B-16.4 Studies on Emission Control of CH_4 and N_2O from Solid Waste Disposal Facilities

Contact Person Masaru Tanaka
Director
Department of Waste Management Engineering,
The Institute of Public Health
Shirokanedai 4-6-1, Minato-ku, Tokyo, 108 JAPAN
Phone +81-3-3441-7111 (Ext. 373), Fax +81-3-3446-4314
E-mail: maxta@iph.go.jp

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Abstract

State and control methods of CH_4 and N_2O emission from solid waste disposal facilities were studied by means of *in situ* observation and published data analysis. At night soil treatment plants, the N_2O emission was greatly depended by the ORP in the single type nitrification-dinifitrification reactor. Therefore, it is effective for N_2O reduction to control the ORP range and average during nitrification-dinifitrification cycles by means of air supply to reactor. The open-path type FTIR successfully detected the surface CH_4 concentration above atmosphere level at a landfill site. It is shown that the water content of landfill cover soil affect methane oxidation in soil. We discussed about the methodology for estimating the degradable organic carbon in landfilled waste from national waste statistics in Japan. We noticed that degradable landfilled waste would be significantly over-/underestimated by assumption in sorts of waste and treatment. We consider that it can apply to the *in situ* monitoring of CH_4 emission from landfill sites. From waste management statistics and time-depended gasification model, national CH_4 emission from Korean and Japanese landfill sites were estimated. Since the rate of landfilling of municipal solid waste in Korea is higher than that of Japan, the CH_4 emission form landfill sites in Korea would exceed that of Japan at 1990.

Key Words Methane, Nitrous Oxide, Solid Waste Disposal, Night Soil Treatment, Control Method, Estimation of National Emission

1. Introduction

In the field of solid waste disposal, most CH_4 is emitted from MSW (municipal solid waste) landfill sites by microbial digestion of organic wastes and N_2O is mainly emitted from incineration plants and night soil treatment plants by combustion and denitrification, respectively. In this study, we attempt to extract some factors regulating the GHG emission and its estimate by means of in situ observation, laboratory experiments, published data analysis, and to establish evaluation and control measures for the GHG emissions from facilities and countries.

2. N_2O emission control measures for night soil treatment plants

In order to observe the diurnal variation of N_2O emitted from a night soil treatment plant with the high loading dinitrification process with UF membrane separator, exhaust gas from the single type biological reactor was piped and introduced to IR N_2O analyzer (Model 46C-HL, Thermo Environment Instruments) via moisture traps. Result is shown in **Fig. 1**. N_2O concentration in exhaust gas was increased just after the charge of substrate and decreased with ORP at every 30 min. The maximum concentration was reached to 550 ppm (0023 mol/m^3). **Fig.2** shows the relationship between the ORP range and average during 30 min and N_2O emission. It is suggested that ORP control by air could reduce the N_2O emission from the reactor.

