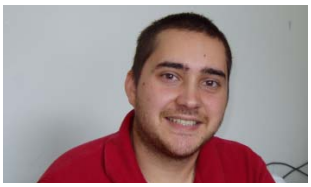

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A Methanotroph-embedded Biotarp for Use as Alternative Daily Cover

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Although highly engineered bio-based systems exist to reduce methane emissions from closed landfill cells, no such system exists for open, active landfill cells. Data suggest that significant amounts of methane can be produced soon after waste placement, and large amounts of methane may enter the atmosphere before final capping and gas collection system installation. We have been investigating the methane oxidation capacity of immobilized methanotrophic bacteria in potential "biotarp" materials that could be used as alternative daily cover (ADC) to control emissions from open landfill cells. A population of methanotrophic bacteria enriched from landfill cover soil was immobilized by adsorption onto various combinations of commercial materials. Batch studies were conducted under a 10% methane-in-air headspace to measure the relative performance of the bacteria on different material supports. The results showed that methanotrophs adsorbed well to certain synthetic geotextiles that had high density and water absorbency, and the combination yielded high methane uptake rates. Methane oxidation rates by the adsorbed cells were assessed at varying temperatures, under 12-hour starvation cycles, and after agitation in water to simulate hard rainfall. Subsequently a continuous flow bioreactor designed to simulate field gas flux rates was used to examine biotarp prototypes. Methanotroph-embedded biotarp samples tested in continuous flow landfill gas simulation chambers (methane flux was 22.5 $g/m^2/day$) retained good methane oxidation activity when tested in batch after three weeks of incubation. Field trials of the methane oxidation capacity of immobilized methanotrophs are underway using flux chambers atop recently placed waste at a local landfill. Field trials suggest that flux reductions ranging from 30-100% are achieved when the geotextile is placed atop areas of flux ranging from 2-300 $g/m^2/d$.

Objectives

- To find an appropriate support on which to adsorb cells for incorporation into a biotarp
- To evaluate activity of adsorbed cells under potential environmental stresses
- To evaluate methane oxidation of a biotarp prototype in a simulated landfill bioreactor
- To evaluate methane oxidation of a biotarp prototype under field conditions

Conclusions

- Methanotrophs can be adsorbed to a synthetic geotextile support, and the cells oxidize methane well when adsorbed.
- Low temperatures and methane deprivation reduce methane oxidation rates by adsorbed cells.
- Methanotrophs adsorbed to a layered geotextile biotarp prototype removed 25% of introduced methane in landfill simulations.
- In the field, bare soil methane fluxes were highly variable, and tarp flux reduction was also variable, likely due to weather changes.
- Addition of shale improved biotarp performance, perhaps because of better microbial adsorption and/or better water holding capacity.
- Future work will test a newly designed geotextile with superior water-holding capacity and investigate the potential for methanotroph inhibition by ammonia or other non-methane emissions.