

Guideline for the end of aftercare of a closed landfill in Japan

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Introduction

The Japan Society of Material Cycles and Waste Management published a report, "Survey and evaluation method of landfill completion criteria for landfill sites" in 2002. "Landfill Completion Criteria" is recognized as the end of aftercare of a closed landfill in Japan. The standard for landfill gas (LFG) is set at "The generation of gas from the landfill site is scarcely observed, or that no increase of the generation of gas is observed over two years or more" in the Ordinance. This published report showed the exact evaluation methods in terms of landfill gas flux.

In this paper an old and closed landfill in Hokkaido, Japan is studied to examine LFG flux in terms of landfill stabilization related to the landfill completion criteria. A LFG monitoring well was installed for observing pressure difference between the atmosphere and inside waste body, temperature, gas components, and LFG flux rate since the end of landfilling in 2003. The observed data shows the stabilization process of this closed landfill. Then the standard for LFG is evaluated by numerical simulate with multi gas component transfer modelling.

Results in a monitoring well of a closed landfill

The surveyed landfill is located in Hokkaido, the northern part of Japan. Ambient temperature is 6.4°C and annual precipitation is 1090mm. Operation originally started in this landfill started in 1977, however, second stage of operation started in 1986 at the area. This landfill accepted mainly municipal wastes without incineration until 1996 (an incinerator operated from 1996), so large amount of biodegradable wastes like food, paper, wood, etc. was landfilled and closed in 2003. The monitoring well had been capped for observation of pressure difference and was temporarily opened for monitoring LFG gas component, LFG flux rate and temperature (4 times in a year).

LFG compositions and temperature in the well in this closed landfill is shown in Figure 1. LFG components showed high concentrations of CH₄ and CO₂ and low concentration of O₂ resulted from anaerobic biodegradation. The LFG temperature varied seasonally and the same trend of the atmosphere temperature. The maximum CH₄ concentration was 58% when the carbon dioxide concentration was 31%. The O₂ concentrations were nearly zero in the most monitoring period, so anaerobic biodegradation occurred inside the wells. Such anaerobic biodegradation resulted in the increased pressure inside waste body.

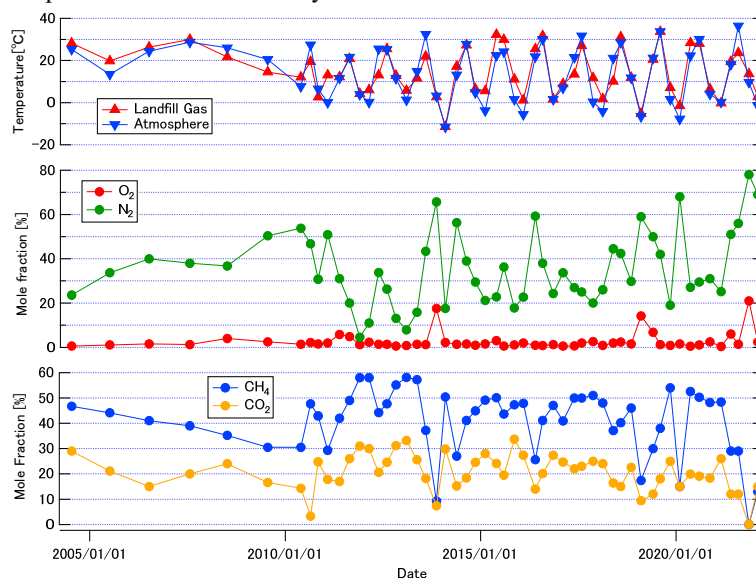


Figure 2. Observed landfill temperature and gas components in a monitoring well

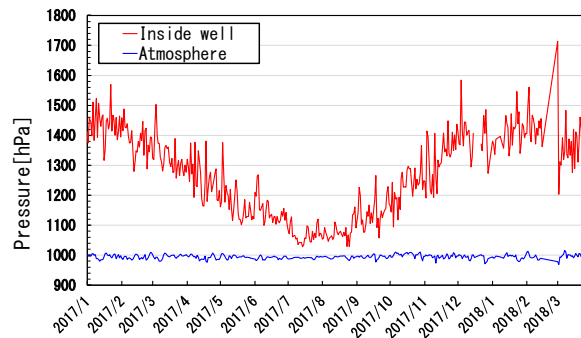


Figure 2. Observed pressure in atmosphere and a monitoring well

Pressure in the well and atmosphere pressure are shown in Figure 2. Significant pressure increase resulted from anaerobic biodegradation. The pressure difference between atmosphere and inside waste body was 50-500 hPa. Such pressure increase may represent the driving force for advective LFG flux.

Simulation of LFG flux around a monitoring well

LFG transfer in waste body and around a monitoring well is simulated by numerical simulation software, COMSOL Multiphysics®. Figure 3 shows the results of calculated pressure difference [hPa] and LFG velocity [m/s] inside waste body. LFG transfer is simulated by Darcy's law and multicomponent diffusion (Maxwell-Stefan diffusion).

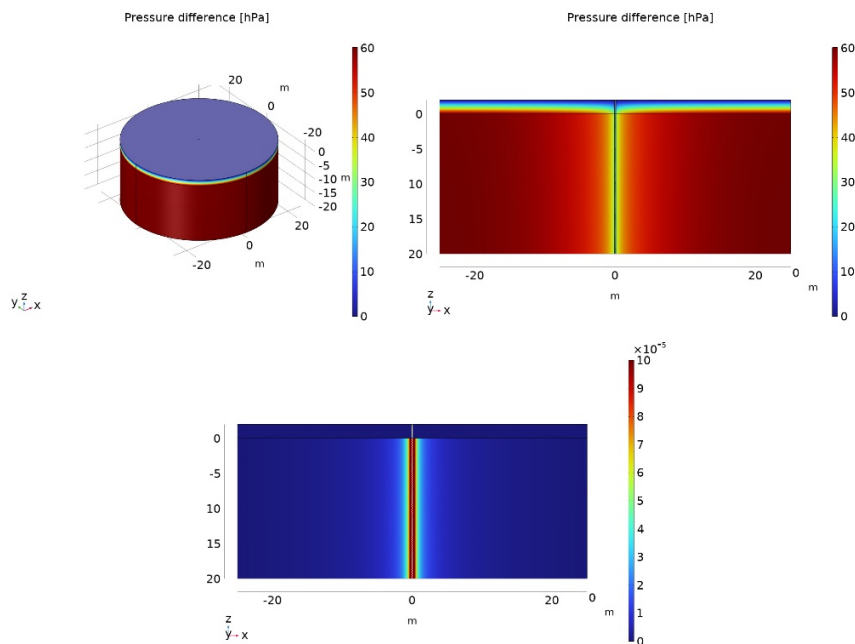


Figure 3. Simulation results of pressure difference [Pa] between waste body and atmosphere and velocity [m/s]

This simulation is based on LFG production scenario ($3 \text{ m}^3/\text{m}^3\text{-waste body/y}$) in the published report. Maximum pressure difference is 60 hPa which is the same level of the observed pressure difference in a well. Maximum LFG velocity in a monitoring well is 0.06 m/s. This velocity is the same level of the observed velocity in a well. Finally an appropriate revised standard related to “Landfill Completion Criteria” for evaluating landfill gas flux in a monitoring well is proposed.