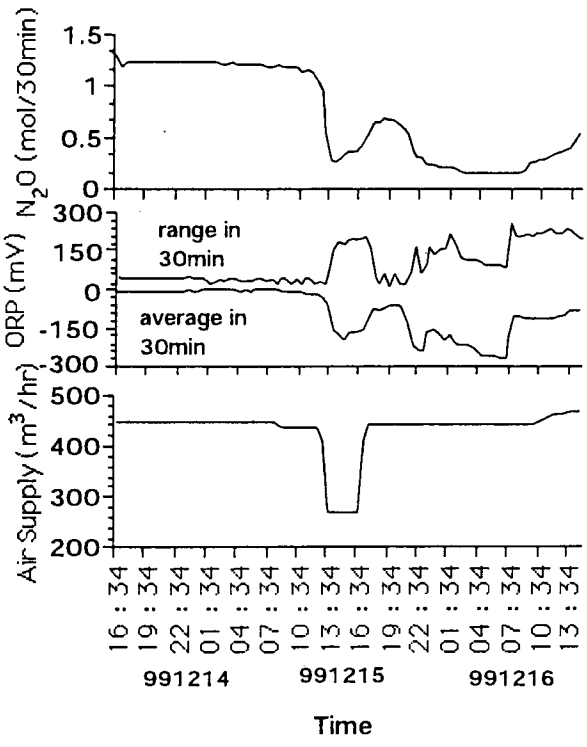

Fig.1 N_2O emission and other operational factors

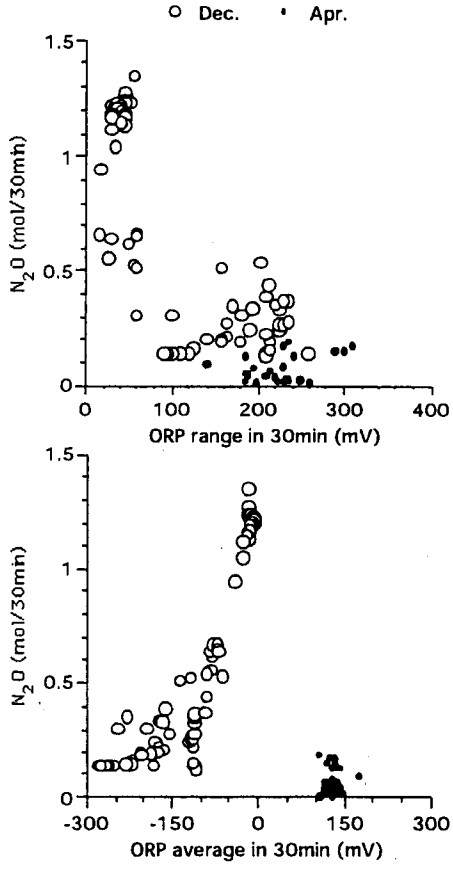

Fig.2 Relationship between N_2O and ORP

3. Measurement CH_4 at landfill ground level

There is little methodology to estimate the actual methane emission from the ground surface by field observation basis. We attempted to introduce the open path type FTIR analyzer to *in situ* measurement of CH_4 emission from landfill sites. We used AirSentry-FTIR^{TM} (Environmental technologies Group., Inc.) for this purpose. This analyzer scans absorbency of gas (air) between the infrared radiation emitter and the mirror, and analyzes the components and their concentration by means of infrared absorption bands. **Fig.3** shows the result of the filed

observation at a MSW landfill site. This analyzer successfully detected the surface CH_4 concentration above atmosphere level at a landfill site.

