QUARTERLY PROGRESS REPORT

September 1 - November 30, 2009

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

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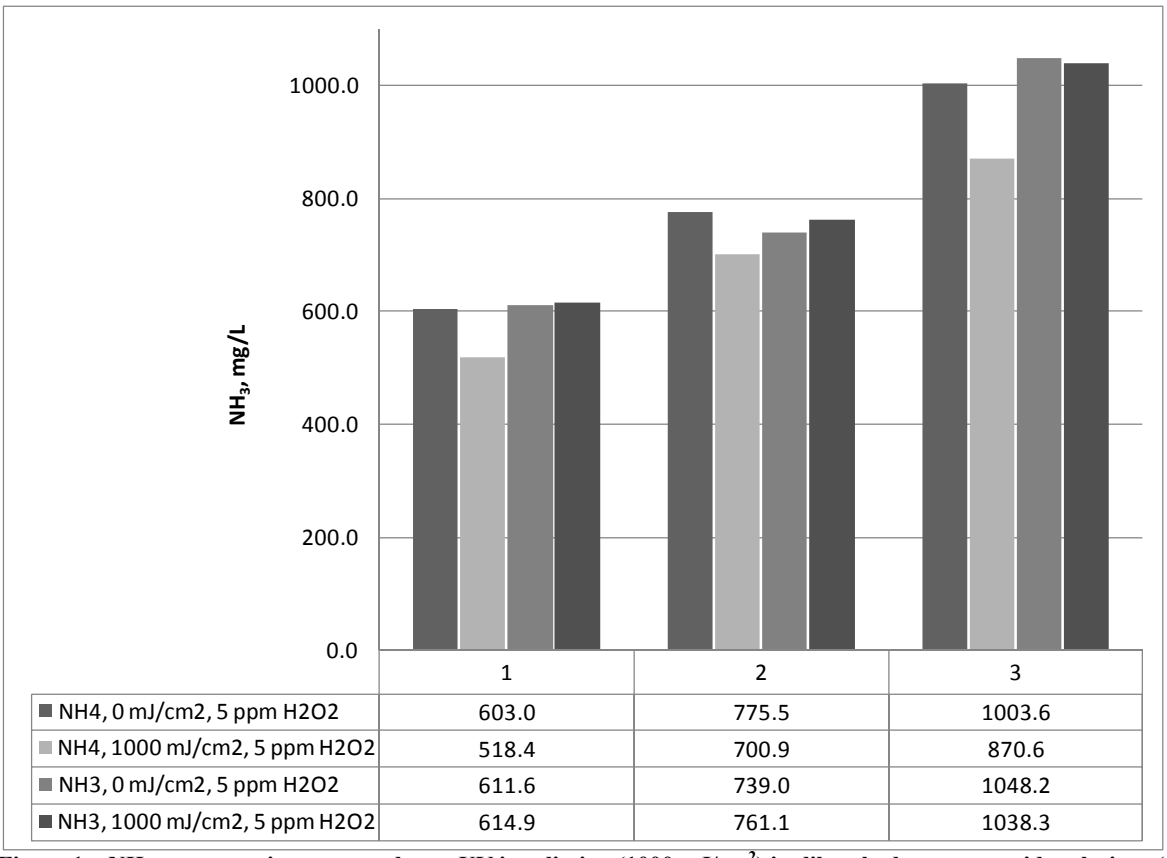
PROJECT WEBSITE ADDRESS (URL):

SCOPE OF WORK: The vast quantity of pharmaceuticals, personal-care products, flame retardants, and plasticizers 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: A particular concern for UV treatment of landfill leachate is the presence of high-levels of photon absorbing, oxidizing-radical scavenging ammonia-N. During this project period, project investigators thoroughly examined the possible treatment interferences associated with ammonia-N concentrations relevant to Florida leachate (500 – 1000 mg/L NH_3). Absorbance spectra measurements for dilute solutions of NH_3/NH_4^+ were used to assess the probability of shortwave-UV scavenging by ammonia-N in leachate. An absorbance maxima was observed at $\lambda < 200$ nm, with minimal absorbance by NH_3/NH_4^+ above wavelengths of 200 nm. Therefore, it can be safely assumed that light emitted by state-of-the-art germicidal UV lamps (monochromatic, $\lambda = 254$ nm) will not be absorbed by ammonia-N in leachate.

As hydrogen peroxide addition is often used to enhance UV treatment of waste waters, the significance of hydroxyl radical (formed from the absorbance of UV by H_2O_2) reaction with ammonia-N was also assessed. Figure 1 highlights the observed indirect photochemical degradation of NH_3 and NH_4^+ in UV irradiated solutions of H_2O_2 (5 mg/L).



	1	2	3
NH4, 0 mJ/cm2, 5 ppm H2O2	603.0	775.5	1003.6
NH4, 1000 mJ/cm2, 5 ppm H2O2	518.4	700.9	870.6
NH3, 0 mJ/cm2, 5 ppm H2O2	611.6	739.0	1048.2
NH3, 1000 mJ/cm2, 5 ppm H2O2	614.9	761.1	1038.3

Figure 1 – NH_3 concentrations pre- and post-UV irradiation (1000 mJ/cm^2) in dilute hydrogen peroxide solutions (5 mg/L). Predominantly NH_4^+ solutions were pH <5, while predominantly NH_3 solutions were pH > 11.

Measurable ammonia-N disappearance was observed in predominantly NH_4^+ solutions, while no significant NH_3 losses were recorded in UV irradiated H_2O_2 solutions. However, NH_4 degradation was observed at low pH (<5) and at higher UV dose (1000 mJ/cm^2) than would be applied in practice. Since most landfill leachate will be a mixture of NH_3 and NH_4^+ near neutral pH, it is anticipated that indirect photochemical degradation of ammonia-N will not be significant during UV irradiation. Nevertheless, any photooxidation of ammonia-N to nitrate or nitrite will be a concern for beneficial reuse of landfill leachate and will thus be monitored in future experiments.

NEXT PROJECT PERIOD: An important question to be answered by this research relates to the appropriate order of treatment: UV followed by MBR, or MBR followed by UV. Our approach will be to determine the optimal treatment scheme for landfill leachate with respect to removal of anthropogenic xenobiotics. During this project period co-solutions of bisphenol-a, ethinyl estradiol, estradiol, and estrone (equimolar, ~4 mg/L each) will be treated with practical doses of UV/H_2O_2 at FSU, followed by anaerobic biodegradation of residual xenobiotics and their oxidation products at USF. Quality control measures will include requisite blank samples, internal standards, and external standard calibrations of analytical equipment.

TAG: Jeff Bandy (*Carollo Engineers*), Gang Chen (FSU), Tarek Abichou (FSU), Hooshang Boostani (Hillsborough County), Allan Choate (Polk County). *Next meeting:* early February 2010.