QUARTERLY PROGRESS REPORT

December 1 – February 28, 2011

PROJECT TITLE: *Sequential MBR-UV Treatment of Landfill Leachate*

PRINCIPAL INVESTIGATOR(S): Michael Watts*(mwatts@fsu.edu), Daniel Yeh(dhyeh@eng.usf.edu)**

AFFILIATION: *Dept. of Civil & Env. Engineering, Florida State University, **Dept. of Civil & Env. Engineering, University of South Florida

COMPLETION DATE: 8/31/2011 **PHONE NUMBER:** 850.410.6119

PROJECT WEBSITE ADDRESS (URL):
http://www.eng.fsu.edu/~wattsmi/UV_MBR/index.html

SCOPE OF WORK: The vast quantity of pharmaceuticals, personal-care products, and endocrine-disrupting compounds (EDCs) stored in municipal landfills poses a significant challenge to leachate-water quality. Advanced leachate treatment, utilizing combinations of biological, chemical, and physical water treatments, can be designed to protect groundwaters influenced by landfill-leachate, or provide reclaimed water for non-potable or agricultural purposes. The versatility and multiple barriers in UV treatment make it an attractive option for landfill leachate treatment. However, the rich concentration of leachate constituents which scatter or absorb light must be addressed with pre-treatment. A novel membrane bioreactor (MBR) system at USF, involving anaerobic biological process and ultrafiltration membranes, has been tested for removal of trace organic compounds and xenobiotic contaminants (17β-estradiol, a prevalent female hormone) from landfill leachate. This work seeks to apply state-of-the-art, germicidal-UV-light technology to assist MBR in removal of trace organic compounds.

CURRENT PROJECT PERIOD: An initial survey of local (Leon County, FL) landfill-leachates uncovered the major technical challenges to applications of UV-Advanced Oxidation. High UV_{254}-absorbance (>1 cm^{-1}), and dissolved organic carbon (>500 ppm as C) will impede light penetration and subsequent formation of oxidizing free radicals. At the suggestion of the TAG committee, Ozone-Advanced-Oxidation was tested as a pre-treatment for anaerobic MBR. Ozone used for these experiments was generated using an AZCOZON Industries Ozone generator model RMU16-04.

As was discussed in the previous quarterly report (Quarterly Report #5), a steady decrease in spiked bisphenol-a (BPA) concentration in leachate was observed with increasing O_3 dose. However, BPA degradation was not enhanced by forcing the ozone to decompose to ·OH with H_2O_2. This was explained by the competitive free radical scavenging in landfill leachate by background DOC.

While ozonation of raw leachate is not an efficient method for direct oxidation of *xenobiotics* and endocrine-disrupting compounds, an advantage of pre-treating leachate with low mg/L-doses

of ozone would be in accelerating the subsequent biological oxidation of these compounds. To test this hypothesis, raw leachate was spiked with 17β-estradiol (E2) and BPA, and dosed with ozone solution up to 8 mg/L. The pre-treated samples were then inoculated with anaerobic sludge (50:50 sludge to leachate) and incubated in batch reactors with anaerobic conditions maintained.

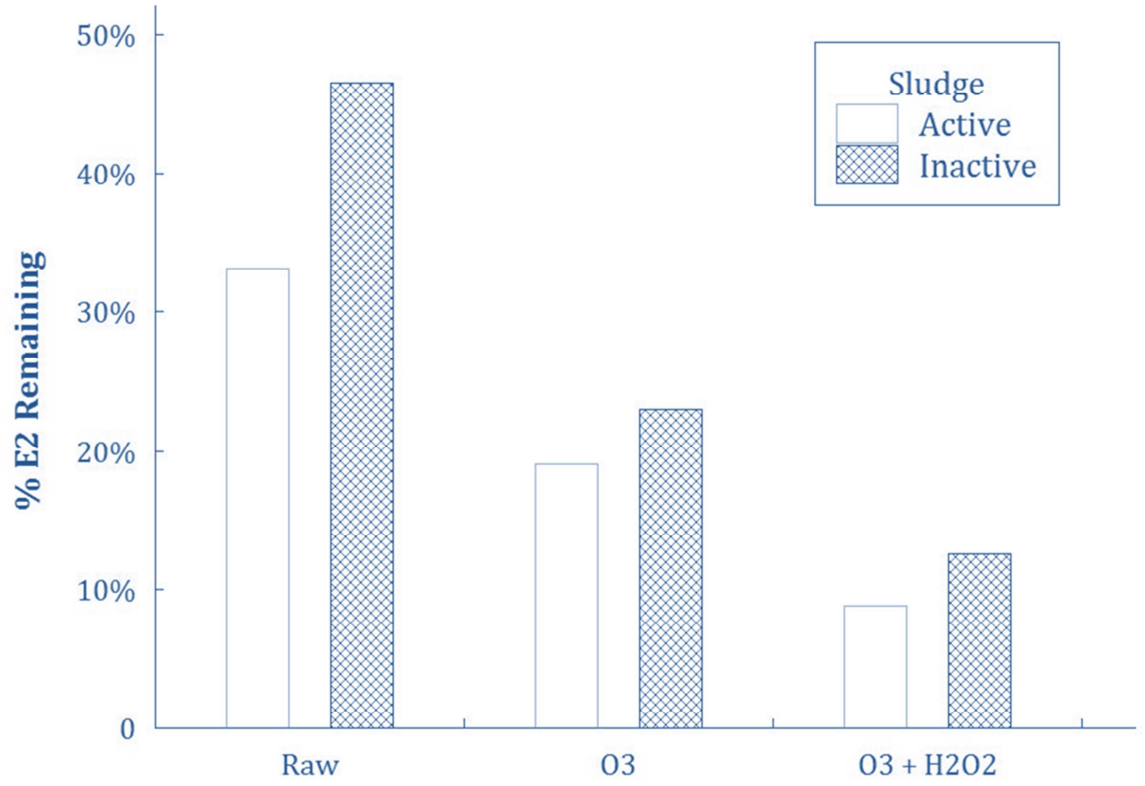

Figure 1 – Degradation of E2 in Leon County leachate under anaerobic conditions (batch) after pre-treatment with ozone or 'peroxone' (H_2O_2 + O_3). Incubation: 24 hrs.

In all 3 pre-treatment conditions, raw, ozone, or *peroxone*, a significant sink of E2 and BPA was sorption to sludge solids. The extraction analysis of sorbed E2 and BPA concentrations is on-going. However, the trend is clear that by pre-treating leachate with an ozone-based advanced oxidation process, the anaerobic decomposition of E2 is accelerated (~1-log removal of E2 after 24 hrs).

NEXT PROJECT PERIOD: Having established that a significant sink for E2 and BPA in anaerobic sludge systems is sorption to sludge, the project team will test another model anthropogenic leachate contaminant, the flame retardant tris-chloroethyl phosphate (TCEP). TCEP is highly water soluble, and slow to sorb to organic solids. In addition, previous collected data by the researchers has shown that it is resistant to direct ozonation. This will provide an additional opportunity to confirm the hypothesis that ozonation pre-treatments do little for direct oxidation of leachate contaminants but can accelerate their removal by biological treatment.

TAG: Dr. Jeff Bandy (*Carollo Engineers*), Dr. Gang Chen (FSU), Dr. Tarek Abichou (FSU), Hooshang Boostani (Hillsborough County), Allan Choate (Polk County).