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

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Progress Report 2
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BioCells and BioCovers:

Placement of a BioCells composed of a glass cullet dispersion layer and a mulch layer over an intermediate soil cover at the Tallahassee MSW Landfill 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. Over the one-year period of study, the difference in methane emission rate and methane oxidation percentage in the control and the BioCells were statistically significant ($p < 0.001$). Following the initial three-month curing period, the mean % oxidation for the BioCells was 41%, and the mean % oxidation for the control was 14% ($p < 0.001$). Following the three month curing period we observed 29 negative CH$_4$ 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. Individual flux chambers showed a negative correlation between soil moisture and % oxidation and a positive correlation between soil temperature and % oxidation. Neither flux nor % oxidation exhibited a distinct seasonality, perhaps due to relatively warm temperatures throughout the year or the effects of soil moisture buffering the effects of temperature.

![Average Measured Flux (g/m²/day)](chart)

**Fig. 1.** Methane Emissions from BioCells and Control Cells in Site 1.
BioCovers consisting of thin, and thick layers of freshly chopped mulch were placed on Site 4 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%). Fig. 3 and Fig. 4 show the emissions and oxidation from all BioCovers.

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**Fig. 2.** Methane Oxidation from BioCells and Control Cells in Site 1.

**Fig. 3.** Methane Emissions from Mulch BioCovers and No BioCovers
Two designs of BioFilters are being evaluated. 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}, \text{gm}^{-2}\text{d}^{-1}) were measured using the static chamber technique and the Pedersen et al. (2001) diffusion model. Methane oxidation rate (J_{ox}, \text{gm}^{-2}\text{d}^{-1}) and fraction of methane oxidized (f_{ox}) were determined by mass balance. For methane inflow rates (J_{in}) between 250 and 500 \text{gm}^{-2}\text{d}^{-1}, the compost J_{ox}, 242 \text{g m}^{-2}\text{d}^{-1}, was not significantly different (p=0.0647) than the water-spreading J_{ox}, 203 \text{g m}^{-2}\text{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. Fig. 5 shows the oxidizing capacity of each design of BioFilters.
Fig. 5 Fraction Oxidized Measured from Two BioFilter Designs.