as ammonium and phosphorus from the water phase through MAP precipitation, magnesium is deficient and needs to be added. Two types of magnesium, $Mg(OH)_2$ and $MgCl_2$, are generally used in MAP precipitation. Compared to $Mg(OH)_2$, $MgCl_2$ is more widely used because it dissociates faster than $Mg(OH)_2$, resulting in shorter reaction time. In this research, $MgCl_2$ $6H_2O$ was used.

For this part of research, variable $NH_4^+/Mg^{2+}/PO_4^{3-}$ molar ratio was tested to provide optimum MAP precipitation. So far, $NH_4^+/Mg^{2+}/PO_4^{3-}$ molar ratio of 1:1:0, 1:1:0.5, 1:1:0.75, 1:1:1, 1:1:1.1, 1:1:1.25, 1:0:1, 1:0.5:1, 1:0.75:1, 1:1:1, 1:1.1:1, and 1:1.25:1 was tested. Landfill leachate collected from Leon County Landfill was used for this part of research, which was diluted to the desired concentrations. Before $Mg^{2+}/ NH_4^+/PO_4^{3-}$ ratio reached 0.5~0.6:1:1, ammonium removal rate increased with the increase of Mg^{2+} concentration, after which the effect became moderate (Figure 1). On the other hand, initial ammonium concentration had much obvious effects on ammonium removal, i.e., the lower the initial ammonium concentration, the higher the ammonium removal. This is opposite to what we expected. Since ammonium concentration in the supernatant was measured after gravity settling, supernatant of low initial ammonium might resulted in better removal reading owing to the large solution volume. We plan to redo above experiments by centrifuging the supernatant before the reading.

