Progress Report 3

An Up-date on:

Long Term Performance and Large Scale Implementation of Bio-Oxidation of Landfill Gases to Mitigate Greenhouse Gases and Reduce Odors

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BioCells
Placement of a BioCells composed of a glass cullet dispersion layer and a compost layer over an intermediate soil cover at the Tallahassee MSW Landfill in Florida, USA, reduced methane emissions by a factor of 10 and doubled the % oxidation of methane relative to a non-treated control area of the landfill. The BioCells became more effective than the control in oxidizing methane three months after its initial emplacement. Following the initial three-month curing period, the mean % oxidation for the BioCells was 41%, and the mean % oxidation for the control was 14%. Following the three month curing, period we observed 29 negative CH₄ fluxes and 27 zero fluxes in the BioCells, while only 6 negative fluxes and 22 zero fluxes were observed in the control area. Negative fluxes indicate uptake of atmospheric methane. These zero and negative fluxes represent 100% oxidation and therefore the means for % oxidation for the BioCells and control areas increase to 56% and 39% respectively.

BioCovers
BioCovers consisting of thin and thick layers of freshly chopped mulch and a layer of crushed neon tubes were also placed on an intermediate cover of the Leon County Landfill. Both Deep and Shallow Mulch BioCovers reduced methane flux by 96% in comparison to flux before mulch placement. In contrast during this period the emissions from No Mulch area increased by 61%. The Deep Mulch BioCover oxidized the greatest fraction of methane (27.06%) in comparison to Shallow Mulch (5.62%) and No Mulch (10.31%).

BioFilters
Two designs of biofilters were evaluated using simulated landfill gas. Water-spreading biofilters use the capillarity of coarse sand overlain by a finer sand to increase the active depth for methane oxidation. The sand was not contained but simply shaped into a ridge. Compost biofilters consist of 238 L barrels containing a 1:1 mixture (by volume) of compost to expanded polystyrene pellets. Two replicates of each type of biofilter were tested at an outdoor facility. Gas inflow consisted of an approximately 1:1 mixture (by volume) of CH₄ and CO₂. Methane output rates (J_{out}, g m⁻² d⁻¹) were measured using the static chamber technique and the Pedersen et al. (2001) diffusion model. Methane oxidation rate (J_{ox}, g m⁻² d⁻¹) and fraction of methane oxidized (f_{ox}) were determined by mass balance. For methane inflow rates (J_{in}) between 250 and 500 g m⁻² d⁻¹, the compost J_{ox}, 242 g m⁻² d⁻¹, was not significantly different (p=0.0647) than the water-spreading J_{ox}, 203 g m⁻² d⁻¹; and the compost f_{ox}, 69%, was not significantly different (p=0.7354) than water-spreading f_{ox}, 63%. The water-spreading biofilter was shown to generally perform as well as the compost biofilter, and it may be easier to implement at a landfill and require less maintenance. The water spreading design might also be incorporated in alternative landfill cover design known as capillary barrier covers.

Current and Future Activities
In summary, the BioFilters, BioCovers, and BioCells designed and tested in Florida indicate that an economically feasible and scientifically sound approach for mitigating methane emissions from solid waste landfills. A historical data set of Flux, isotope (or
oxidation calculation), and gas profile probe samples will continue to be developed for the biocells, biocovers, and biofilters. The long-term record of this data has high interpretative value for the performance of bio-oxidization practices for the landfill industry, as no research has yet captured the effective longevity and maintenance expectations.

Further investigations with regard to bio-oxidization practices are being planned for by this research team. An investigation of a large-scale biofilter is in development status. The objective is to evaluate the techniques and abilities to capture surface emissions on a large-scale and transmit to modular biofilters for methane oxidization. This exercise will make steps to bringing the mitigation of landfill emissions closer to industry use.

A second investigation using biofilters for the reduction of Hydrogen Sulfide and nuisance odor emissions is in planning mode. The objective is to transmit landfill gas from passive vents to bio-scrubbers that will reduce nuisance odors. Different media for the biofilter will be evaluated for H$_2$S reduction. Further expectations for Sulfur work are being developed to investigate use of remedy biocovers for landfill covers that emit nuisance odors.