FIELD INVESTIGATIONS OF METHANE OXIDATION IN SOIL ADJACENT TO AN OLD LANDFILL

Mette Christophersen[1] & Peter Kjeldsen
Department of Environmental Science and Engineering
Technical University of Denmark, Building 115
DK-2800 Lyngby, Denmark

Introduction

Landfill gas (LFG) contains high concentrations of methane, and methane from landfills is estimated to 40 Tg out of the total amount of 600 Tg methane emitted to the atmosphere. LFG thereby contributes to the greenhouse effect. Methane is an important greenhouse gas and a more powerful greenhouse gas than carbon dioxide. Over a 100 year span methane has a global warming potential of 21 (kg CH_4/kg CO_2) (Lelieveld, 1998).

LFG is transported through soil layers in landfill top covers or in adjacent areas before being emitted to the atmosphere. While transported in the soil layers the landfill gas is mixed with atmospheric air, and the methane may be oxidised by the methanotrophic bacteria in the soil. Oxidation of methane in top covers of landfills has been observed at several occasions, and soil exposed to elevated methane concentrations can develop a high capacity for methane oxidation (e.g. Whalen et al., 1990).

There are two main ways to reduce methane emission from landfills. One option is gas recovery with associated gas use, which are very effective at large landfills with high methane generation. At smaller and older landfills with low methane generation it is more effective to encourage methane oxidation in the soil cover of the landfills. In northern Europe there are many small and old landfills with low gas generation, and here methane oxidation is a possible way to manage methane emission. The objective of this study was to investigate methane oxidation in soil adjacent to an old municipal landfill, in order to evaluate the importance of methane oxidation on landfill gas emissions.

Methods

The field investigations were carried out at Skellingsted Landfill, Denmark. The landfill is placed in an old gravel pit and there are no liners. Sampling equipment was installed along two transects with the first station in the top cover of the landfill and the subsequent stations on a line perpendicular to the landfill border. Each transect consisted of 9 measuring stations, and each station consisted of a stationary flux chamber, soil gas probes to measure gas concentrations and pressure above barometric pressure at 6 depths and probes to measure the volumetric soil moisture content at 5 depths down to 1 m below surface (b.s.). Air and soil temperatures were measured. Measuring campaigns were conducted approximately every second week from May 1997 to May 1998. To quantify the methane oxidation isotope analysis were conducted at one measuring campaign.

[1] Corresponding author, fax. (+45) 45 93 28 50, e-mail: mch@imt.dtu.dk

Results & Discussion

At the Skellingsted landfill many indications of methane oxidation were observed during the one-year measuring period:

- The CH_4/CO_2 ratio fell with distance from the landfill and up through the soil profile.
- Nitrogen concentrations above the atmospheric content was observed as a result of the volume reduction caused by methane oxidation.
- Methane oxidation is an exothermic process and the soil was warmer in the areas, where methane oxidation was occurring.
- High concentrations of carbon dioxide associated with methane concentrations below the detection limit in the soil (up till 22% carbon dioxide).
- Methane fluxes were never measured in the summer however high carbon dioxide fluxes were found.

Box-calculations were conducted to estimate the methane oxidation in the top 1 m of the soil profile. The measured fluxes and concentrations of methane and carbon dioxide were used in the calculations, and it was assumed that no carbon dioxide was dissolved in the pore water and that no gas was produced in the soil. The calculations showed that all the methane was oxidised in the summer. On an annual basis 89% of the lateral migrating methane was oxidised. However isotope analysis of the methane at one measuring campaign showed lower fractions of methane oxidised, compared with the box-calculations in the situations, where methane was detected in the flux chamber. The isotope analysis showed that the largest part of the oxidation was occurring in the top 20 cm of the soil profile.

References

Lelieveld, J. Crutzen, P. J. & Dentener, F. J. (1998) Changing concentration, lifetime and climate forcing of atmospheric methane. *Tellus* 50B, 128-150.

Whalen, S.C., Reeburgh, W.S. &. Sandbeck. K.A. (1990) Rapid Methane Oxidation in a Landfill Cover Soil. *Applied and Environmental Microbiology* **56**, 3405-3411.