

# QUARTERLY PROGRESS REPORT

December 1, 2009 - February 28, 2010

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

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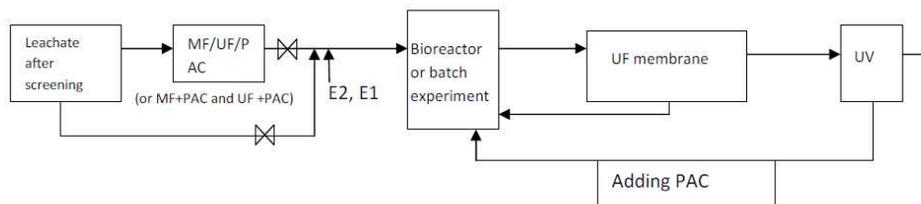
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[http://www.eng.fsu.edu/~wattsmi/UV\\_MBR/index.html](http://www.eng.fsu.edu/~wattsmi/UV_MBR/index.html)

**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 (17 $\beta$ -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:** The determination of optimal process order for a MBR-UV landfill leachate reclamation operation is an important component of the sponsored work. Various benefits can be gained by placing the germicidal UV reactor before a bio-reactor incorporating an ultrafiltration membrane, and vice-versa; as photo-oxidation of anthropogenic organic compounds in landfill leachate can be expected to be incomplete at reasonable doses of radiant energy, it can be advantageous to follow UV irradiation with advanced biological treatment to ensure complete removal of residual toxicity and bio-activity associated with organic contaminants and their daughter-products. With this in mind, project investigators have considered the following treatment scheme for testing:



Recycling a portion of UV reactor effluent allows for further treatment of potentially harmful photoproducts. The addition of powdered activated carbon (PAC) will lead to increased organic contaminant residence time in the treatment train (due to contaminant adsorption to activated carbon), and subsequently higher levels of biodegradation. All PAC added will be retained within the membrane-bioreactor phase of the system, and will not interfere with UV irradiation.

Project investigators have generated samples of EDC-contaminated lab-grade water (a co-solution of Ethinyl Estradiol,  $\beta$ -Estradiol, and Bisphenol-a at equimolar initial concentrations). These samples were exposed to UV doses relevant to disinfection of high-strength wastewaters (0 - 250 mJ/cm<sup>2</sup>). Prior to UV exposure, samples were spiked with H<sub>2</sub>O<sub>2</sub> (to 5 mg/L) to ensure the formation of photosensitized free radicals under UV light. The UV treated samples were then shipped to Dr. Yeh's laboratory at the University of South Florida for inoculation with anaerobic "sludge" (cultured MLVSS). After incubation, membrane-filtered samples were collected for characterization with gas chromatography-mass spectroscopy. Currently, project investigators are elucidating degradation rates for parent EDCs, and the identity of residual daughter EDCs from the collected/treated samples.

**NEXT PROJECT PERIOD:** Subsequent rounds of sample treatment and analysis will focus on replicating the above treatment scheme (see flowchart) with collected landfill leachate. Landfill leachate spiked with EDCs will be inoculated with anaerobic sludge, incubated, and membrane filtered. Membrane permeate will be sent to Dr. Watts' laboratory at Florida State University for analysis and UV irradiation. Collected samples will be analyzed for parent EDCs and daughter EDCs identified in previous round of sampling.

**TAG:** Dr. Jeff Bandy (*Carollo Engineers*), Dr. Gang Chen (FSU), Dr. Tarek Abichou (FSU), Hooshang Boostani (Hillsborough County), Allan Choate (Polk County), and Dr. Erik Rosenfeldt (UMass-Amherst). *Next meeting:* to be scheduled during the week of March 22, 2010.