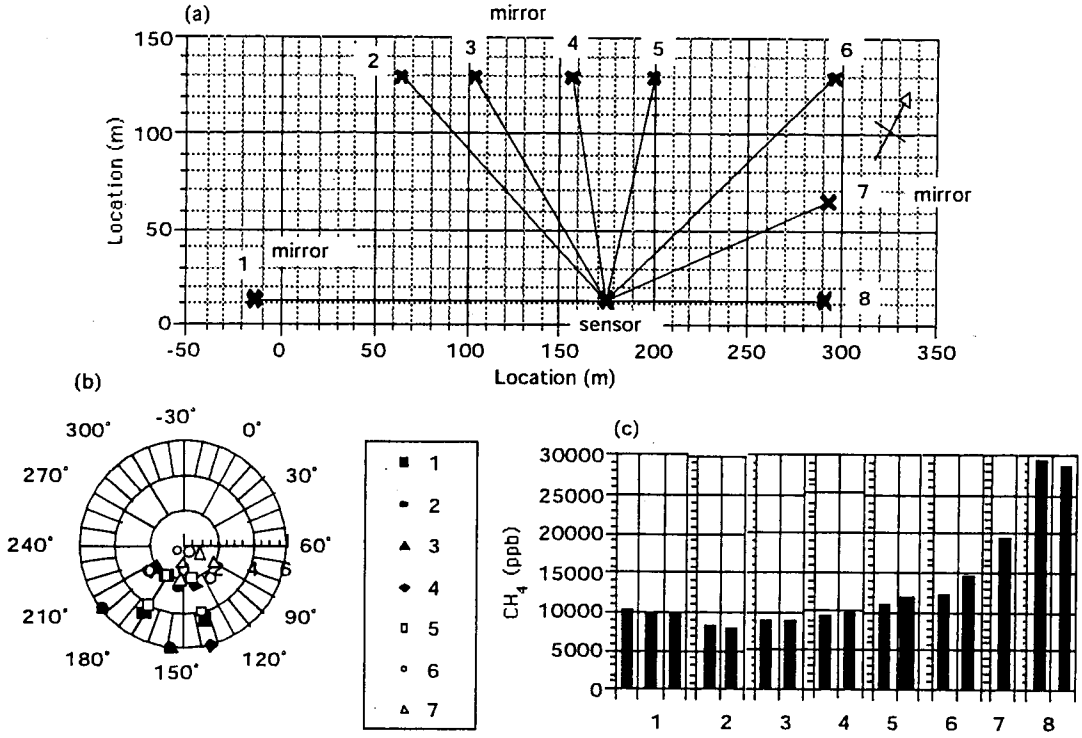

Fig.3 Result of FTIR observation: (a) Location, (b) Wind、(c) CH_4 Concentration

4. Effect of water content to CH_4 oxidation in landfill cover soil

Former model study[1] showed that the physical nature of soil, such as air filled porosity, is strongly affected to the CH_4 oxidation through the landfill cover. Water content of soil can be one of major regulators of air filled porosity in landfill cover soil, for example by rainfall. We investigated the effect of water content to CH_4 oxidation rate in soil with the laboratory scale batch test. We transferred the pre-cultured landfill soil to glass vessels and sealed. Vessels were filled them with gas including CH_4, CO_2, O_2, N_2, which are almost same concentration as landfill cover soil gas and incubated at 30 °C. After 0 to 5 hr, we sampled headspace gas of vessels and analyzed the CH_4 and other components in samples. Then, CH_4 oxidation rate of soil was calculated. **Fig.4** shows the effect of water content to CH_4 oxidation rate of

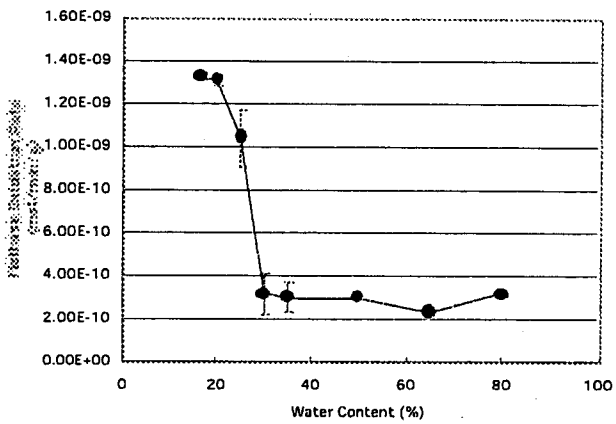

Fig.4 Effect of water content to Methane Oxidation

soil. CH_4 oxidation rate was dramatically decreased between 20% and 30% (w/w) of water content. It is suggested that pores between soil particles would be filled with water at this range, then diffusion of gas from the head space could be deceased, in other words, availability of substrate gas to CH_4 oxidation organisms could be inhibited.

5. Estimation of degradable landfilling waste from national waste statistics.

Product of activity and the emission factor can estimate GHG emissions generally. It seems that less consideration has been given on the issue of how to estimate the Activity, i.e. the amount of landfilled degradable organic waste, from national statistics. Taking Japanese MSW statistics, which is supposed to be relatively well prepared. However, the amount of degradable organic waste from this statistics can not be determined, because there are no available data on the composition of the generated waste or data to represent the change of that composition due to the intermediary treatments. In this case, some obtainable data that are expected to be similar to the composition of landfilled waste such as the composition of combustible waste generated, may be used to estimate CH_4 emissions as the second best option. However, as shown in the box above, the activity data estimates may be highly uncertain depending greatly upon the assumptions. In this example, one assumption gives about 4 times as much value as the other assumption does (**Fig.5**).

Assumption 1; **Direct Disposable Waste is mainly Uncombustible Waste**

Land Disposal Degradable Organic Waste
= Direct Disposal Waste - Uncombustible Waste

= 5,720,795 - 4,536,454 =1,184,341 (ton/year)

Assumption 2; **Direct Disposable Waste is mainly Unseparated Waste**

Land Disposal Degradable Organic Waste
= Direct Disposal Waste - Unsepareted Waste
x [Uncombustible Waste / (Combustible Waste + Uncombstible Waste)]

= 5,720,795 - 7,574,255 x [4,536,454 / (28,667,026 + 4,536,454)]
= **4,685,955** (ton/year)

Fig.5 Estimation of degradable landfilling waste in MSW

Table 1 Estimation of CH4 emission from industrial waste

(a) 100% Direct landfilling

	Genertion	Degradable Landfilling waste	CH4 emission
	Gg/year	Gg/year	Gg/year
Organic Sludge	132,499	132,499	15,529
Paper	2,904	2,904	82
Wood	6,433	6,433	200
Bio-residue	4,410	4,410	389
sum			16,200

(b) 9% Direct landfilling

	Genertion	Degradable Landfilling waste	CH4 emission
	Gg/year	Gg/year	Gg/year
Organic Sludge	132,499	11,925	1,398
Paper	2,904	261	7
Wood	6,433	579	18
Bio-residue	4,410	397	35
sum			1,458

In case of industrial wastes, there are same problems as MSW, especially in the intermediary treatments. **Table 1**

shows the deference of estimates on degradable landfilling waste between the intermediary treatments assumptions. Using a statistics[2], which categorize the intermediary treatments for each waste item, from some local municipalities, degradable landfilling waste is estimated in **Table 2**.

