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Endocrine Disrupters in Leachate from Sanitary Landfill Sites

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1. Introduction

Recently endocrine disrupters(EDCs) have been of considerable public concern and interest. EDCs, which affect the normal functioning of hormones in human at even trace level, are found among chemicals used in modern industry, products and everyday life.

Since some of these EDCs are widely used in plasticizer(phthalic esters) of stabilizer (organotin compounds), it is no doubt that EDCs exist in leachate from landfills, which were dumped with large amount of waste plastics. However, few studies have investigated EDCs levels of leachate from landfill.

Therefore, the purpose of this study was to investigate EDCs levels in leachate from two MSW landfills, and compare them with background levels in the environment. The followings were mainly investigated.

1) The difference of concentrations of EDCs in leachate from solid waste of different ages.

2) Each removal rate of EDCs at a chain of treatment process units of leachate in leachate treatment plant.

2. Materials

In July 1997, Japanese Environment Agency published about 70 chemical substances suspected of having endocrine disrupting properties. Of these EDCs, this study focuses on the chemical substances which are suspected to exist in landfill and frequently detected in other surroundings(Table 1). Figure 1 shows the trend of amount of produced substances selected in this study. The amounts of produced BPA, PE and OT are substituted for those of polycarbonate & epoxy resin, plasticizer of PE type, and polyvinyl chloride resin, respectively.

Table 1. Characteristics of objective chemical substances

Category	Substance	Purpose	Influence on the environment
Alkyl Phenol(AP)	4-t-Octylphenol (4tOP) 4-n-Octylphenol (4nOP) Nonylphenol (NP)	Nonionic surface activate, Ink	Hermaphroditism of fishes in UK rivers
Bisphenol A(BPA)	Bisphenol A (BPA)	Polycarbonate, Epoxy resin	Estrogenic action suspected
Phthalic Ester(PE)	Diethyl phthalate (DEP) Dibutyl phthalate (DBP) Butyl benzyl phthalate (BBP) Diethylhexyl phthalate (DEHP)	Plastisizer	Estrogenic action suspected
Organotin Compound(OT)	Tributyltin (TBT) Triphenyltin (TPT)	Ship's bottom paint, Stabilizer for polyvinyl chloride resin	Imposex in gastropods

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3. Measurement of the leachate from the landfill sites

(1)The objective landfills of the investigation

Landfill site A are mainly composed of shredded solid waste and commingled municipal solid waste(MSW) without incineration, the composition of waste are characterized as food wastes(31%), paper(37%) and plastics(15%). Meanwhile, landfill site B has bottom ash(20%) and MSW without incineration(80%). Sampling points of leachate and operation period of two landfills are shown in Figure 2 and Table 2 respectively.

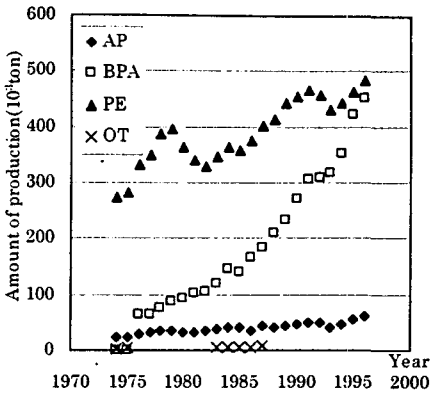

Figure 1. Production of objective chemical substances

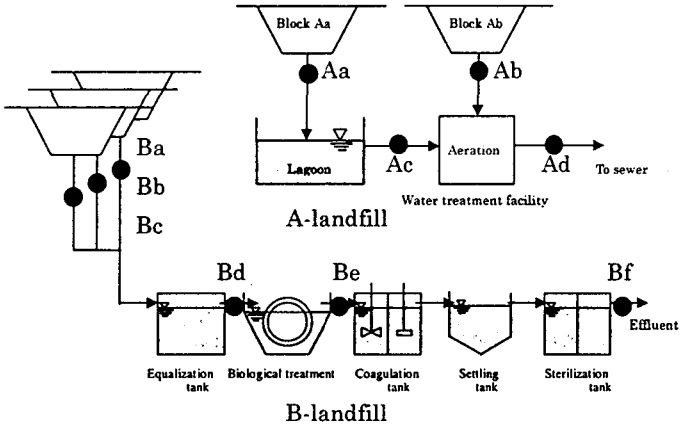

Figure 2. The objective landfills and the leachate treatment process

(2)Procedure

Samples were separated by filtration into liquid and solid, and each of them was pretreated and measured based on *Interim Manual for Endocrine Disrupter Chemicals Examination*[2]. Selected EDCs were determined by gas chromatography / mass spectrometer.

Table 2. Operating period of blocks in the landfill sites

Landfill site	Block	Operating period
A	Aa	1979-1991
	Ab	1992-
B	Ba	1984-1991
	Bb	1991-1996
	Bc	1995-

(3)Results and discussion

Alkyl Phenol(AP) :

The concentrations of 4tOP were less than 0.4 μ g/L(the detection limit is 0.01 μ g/L) in all measuring points. 4nOP and NP were less than 0.1 μ g/L(the detection limit is 0.01 μ g/L and 0.1 μ g/L, respectively).

It was reported that influent concentrations of sewage treatment plant ranges from 1 μ g/L to tens of μ g/L,

0.1-1 μ g/L in treated wastewater and 0-2 μ g/L in river. From these results, the main sources of NP are considered to be industrial and domestic waste water, but not leachate from landfill.

