# Experimental Study on a Combined Anaerobic and Semi-Aerobic Landfill Operation System for MSW

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Approximately 47% of municipal solid waste (MSW) in Korea was disposed of by burial in a landfill in 2000. Because Korea is faced with a shortage of energy and land resources, it is essential to develop landfill alternatives that increase the utilization of landfill gas and shorten the waste stabilization period so that land may be reused.

The purpose of the study is to develop a new landfill method to accomplish the following:

- Accelerate landfill gas production during the initial and intermediate stages of landfill stabilization so to improve the economics of gas recovery and utilization
- Minimize landfill gas generation during the final stage of waste stabilization so that the land may be used productively as soon after closure as possible.

Two sets of pilot-scale experiments were conducted to simulate two different periods of waste decomposition. The first set of experiments was intended to simulate the initial and intermediate stages of waste decomposition. Three lysimeters were filled with fresh MSW, and operated under anaerobic conditions as follows:

I. A control in which only precipitation was applied.
II. A reactor in which precipitation was applied and the leachate was recirculated.
III. A reactor in which precipitation was applied and the sludge from the anaerobic digestion of landfill leachate was recirculated.

To simulate the final stage of decomposition, decomposed waste that was mined from a closed landfill was used in two additional lysimeters as follows:

A. Anaerobic conditions with the application of precipitation.
B. Semi-aerobic conditions in which air was introduced to the bottom of a lysimeter through the leachate collection pipe, and precipitation was applied.

Gas generation rates for the first set of reactors are presented in Figure 1. The onset of methane production was about 530 days in lysimeters I and II and almost immediately in lysimeter III. Methane yields were 29.77, 64.07 and 77.18 L $CH_4$/dry-kg waste in lysimeters I, II and III, respectively(Table 1). The yield for lysimeter III indicates that about 76% of total chemical-oxygen-demand (COD) released from Lysimeter-III was recovered as methane gas. These results show that leachate recirculation plus the addition of digested sludge was most efficient in reducing the lag time to methane generation.

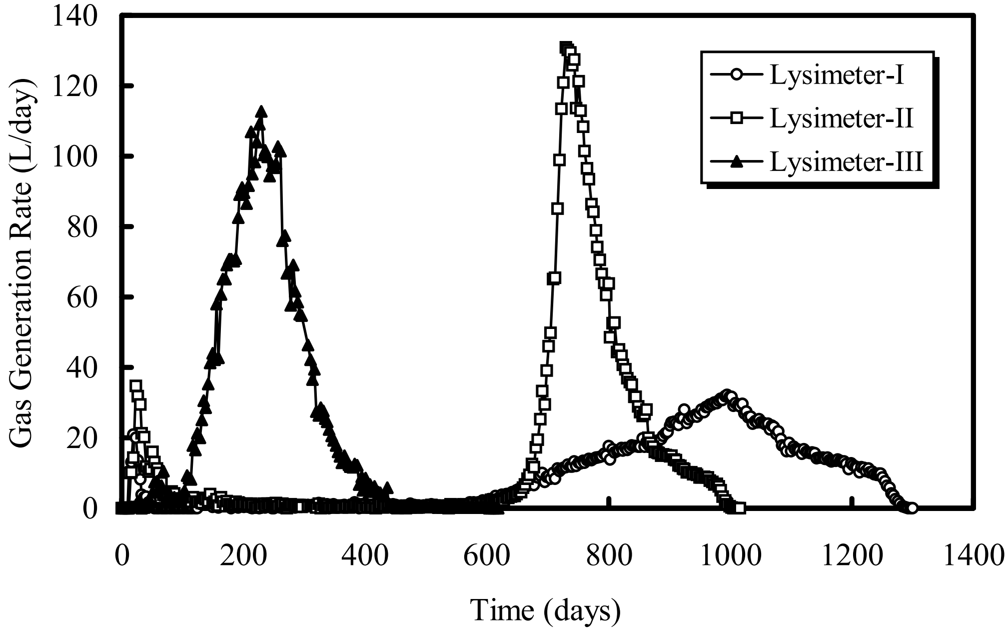


Fig. 1 Gas Generation Rates

Table 1 COD and Gas Generated During the Period of Experiments

| Lysimeter | I | II | III |
|---|---|---|---|
| COD released as leachate (g) | 11,327 | 9,318 | 7,157 |
| COD recovered as $CH_4$ (g)[a] | 9,696 | 20,868 | 25,140 |
| $CH_4$ yield (L $CH_4$/dry-kg waste) | 29.77 | 64.07 | 77.18 |

a. This volume was calculated by assuming that 0.35 L of $CH_4$ are produced per gram of COD.

In the second set of experiments, Lysimeters A and B showed a decrease in leachate COD. However, Lysimeter A stabilized faster than Lysimeter B in organic matter. In addition, due to nitrification and denitrification in Lysimeter B, the total nitrogen concentration in its leachate was lower than that in Lysimeter A leachate.

The results of this study show that refuse decomposition can be accelerated when anaerobically digested sludge is added to refuse and the leachate is recirculated during the most active period of decomposition. Once decomposition is nearly complete, as characterized by a much reduced gas production rate, the addition of air will assist with the completion of refuse stabilization. This strategy for landfill operation will increase the effective utilization of landfill gas and the reclamation of the landfill site, and will also reduce the release of "greenhouse" gases to the atmosphere.