These means that the uncertainties arising from estimation of activity data will significantly affect the GHG inventories.

Table 2 Estimation of CH4 emission from industrial waste

Considering the intermediary treatment

	Genertion	Degradable Landfilling waste	CH4 emission
	Gg/year	Gg/year	Gg/year
Organic Sludge	132,499	11,925	1,398
Paper	2,904	261	7
Wood	6,433	579	18
Bio-residue	4,410	397	35
sum			1,458

6. Estimation of CH4 emission from landfill sites in Korea

Using the time-depended gasification model model[3], we estimated CH_4 emission from Korean and Japanese landfill sites. We collected and estimated data on MSW generation, composition and amount of landfilling from Korean and Japanese national statistics and a data book[4]. We also considered main degradable components in MSW as food waste (garbage), paper waste and wood waste and estimated the rate of DOC (degradable organic carbon) as 8, 27, 24%, respectively, and set rate of CH_4 production from DOC as 30%. Then we distributed the total CH_4 emission from annual land disposal to following years by the Sheldon Arleta model and sumed up at each year. Half degradation time of each waste component was assumed as 3,

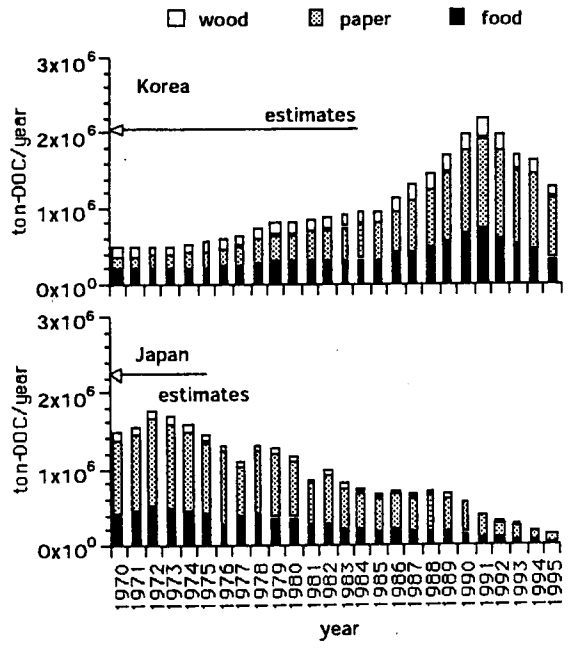

Fig.6 DOC trends

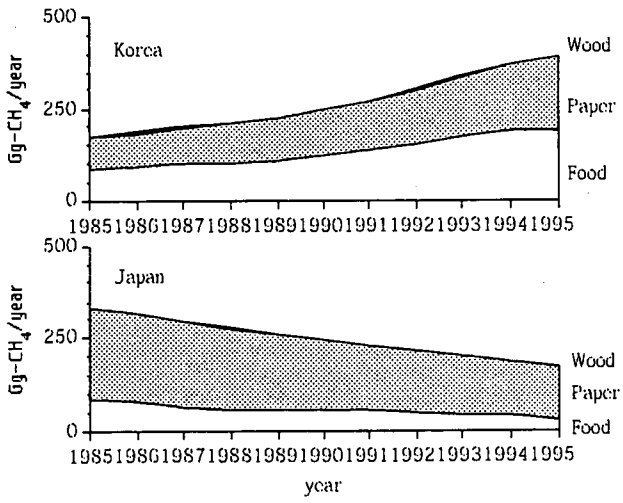

Fig.7 CH_4 emissions from landfill sites

7 and 24 years, respectively. Results are shown in **Fig.6** and **Fig.7**. In Korea, amount of landfilled waste was smaller than that of Japan. However, high rate of direct landfilling leaded to larger landfilled DOC than that of Japan. While paper waste was a major component of MSW in Japan, garbage was a major component of MSW in Korea. It is suggested that annual CH_4 emission from landfill sites in Korea would become to exceed that of Japan in 1990.

Reference

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