A Publication of the Environmental Research and Education Foundation

RESEARCH BULLETIN

Environmental Research and Technologies for the Future Issue 1, Volume 2 Fall 2003 www.erefdn.org

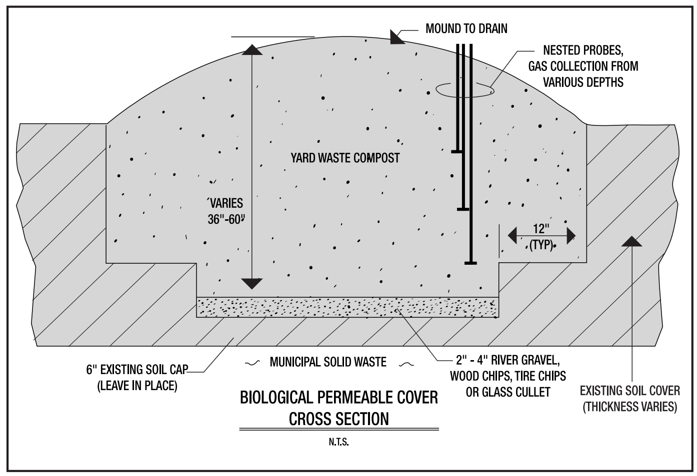
Reduced Methane Emissions – A Case for Landfill Biocovers

ABSTRACT: *EREF is Investigating the Performance of Biologically Active Landfill Covers for Controlling Air Emissions at the Outer Loop Landfill in Louisville, Kentucky.*

Municipal solid waste (MSW) landfills are responsible for approximately 35 percent of the man-made methane (CH_4) emissions in the United States. Reducing CH_4 emissions from MSW landfills has become increasingly important because of its high global warming potential, almost 21 times that of carbon dioxide (CO_2). Efforts to reduce landfill gas (LFG) emissions have led to the installation of gas collection and control systems at many MSW landfills in the United States. While LFG collection systems are highly effective, there is an interest in additional design features that could be used to further reduce gas emissions.

Recently, laboratory and field-scale tests have shown that a biologically active cover (i.e., biocovers) can enhance the oxidation of CH_4 as it passes through the landfill's surface. Biocovers are biologically active surface layers containing active populations of CH_4 oxidizing microbes that enhance the biodegradation of CH_4 and potentially other volatile organic compounds (VOCs) present in MSW landfill gas. In theory, the success of biocovers will result in a low cost solution to air emissions at MSW landfills, thereby reducing the need for expensive LFG collection and combustion equipment. Additionally, a biocover could be used in place of a soil interim cover to promote the oxidation of CH_4 not captured by a gas collection system (i.e., fugitive emissions).

This study was conducted at the Outer Loop Facility in Kentucky and is the first large-scale test of biocovers in the United States. The objective of this investigation was to evaluate the use of a biologically active interim cover to reduce the emissions of CH_4, non-methane organic compounds (NMOCs), and hazardous air pollutants (HAPs) from MSW landfills. In addition, the research will assist in understanding and quantifying the maintenance requirements and costs of biocovers. In the research, interim soil cover was compared with biocovers by measuring the composition of gaseous emission samples collected from specially designed static flux chambers and the measurement of near surface gas concentration profiles. The ability to compare the efficacy of flat versus sloped covers was also incorporated into the investigation design. The total area for the biocover test was approximately two acres.



Cross Section of Biocover

The biocover utilized in the study consisted of a 1.0 to 1.5 meter layer of composted yard waste underlain by 15 to 20 cm of tire chips and approximately 15 cm of clay. The composted yard waste layer provided a biologically active matrix in which CH_4 and certain other VOCs could be oxidized. The purpose of the tire chips was to serve as a gas distribution layer. In addition to comparing biocovers with conventional soil covers at an MSW landfill, gaseous emissions from a facultative landfill bioreactor (FLB) were compared with those of a conventional MSW landfill as part of the on-going bioreactor study at Outer Loop. The presence and concentration of nitrous oxide (N_2O) was compared between locations. The FLB combines conventional anaerobic decomposition with a mechanism to treat recirculated leachate to avoid excessive build-up of ammonia concentrations in the waste mass. Leachate removed from the landfill mass is treated by

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conventional biological nitrification to convert ammonia to nitrate. The treated leachate is then recirculated into the waste mass where facultative bacteria can use the nitrate for respiration. The resultant production of nitrogen gas (N_2) converts the nitrogen to an environmentally benign form within the landfill system.