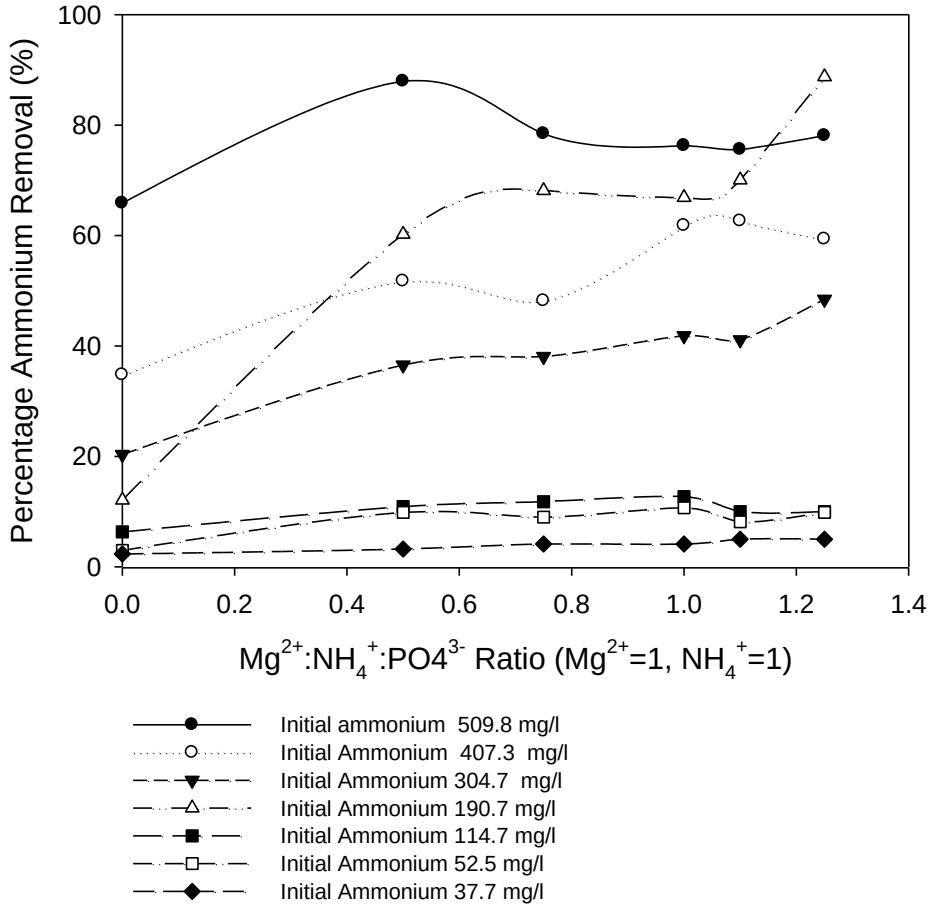

Figure 1. Ammonium Removal as a Function of Mg^{2+} Concentration

For the impact of PO_4^{3-} concentration on ammonium removal, similar observations were made. Before $PO_4^{3-}/NH_4^+/Mg^{2+}$ ratio reached 0.5~0.6:1:1, ammonium removal rate increased with the increase of PO_4^{3-} concentration, after which the effect became moderate (Figure 2). Again, initial ammonium concentration had much obvious effects on ammonium removal, i.e., the lower the

initial ammonium concentration, the higher the ammonium removal. We will repeat above experiments by centrifuging the supernatant before we do the reading.

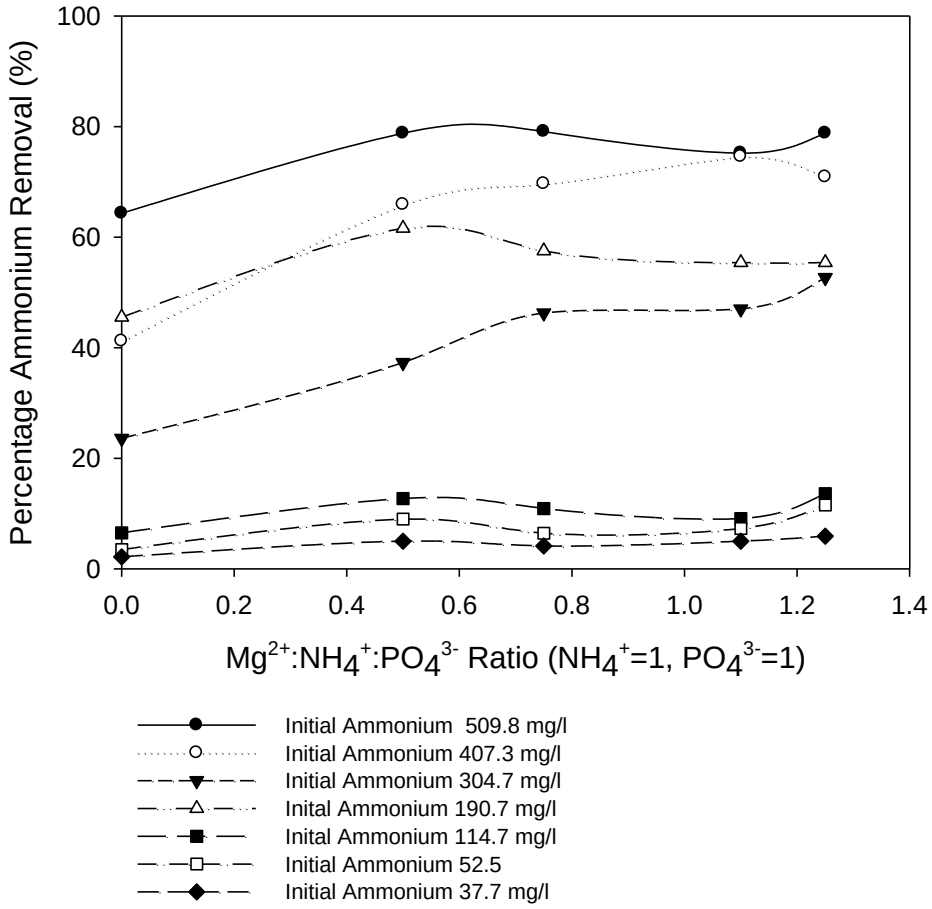

Figure 2. Ammonium Removal as a Function of PO_4^{3-} Concentration

INFORMATION DISSEMINATION ACTIVITIES:
TAG members: Lee Martin, Peter Grasel, Casey Taylor, and Michael Watts

TAG meetings: First TAG meeting will be held in January, 2010 at FAMU-FSU College of Engineering. The meeting minute will be 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.