ASSESSMENT ON TWO TECHNICAL DECABROMODIPHENYL ETHER CONTAMINATED SITES IN CHINA

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Introduction

Decabromodiphenyl ether (DecaBDE) is released by different processes into the environment, such as emissions from manufacture of decaBDE-containing products and from the products themselves. However, reports on technical decaBDE production factories were scarce. In this study, two technical decaBDE production factories in China were selected to evaluate the pollution status of the surrounding environment.

Materials and methods

A total of 89 samples were collected including four water samples, 22 plant samples, 51 surface soil samples, and 12 column soils from two technical decaBDE production factories (F1 and F2) in China. The target polybrominated diphenyl ethers (PBDEs) were BDE-28, BDE-47, BDE-100, BDE-99, BDE-154, BDE-153, BDE-183, and BDE-209. The analytical method was based on US EPA Method 1614 and ISO 22032, with minor modification.

Tri- to hepta-BDEs were determined by gas chromatography–mass spectrometry (GC-MS) (2010plus, Shimadzu, Japan) with EI mode. A DB-5ms capillary column (30 m long, 0.25 mm i.d., 0.25 μm film thickness) was used for tri- to hepta-BDEs determination. The temperature program of GC oven: initial hold at 100°C for 1 min, increase at 25°C·min^{-1} to 250°C, then increase at 7°C·min^{-1} to 320°C, hold for 7 min. For BDE-209, ZB-5HT capillary column (15 m long, 0.25 mm i.d., 0.1μm film thickness) was used with GC-MS in ECNI mode. The temperature program of GC oven: initial hold at 100°C for 1 min, increase at 30°C·min^{-1} to 320°C, hold for 4 min. The instrument detection limits of tri- to hepta-BDEs ranged from 0.3 to 1.0 ng. For BDE-209, the instrument detection limit was 27 ng.

Results and discussion

PBDEs in soil and plant samples from F1

BDE-209 was the predominant congener in soil (mean: 21,700 μg/kg) and plant (20,600 μg/kg wet weight) samples from F1 (Figure 1 left). Of the lower-brominated PBDE congeners, BDE-153 and BDE-183 were the most abundant congeners, followed by BDE-154, BDE-99 and BDE-47. PBDEs concentrations in plant samples were relatively lower than values in the soils.

BDE-47, BDE-99, BDE-153, BDE-183, and BDE-209 were main congeners detected in soils from Chinese e-waste dismantling areas[1]. PBDE congener pattern in soil and plant samples from technical decaBDE production factory (F1) is similar to the soil samples from the e-waste dismantling areas.

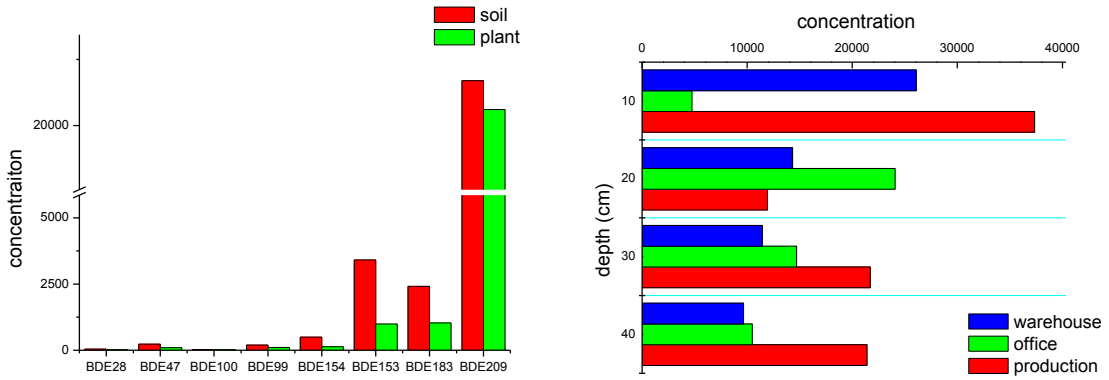

Figure 1. Left: Mean concentration (μg/kg) of PBDEs in soil (n = 47) and plant (n = 22) samples from F1; Right: BDE-209 concentrations (μg/kg) at different depths in warehouse, office, and production workshop soils, respectively.