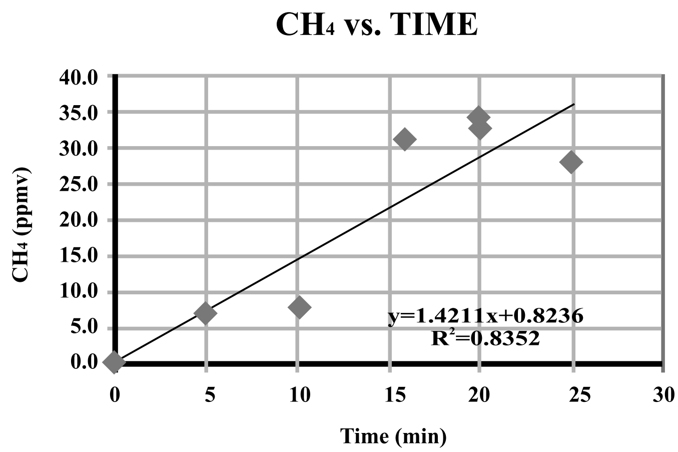
Static Flux Chamber Sampling

Gas emissions were measured utilizing the flux chamber methodology, with flux chambers specifically designed for the project. The flux boxes were 10 to 12 times larger (approximately 1 m^2) than conventional flux chambers. They were constructed of stainless steel with removable tops, sealed using Teflon coated gaskets. Each box collar was driven into the surface to a depth of 0.1 meter leaving 0.3 meter above the surface and left in place for the duration of the test period. A fan was mounted in the top of each box to mix the air in the box. The box top included a series of fittings to allow for the removal of gas samples, measurement of temperature and pressure, and the removal of a large volume of gas for NMOC and HAP analysis. Within 30 to 50 minutes of lid placement on the static collar, a series of gas samples were extracted from the box for a period of 30 minutes.

Triplicate chambers were placed at four different locations in each sampling area. On the conventional MSW landfill cell, chambers were placed at both sloped and flat sections of the biocover, and at a sloped section of typical soil cover. An additional three chambers were used to monitor gaseous emissions from soil cover on the landfill cell operated as an FLB and receiving nitrate-rich leachate.

A combination of techniques was used to evaluate the gaseous emissions and effectiveness of the biocover. In addition to measuring surface emissions using the flux chamber methodology, near surface and deep gas samples were extracted using probes installed specifically for the study and existing LFG wells respectively.

Five rounds of sampling were conducted and multiple samples were collected and analyzed for CH_4, NMOCs, HAPs, N_2O and ammonia at each round. The surface CH_4 flux and the bulk gas composition of LFG extracted from below the landfill surface was measured on site by gas chromatography. All other constituents were determined by remote laboratory analysis. The study also applied a novel technique involving the use of stable isotopes to measure the fraction of the produced methane that was oxidized in each cover during each sampling event.



Example Flux Data

All sampling rounds for the study have been completed and results are expected to demonstrate a simple technology for further reducing surface emissions from both traditional and bioreactor landfills. Theoretically, this methodology could be applied to both fugitive emissions at controlled sites and bulk emissions at uncontrolled sites with the beneficial use of local compost-type materials. In addition, the results should provide sufficient validation of the large flux chamber field technique used to measure the CH_4 flux.

The biocover investigation has the potential to provide landfill owners and operators with an inexpensive, simple method to reduce surface emissions of CH_4 and other organics through the application of yard-waste compost. The biocover would replace the conventional soil cover and may reduce the necessity for expensive LFG collection and combustion assemblies.

This study was conducted in conjunction with an ongoing bioreactor study underway at Outer Loop Landfill. The principal investigators include SCS Engineers, Reston, VA (Greg Vogt at 703-471-6150) and Waste Management, Inc. (Gary Hater at 513-389-7370).

Photos courtesy of SCS Engineers