Bisphenol A(BPA) :

In A-landfill, the concentrations of BPA in leachate from relatively new block Ab were 144-222 μ g/L, which was about 4 times higher than those from block Aa that has passed 10 years since landfilling operations finished(Figure 3). The concentrations of BPA in river are 0-1.4 μ g/L, so BPA was dissolved in raw leachate approximately 100 times higher than those in river. The lower concentrations in old waste may be due to washout by water from the waste and decomposition by microorganisms. As shown in Figure 1, lower production of BPA in operation periods of Aa, half of that in Ab, may be another reason. The same time-dependency can be seen. Also in the landfill-B, i.e. the concentrations in the block Ba is lower than those in the both block Bb and Bc.

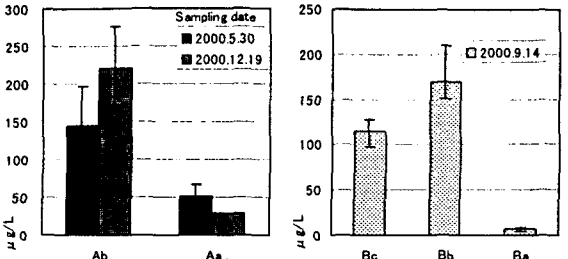

Figure 3. BPA in raw leachate

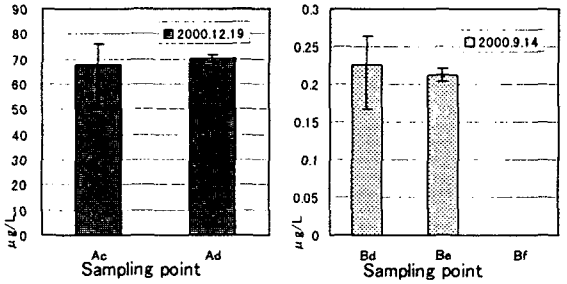

Figure 4. BPA in leachate treatment facility

In the A-landfill, there was no reduction of BPA after aeration and coagulation treatments(Figure 4). In the B-landfill, the concentration at the sampling point Bd, before biological treatment, was already as low as that in river. No removal was obtained by rotating biological contactors. BPA in effluent(Bf) was lower than the detection limit, 0.01 μ g/L. It is reported that a activated carbon treatment is effective for BPA removal from a leachate[3], but it was not clear which process were effective to remove BPA.

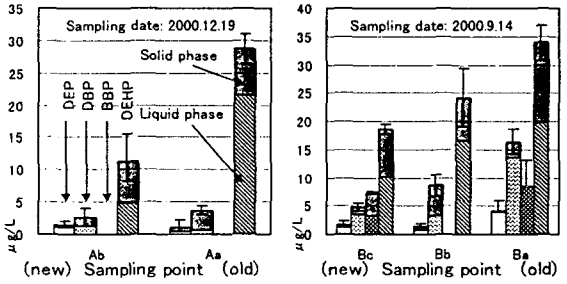

Figure 5. PE in raw leachate

Phthalic Esters(PE) :

In figure 5, the concentrations of DEHP was the highest among PE constituents at all sampling points. The decrease in old landfill was not clearly observed. DEHP in leachate from older blocks(Aa and Ba) were about 30 μ g/L, so they are higher than those in river, 0-9.4 μ g/L.

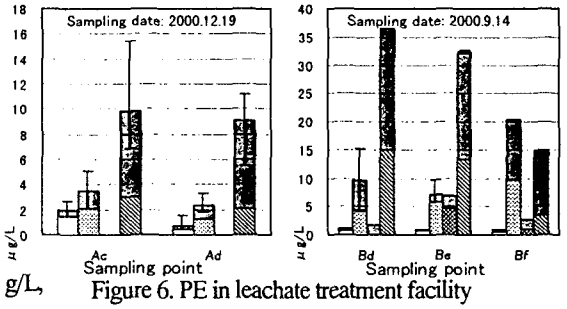

Figure 6. PE in leachate treatment facility

Figure 6 shows PE concentrations in leachate treatment systems, but no reduction was observed. The

concentrations of DEHP in effluent were 2.2-3.4 μ g/L, almost the same level of river.

Organotin compounds(OT) :

OT(TBT and TPT) is used as stabilizer for polyvinyl chloride resin, so it was expect to be detected in leachate. But TBT and TPT were not measured in the leachate(the detection limit was 0.01 μ g/L). The concentrations of TBT and TPT in firth and bay waters are 0-0.08 μ g/L. It is believed that lower concentrations of TBT or TPT than the detection limit have toxicity.

4. Conclusions

1. BPA and PE in leachate, which is originated from plastics, were found in higher concentrations than those in river.
2. In leachate from 10-year-old waste, BPA and PE are still higher than that of river. So they will be discharged for a long time after the closure of landfill.
3. No reduction of BPA and PE were observed in leachate treatment system, with exception of BPA reduction in a equalizing tank in B-landfill.
4. The concentrations of AP and OT were lower than those in river.

References

1) River Planning Division, Ministry of Construction: Field Research of Endocrine Disrupters in the Rivers, 1998(in Japanese).
2) Water Management Section, Water Protection Department, Ministry of Environment,1998(in Japanese).
3) Taro Urase, Kazuya Yamada, Tomonori Matsuo: Analysis of Endocrine Disrupters in Landfill Leachate, *Proceedings of the 9th Annual conference of the Japan society of Waste Management Experts*, pp. 830, 1998(in Japanese).