# A CHRASTRISTICS OF THE REDUCTION IN DIOXINS FOR 24 MONTHS IN THE EXAMINATION OF A BIO-REMEDIATION LYSIMETER

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## Introduction

In 2005 Dioxin conference, we reported the result of a 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[1)]. The report has indicated that we got a high level degradation range of dioxin dioxins in lysimeter test with added new mineral salts. Therefore, we continued to examine the lysimeter test for 24 months.

In this study, we reported the result of lysimeter test actual dioxin-contaminated soils in landfill sites for 24 months.

## Materials and methods

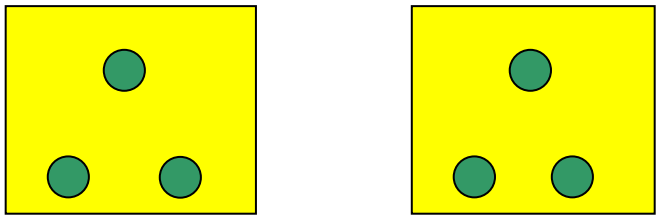
*(1) Items measured in the experiment*

Items measured in the experiment are as follows:

1. Dioxins (PCDDs, PCDFs, Co-PCB) variously, 2. Water content, 3. pH, 4. ORP (oxidation-reduction potential), 5. Numbers of bacteria, and 6. Temperature.

*(2) Installation of the lysimeter*

Two lysimeters were installed (A: Organisms mixture + nutrient salt + minerals (Mnso4, FeCl2, ZnSO4, CuSO4, Na2MoO), andB: Organisms mixture + nutrient salt + minerals + caustic silver). 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. 450kg of soil, 20kg of bacteria and 30kg of new dilution nutrient salt were placed in lysimeter A, and 400kg of soils, 20kg of bacteria and 80kg of nutrition were pleased in lysimeter B.



A: bacteria (mixture) Nutrient and minerals

B: bacteria (mixture), nutrient salt, minerals and caustic silver

Figure 1 Conditions of lysimeter tests and sampling points

The concentrations of the dioxin based on toxicity equivalence quantity (TEQ) were A: 1,870 pg-TEQ/g, and B: 1,860pg-TEQ/g. The total dioxin concentrations A: 129,600 pg/g and B: 119,200pg/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.

*(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[2)]. 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 and Discussion**

*(1) Changes in pH and ORP in the lysimeter*

Changes in the pH in the lysimeter A were 5.5-8.1, and in the lysimeter B were 4.8-4.9. It was shown that ORP in Lysimeter A was 98 to 216 mV and that in B was 214 to 365 mV. The lysimeter A and B were in aerobic condition.

*(2) Reduction of dioxins in the contaminated 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 24 months, dioxins were reduced by 19.4% in lysimeter A. Lysimeter B showed a dioxin reduction of 10,100 pg/g, corresponding to about 8.5% reductions. It was indicated that the strains in the lysimeter A might had the ability to degrade the dioxins.

Table1. Reduction of total dioxins in the contaminated soil (pg/g)

| | Start | 24 months | Deference | After 24 months reduction % |
|---|---|---|---|---|
| A | 129,600 | 100,600 | 29,000 | 22.4 |
| B | 119,200 | 109,100 | 10,100 | 8.5 |

*(3) Reduction of dioxins based on TEQ*

The reduction based on TEQ of dioxin is shown in table 2. After 24 month, lysimeter A showed a dioxin reduction of 430 TEQ–pg/g, corresponding to about 23% reductions.

Table2. Reduction of total dioxins in contaminated soil (TEQ-pg/g)

| | Start | After 24 month | Deference | Reduction % |
|---|---|---|---|---|
| A | 1,870 | 1,300 | 570 | 30.5 |
| B | 1,860 | 1,600 | 260 | 14.0 |

*(3) Characteristics of Reduction of PCDDs in* lysimeter *A*

The characteristics of the reduction based on each kind of PCDDs concentration in lysimeter are shown in Fig. 2.

The results were showed that in lysimeter A resolution proceeds with PCDDs from TCDDS to OCDDs were degradated well. HCDDs , PCDDs and TCDDs were degradated 33%,32.9% and 27%, repeatedly.

