BIO-REMEDIATION EXAMINATION IN A FIELD WITH DIOXIN CONTAMINATED SOIL USING A LYSIMETER

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Introduction

Treatment of incinerated ash of municipal waste, especially fly ash, containing dioxin and incinerated ash disposed at landfill sites in the past has become a problem in Japan. For example, in Nose city, Osaka, Japan, the contaminated soil with high concentration dioxins has been stored in a building, and has not been treated yet[1)]. Our report has been indicated that runoff of dioxin from contaminated sites where incinerated ash was previously disposed of could cause environmental pollution[1)]. Not only is there a concern that this dioxin can contaminate rivers but also that the effects can reach the downstream region. Therefore, decontamination process of the dioxin-contaminated soil including incinerated ash becomes an important problem in environmental preservation. In the past Dioxin conference, we reported the microbial degradation of dioxin in laboratory experiments[2, 3)].

In this study, we reported the result of lysimeter test using actual dioxin-contaminated soils and mixtures of microorganisms in landfill sites, in order to determine the degree of dioxin digestion by microorganisms in the field.

Materials and methods

(1) Items measured in the experiment

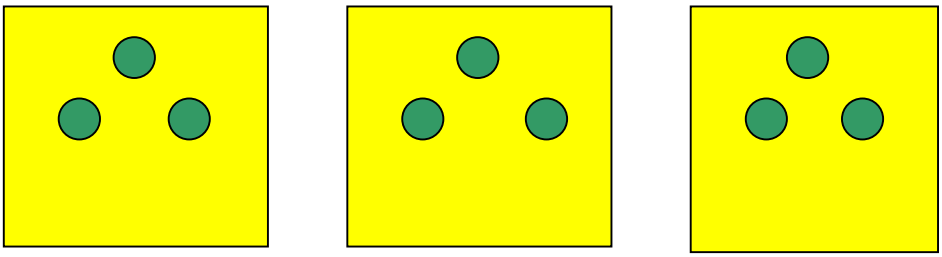
Items measured in the experiment are as follows:

1. Dioxins (PCDDs, PCDFs, Co-PCB) variously, 2. water contents, 3.pH, 4.ORP (oxidation-reduction potential), 5. numbers of bacteria, and 6. temperature.

(2) Installation of the lysimeter

Three lysimeters were installed (A: Control, B: Mixture + dilution nutrient salt, and C: Mixture + source of nutrition). The lysimeter measured 1.35m×1.35m×0.4m. Deposition of the contaminated soils was adjusted so that it passed through a sieve of 1×2mm mesh in the lysimeter. Five hundred grams of soil were placed in lysimeter A, 450kg of soil, 20kg of bacteria and 30kg of dilution nutrient salt were placed in lysimeter B and 400kg of soils, 20kg of bacteria and 80kg of nutrition were pleased in lysimeter C. The concentrations of the dioxin based on toxicity equivalence quantity (TEQ) were A: 5,207 pg-TEQ/g, B: 4,774pg-TEQ/g, and C: 4,838pg-TEQ/g. The total dioxin concentrations were A: 326,000 pg/g, B: 314,000 pg/g, and C: 304,000 pg/g. These

concentrations were determined by the method described in the next section. Measuring items of the sample was carried out periodically over a 1-month period from 3 points per each lysimeter, as shown in figure 1. Water was sprinkled periodically, and the moisture of the lysimeter was controlled.



A: Control
dilution nutrient salt

B: bacteria (mixture) and

C: bacteria (mixture) and nutrient

Figure 1 Conditions of lysimeter tests and sampling points

(3) Extraction and analysis of dioxins and Co-PCB

We determined concentration of dioxins based on the modified standard method of Ministry of the Environment in Japan [4]. After cultivation, from 5 g of cultured soil, the dioxins were extracted to 20 ml of ethyl acetate as shown below. The cultured soil was shaken vigorously for 10 min with a reciprocating shaker. Standing for several minutes separated ethyl acetate phase and solid phase, and Na_2SO_4 was used to dry the ethyl acetate phase. The extracted dioxins in the ethyl acetate phase were diluted and analyzed by gas chromatography-mass spectrometry (selected SIM mode) with JMS-SX102A and a fused silica SP-2331 capillary column (60 m by 0.22 mm i.d.).

The operating parameters for the GC were as follows: injector, 270 ; carrier gas, He; carrier flow, 0.8ml/min; injection method, splitless. The oven temperature was initially maintained at 100 for 1 min and then increased to 250 at 8 /min and finally to 290 at 4 /min and maintained at 290 for 5 min.

Results

(1) Changes in pH and ORP in the lysimeter

Changes in the pH in the lysimeter were 7.4-7.8 in the lysimeter A, 6.5-7.5 in the lysimeter B and 6.3-8.0 in the lysimeter C. It was shown that ORP in Lysimeter A was 220 to 383 mV and that in B was –170 to +383 mV, and C was –314 to +207. Therefore, the lysimeter C had a condition of more anaerobic condition than the lysimeter A and B, because adding nutrient caused the high activity of microorganisms.

(2) Reduction of dioxins in thecontaminated soil based on total concentration

The percentages of reduction in total concentration of dioxin determined in the three lysimeters are shown in table 1. After 5 months, dioxins were reduced by 17.6% in lysimeter C. It was indicated that the strains in the lysimeter C might had the ability to degrade the dioxins.

Table 1. Reduction of total dioxins in the contaminated soil (pg/g)

	Start	After 5 month	Reduction %
A	326,000	324,000	0.6
B	314,000	318,000	-1.3
C	304,200	250,600	17.6

(3) Reduction of dioxins based on TEQ

The reduction based on TEQof dioxin is shown in table 2. After 5 month, lysimeter C showed a dioxin reduction of 977 TEQ–pg/g, corresponding to about 20% reduction.

Table 2. Reduction of total dioxins in contaminated soil (TEQ-pg/g)

	Start	After 5 month	Reduction %
A	5207	5069	2.7
B	4774	5086	-6.5
C	4838	3851	20.2

Discussion

As shown in the above results, dioxins concentration based on TEQ decreased by about 20% and total dioxins were decreased by 17.8% in the sample of the lysimeter C. The reason is considered that activity of microorganisms in the lysimeter C was higher than the lysimeter A and B, because the lysimeter C shown lower ORP value than A and B due to adding nutrient. The degree of reductions was not as high as the previously reported average, but the examination of this study was performed in the field. These data indicate that degradation of dioxins by microorganism occurred on the site.

Acknowledgements

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References

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