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Biologically Active Covers for Mitigation of Landfill Gas Emissions

Methane (CH4) is a greenhouse gas with an infrared activity 25 times that of carbon dioxide (CO2) and therefore an important gas in climate forcing. Atmospheric CH4 has increased by a factor of two over the last century and almost 70 percent of the annual atmospheric input of CH4 is from anthropogenic (i.e., manmade) sources. On a global scale, landfills make up eight percent of the total CH4 sources and are the largest source of anthropogenic CH4 in the United States.

Several factors influence the extent of CH4 oxidation in landfill cover soils including CH4 and oxygen (O2) concentrations, temperature, moisture content, soil composition, moisture holding capacity, pH, and nutrient content. To the extent that O2 availability limits CH4 oxidation, cover designs that enhance O2 availability will enhance CH4 oxidation.

In addition to CH4, landfill gas contains trace organic compounds including alkanes, aromatics, chlorinated aliphatic hydrocarbons, alcohols, ketones, terpenes, chlorofluoro compounds (CFCs), and siloxanes. Some of these compounds biodegrade under aerobic (i.e., with air) conditions. Therefore covers that promote CH4 oxidation may also result in decreased emissions of trace organic compounds.

The objective of this research was to compare emissions of CH4 and non-methane organic compounds (NMOCs) from landfill cells covered with traditional soil covers to a biologically active covers (biocovers) consisting of yard waste compost. The hypothesis tested was that the compost-covered areas would exhibit lower CH4 and trace organic compounds than the soil-covered areas because of greater oxidation rates. The efficiency of the compost cover was tested with the gas extraction system both on and off to simulate conditions prior to gas collection system installation.

The study was conducted on a section of the Outer Loop Landfill in Louisville, KY. Refuse in the test area was three to five years old when emission testing began and an active gas collection system was in operation. The soil cover was approximately three feet of clay, while the biocover consisted of six inches of clay, overlain by six inches of tire chips, which served as a gas distribution layer, followed by three feet of shredded composted yard waste. The biocovers were constructed by excavating the original soil covers on both flat and sloped sections of the landfill (Figure 1).

Figure 1. Biocover Installation

Figure 2. Static Chamber Sampling

Emissions tests were conducted in April, June, and September 2002 and June 2003 using triplicate 1 m2 static chambers on both flat and sloped soil covers and biocovers. The static chambers included a 1 m2 stainless steel collar and lid. The lid included a fan to mix the chamber headspace, a temperature probe, a pressure probe, and four outlets for sample collection. Gas samples were collected using syringes or summa canisters. The gas-sampling chamber is shown in Figure 2.

The data collected showed that both covers performed well most of the time when the gas collection system was operational. Surface uptake of CH4 from the atmosphere was observed roughly half the time for both the soil cover and biocover when the gas collection system was on. Conversely, when the gas collection system was off, the biocover continued to take up atmospheric CH4