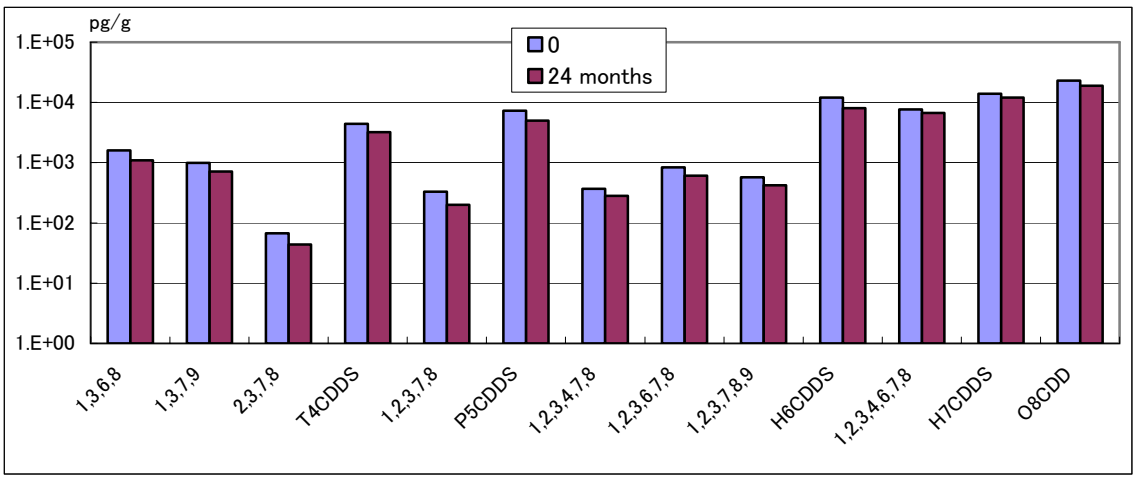



Fig.2 The characteristics of the reduction based on each kind of PCDDs concentration in lysimeter

*(4) Characteristics of Reduction of PCDFs in* lysimeter *A*

The characteristics of the reduction based on each kind of PCDFs concentration in lysimeter are shown in Fig. 3.

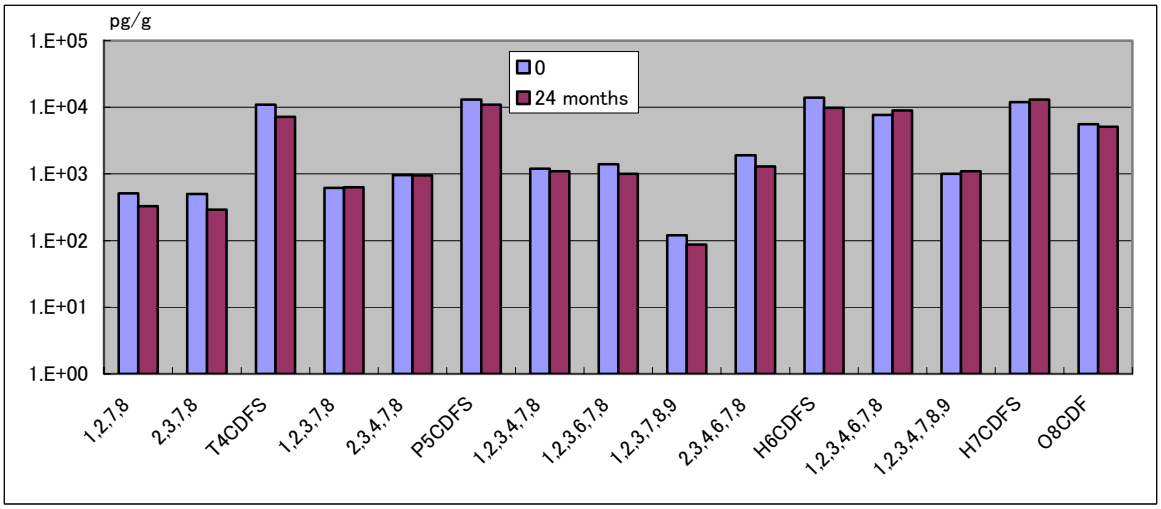



Fig.3 The characteristics of the reduction based on each kind of PCDFs concentration in lysimeter

The results were showed that in lysimeter A resolution proceeds with PCDFs from TCDFS to OCDFs were degradated excepted HCDFs. HCDFs and TCDFs were degradated 30%,and 34.5%, repeatedly.

