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Characteristics of Gas Production in the Landfill of Saturated and Unsaturated Zone

Y. Shimizu, S. Matsui, S. K. Kim, S. Pareek
Department of Global Environmental Engineering, The University of Kyoto
1-2 Yumihama, Otsu City, Shiga, 520, Japan

Introduction

Of all the option available for handling the Municipal Solid Waste (MSW) land filling is the most common because land filling has been considered to be the simplest and most economically attractive of all available solid waste management options. In an conventional landfill site the MSW is subjected to anaerobic decomposition leading to the production of methane and carbon dioxide. The gases produced are emitted into the atmosphere which causes many problems. The most serious problems are 1) Green house gases (methane and carbon dioxide) emitted from the landfill play an important role in the current increase in global warming (8-10%). 2) The methane produced tend to migrate with in the soil into residential area and cause accidents. 3) The gases produced persist in the soil which makes the reuse of the land very difficult. Methane gas from the landfill site accounts for about 90% of methane emission from waste management system. During the initial and final stage of landfill the methane content of the gas produced is relatively very low, making the recovery and use of methane gas highly economical. A long term study has been carried out to control the gas production in simulated Landfill experiments.

Materials and Methods

The method for the control of gas production during the degradation of organic matter is as shown in the equation below

Organic matter + Sulfate $\xrightarrow{SRB}$ Sulfide + CO_2

While in conventional landfill the organic matter is degraded into methane and carbon dioxide a

Organic matter $\xrightarrow{MPB}$ Methane + CO_2

Sulfate is added externally to the solid waste. The added sulfate will be converted to sulfide by SRB(Sulfate reducing Bacteria) and will be removed along with the leachate. The sulfide containing leachate shall be treated in the aeration tank to convert sulfide into sulfate. Finally the sulfate produced shall be recycled back into theland fill reactors.

As shown in Fig.1, four reactor are used in which solid waste (news paper and saw wood) is packed. Table 1 shows the operating condition of the reactors. The gas produced is collected in gas bags and the volume is measured by water displacement method. Methane and carbon dioxide is analyzed by gas chromatography equipped with TCD detector (Shimadzu GC-8A, Column: Propak Q, 3mm x 3m, 80-100; Carrier gas: Nitrogen- 0.75 kg/cm^2; Column Temp.

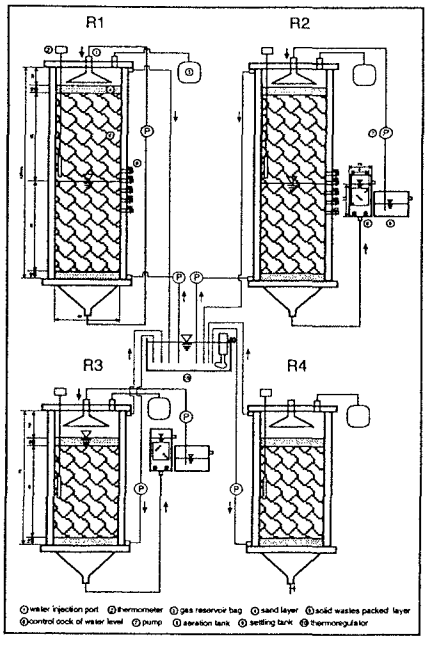

Fig. 1 Reactor Set up

Table 1 Reactor Operating Condition

Reactor No	Sulfate Input	Operation Condition	Circulation
R1	No	Half saturated	Yes
R2	Yes	Half saturated	Yes
R3	Yes	Fully Saturated	Yes
R4	No	No leachate	No

50°C.). Hydrogen sulfide was analyses by Portable gas analyzer. Sulfate in reactor R2 and R3 was added as Sodium sulfate

Result and Discussion

In Fig. 2 the cumulative gas production from day 296-613 in reactors R1 to R4 is shown. The gas production is maximum in reactor 1 where methanogenic bacteria convert the organic substrate in methane and carbon dioxide only. In R2 the gas production is lower than R1 but relatively higher than R3. This may probably be due to the fact that in R2 which has an unsaturated zone may harbor an active population of MPB, while in case of R3 which is saturated may be dominated by SRB keeping the gas production low. The gas production in R4 is similar to gas production in R3.

In Fig. 3 and 4 the concentration of methane and carbon dioxide in the biogas produced is shown respectively. The methane concentration is the highest in R2 followed by R1 and was the lowest in R3. The high methane concentration in R2 can be again explained by the presence of active MPB in the unsaturated zone. High methane concentration in R2 can also be explained by low carbon dioxide concentration in the biogas produced. Carbon dioxide concentration is the lowest in R3 (1-5%) resulting in high inorganic carbon concentration in leachate (data not shown). Carbon dioxide concentration is lower in R2 than in R1 resulting in high IC in R2 leachate. Gas composition of R4 is similar to R1 (data not shown).

Conclusion

1) The gas production in reactor R3 is lower than in reactor R1 and R2.
2) The methane and carbon dioxide concentration is lower in R3 than R1 and R2.
3) The control of biogas production and composition can be attributed to the activity of SRB.

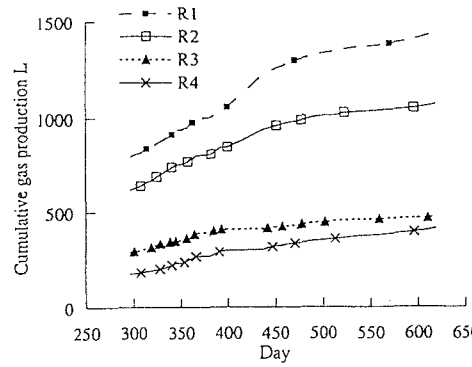

Fig. 2 Cumulative gas production

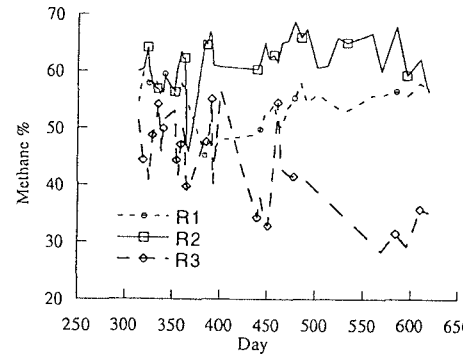

Fig. 3 Methane concentration

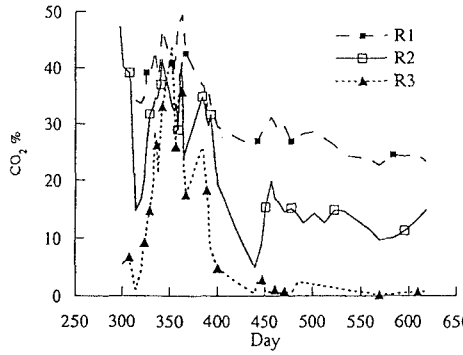

Fig. 4 Carbon dioxide conentration