Soil column samples collected in warehouse, office, and production workshop shows different concentrations at different depths (Figure 1 right and Figure 2). The BDE-209 concentration in the warehouse soils decreased from 26,100 μg/kg to 9,640 μg/kg as the depth increase. However, the highest concentration of BDE-209 (24,100 μg/kg) was detected in the subsurface layer (10-20 cm) soil of the office place. Daily cleaning may led relatively lower BDE-209 in the surface soil (0-10 cm) of the office comparing with the warehouse and production workshop. The highest BDE-209 in the surface soils was found in the production workshop. The value reached to 37,300 μg/kg. Furthermore, BDE-209 was higher in 20-30 and 30-40 cm layers than in 10-20 cm layer for the production workshop samples.

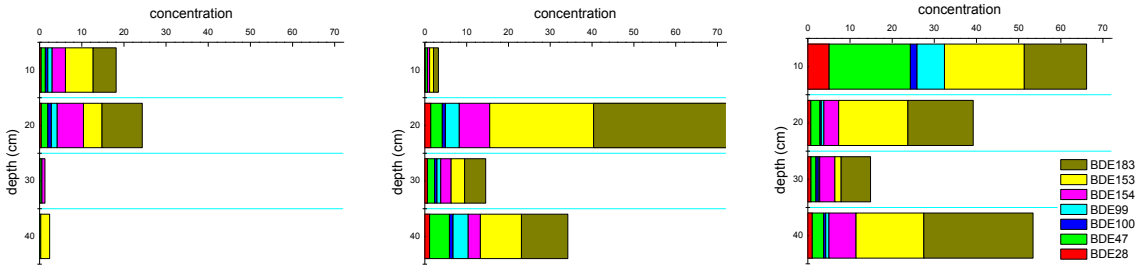

Figure 2. Lower-brominated PBDE congener concentrations (μg/kg) at different depths in warehouse (left), office (middle), and production workshop (right) soils, respectively.

For the lower-brominated PBDE congeners, the pollution patterns were very different in warehouse, office, and production workshop soil samples (Figure 2). Further studies were needed to explore the migration behavior of different lower-brominated PBDE congeners in soils.

PBDEs in soil and water samples from F2

PBDEs in soil and water samples from F2 were listed in Table 1. Similar pattern was found in soils between F1

and F2. BDE-209 was the predominant congener in water samples. For the lower-brominated PBDE congeners, only BDE-47 and BDE-153 could be detected in water samples.

The congeners BDE-28, BDE-47, BDE-100, and BDE-183 were most abundant, where BDE-209 was detected only in trace amounts in marine waters in Hong Kong[2]. Different pollution sources may be the main reason leading to these results.

Table 1. PBDEs concentration in soil (μg/kg) and water (ng/L) from F2

	BDE-28	BDE-47	BDE-100	BDE-99	BDE-154	BDE-153	BDE-183	BDE-209
Soil-1	9.22	46.4	4.38	30.6	29.2	153	149	167000
Soil-2	530	2550	336	4440	4550	31200	27300	156000
Soil-3	16.2	25.4	1.78	1.66	13.5	65.3	92.0	73000
Soil-4	10.8	30.5	1.96	8.53	27.4	158	179	125000
Water-1	N.D.	0.73	N.D.	N.D.	N.D.	2.79	N.D.	514
Water-2	N.D.	N.D.	N.D.	N.D.	N.D.	2.10	N.D.	191
Water-3	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	491
Water-4	N.D.	4.25	N.D.	N.D.	N.D.	N.D.	N.D.	22000

N.D.: not detectable.

Acknowledgements

This work was supported by the National Basic Research Program of China (Grant No. 2009CB421602), and the National Natural Science Foundation of China (Grant No. 21147006).

References

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2. Wurl O, Lam PKS, Obbard JP. (2006); *Chemosphere*. 65(9): 1660-6