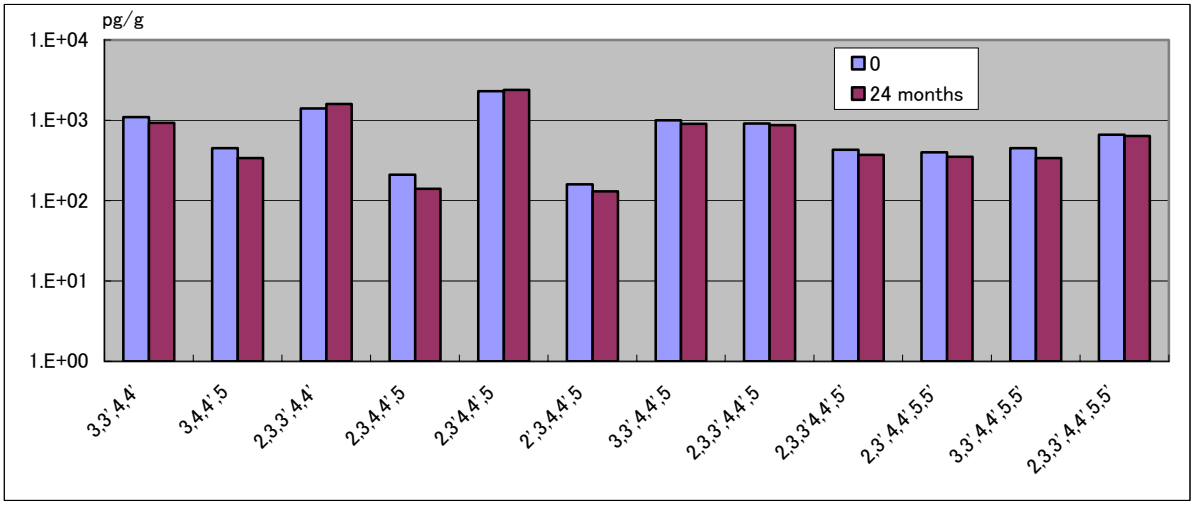



Fig.4 The characteristics of the reduction based on each kind of Co-PCBs concentration in lysimeter

The results were showed that in lysimeter A resolution proceeds with Co-PCBs. 3,3,4,4,TCB was degradated 15.5%. 3,3,4,4,5,5-HCB was degradated 17.5%. All of Co-PCBs werenot degradated well.

The examination of this study was performed in the same field as (well as) our test from 2003 to 2005. We reported the result of 5 months in 2005 Dioxin conference[1)]. As shown in the 2005 reports, dioxins concentration based on TEQ decreased by about 23% and total dioxins were decreased by 28.4 %. These 24 months data indicated that dioxins concentration based on TEQ decreased by about 30.5% and total dioxins were decreased by 22.4 %. TEQ after 24 hours is higher than after 5 months. But, the amount of total dioxins rises conversely. The reason is not clear, but we thinks that it is a thing by the analysis error. In the lysimeter B, the degree of reductions of total dioxins and TEQ was 14.0% and 8.5%, each. The activity of microorganisms in the lysimeter B was lower than that in the lysimeter A. Caustic silver is strongly toxic for the microorganisms. The considered reason was the caustic silver in lysimeter B, which was attached to the microorganisms and disabled them to degrade total dioxins. Though these results, we guesses many kind of dioxins was resolved for a long time by the function of the microorganism.

**Acknowledgements**

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**References**

1. Ikuo Souta et al. (2005), *Organ halogen Compound*s 2527-2529(2005)

2. Ikuo Souta et al. (2004), *Organ halogen Compounds* Vol.66, 1296-1298.