

LEVELS OF PBDE IN HOUSEHOLD DUST AND LINT IN THE UK, GERMANY AND THE USA

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Introduction

Over the past ten years evidence has been emerging about the dramatic rise of levels of polybrominated diphenyl ethers (PBDE) in human samples^{1,2} at the same time when human levels of other Persistent Organic Pollutants are declining due to worldwide emission reductions. Part of the emerging story of the human body burden of PBDE so far has also been that levels in North America tended to be higher than those reported from Europe³. The relative importance of exposure to household dust versus dietary exposure has been subject to a number of recent papers⁴⁻⁹. Whilst there is no consensus as yet it appears that different from other POPs household exposure is more and more likely to be a relevant pathway.

We have evidence from the UK that BDE-209 occurred in very high concentrations in sediment¹⁰. When reporting a comparative study of household dust from Australia, the USA, Germany and the United Kingdom in 2005, Sjoedin et al. observed UK household dust levels to be above those from the United States and have a high predominance of BDE-209⁷.

BDE-209 is the main component (>90% w/w) of the technical mixture Bromkal 820DE. In 2001 Alsopp et al reported on behalf of Greenpeace levels of domestic carpeting from the UK of up to 1600ng/g BDE-209 with other PBDEs below the detection limits¹⁰.

While many of the earlier studies on household dust were unable to measure BDE-209 due to technical difficulties technology has recently advanced so that it can be routinely included in the battery of BDE tests.

Household and vacuum cleaner dust have frequently been used to characterize indoor exposure to household contaminants. However, due to the nature of the inherent variation in sampling and the consequent lack of homogeneity of samples lint or tumble dryer fluff may be a better and more homogeneous indicator matrix for PBDE contamination of households. They may either reflect the indoor air concentration of the room they are located in or act as passive sampler of indoor air and dust of the entire household.

In light of high reported levels of BDE-209 in UK sediments and household dust we present data here comparing household vacuum cleaner dust and lint samples from the North of England, Scotland, the North of Germany, and the Dallas area of Texas.

Material and Methods

Sample collection:

We collected vacuum cleaner dust from 9 households in Scotland and Northern England,. Lint samples were available from 6 household in Scotland and Northern England, 7 households in Northern Germany, and 10 households in Dallas, Texas. Participants provided us with details of their dwelling, age of the property, floor covering, number of occupants, number of electronic devices.

Sample preparation and analysis

Vacuum cleaner samples were sieved using an approximately 2mm sieve, transferred to a Ziploc® bag and stored at room temperature until analysis. Samples were extracted using soxhlet extraction with N-Hexane. Lint

Brominated Compounds - Sources and environmental levels

samples were directly extracted with N Hexane. Samples were analysed using gas chromatography/isotope dilution high resolution mass spectrometry (GC/IDHRMS).

Results and Discussion

Table 1 shows the concentrations of individual PBDEs and their sum in household dust and lint samples.

Table 1 Individual PBDEs and their total by household [ng/g] original sample basis

BDE (Number of bromine substitutes)												
	#17 (3)	#28 (3)	#47 (4)	#66 (4)	#85 (5)	#99 (5)	#100 (5)	#153 (6)	#154 (6)	#183 (7)	#209 (10)	Total
Household No. NorthEast England & Scotland (N=NorthEast England, S=Scotland)												
Dust Only												
3N	0.065	0.29	16	0.53	2.8	38	5.7	6.5	4.0	2.5	1996	2073
4N	0.38	1.2	9.2	0.97	19	n.a.	2.8	7.0	2.2	20	54795	54858
5N	0.13	0.29	30	1.0	4.4	56	9.4	9.7	6.2	20	3796	3934
6S	0.077	Nd 0.2	4.2	0.25	0.53	8.0	1.2	1.00	33	0.88	2795	2844
7S	0.44	1.8	62	3.0	3.7	85	16	8.4	7.8	9.7	1401	1599
10N	0.10	Nd 0.3	27	0.98	5.2	74	11	7.6	7.3	8.9	19502	19644
11N	0.095	Nd 0.2	12	0.49	0.90	16	2.9	2.9	1.4	9.3	7829	7876
Lint Only												
2N	0.034	0.079	5.4	0.17	0.30	6.1	1.1	0.74	0.59	0.67	322	337
8S	0.056	Nd 0.1	5.4	0.19	0.45	8.7	1.4	0.85	0.68	1.4	1079	1098
9S	0.083	0.37	19	0.31	0.71	20	3.1	2.3	1.1	4.6	1446	1497
12N	0.070	0.21	7.0	0.46	0.83	15	2.3	3.0	1.7	7.8	1348	1386
Dust and Lint (N)												
1L	0.025	0.10	4.4	0.18	0.31	5.4	0.92	0.71	0.40	0.47	440	453
1D	Nd(0.06)	Nd 0.2	4.5	0.34	0.52	7.9	1.3	1.8	1.1	3.7	2725	2746
13L	0.12	1.1	17	1.1	0.61	11	2.0	2.0	0.90	4.8	828	869
13D	0.13	0.79	37	1.3	1.7	36	6.1	4.5	3.1	8.8	6262	6361
Lint Only												
Household No. Northern Germany												
14	0.23	0.67	28	0.48	1.8	38	7.0	3.2	3.1	1.9	33	117
15	0.080	0.30	3.6	0.065	0.11	2.1	0.43	0.27	0.18	0.63	22	30
16	0.079	0.26	11	0.23	0.52	8.8	1.5	1.0	0.72	1.0	46	71
17	0.027	0.092	4.9	0.089	0.25	5.7	1.0	0.54	0.45	0.90	47	61
18	0.012	0.044	12	0.21	1.00	33	1.6	2.3	0.69	0.74	17	69
19	0.053	0.13	9.9	0.15	0.66	16	3.1	3.5	1.9	12	64	112
20	0.047	0.27	17	0.23	0.39	9.5	2.0	1.2	0.73	19	2036	2069
Household No. Dallas, Texas												
21	0.30	1.0	71	3.3	3.8	93	18	9.7	8.5	4.3	513	726
22	0.40	3.2	258	9.4	10	275	62	29	25	17	2149	2842
23	0.26	2.2	194	8.8	7.4	265	46	27	20	2.4	114	691
24	0.45	2.6	273	4.6	19	350	76	41	35	1.9	518	1327
25	0.26	2.4	268	13	7.8	344	73	38	32	3.1	871	1657
26	0.55	3.3	278	15	8.4	336	63	42	32	2.4	93	879
27	0.68	8.2	1028	41	27	931	407	99	157	6.9	361	3073
28	1.1	4.5	166	2.4	7.3	143	32	14	13	1.1	59	443
29	0.22	0.85	63	1.8	2.0	73	13	7.0	5.5	1.9	711	880
30	0.41	1.5	105	4.7	4.2	113	22	9.4	9.1	2.0	110	382

Brominated Compounds - Sources and environmental levels

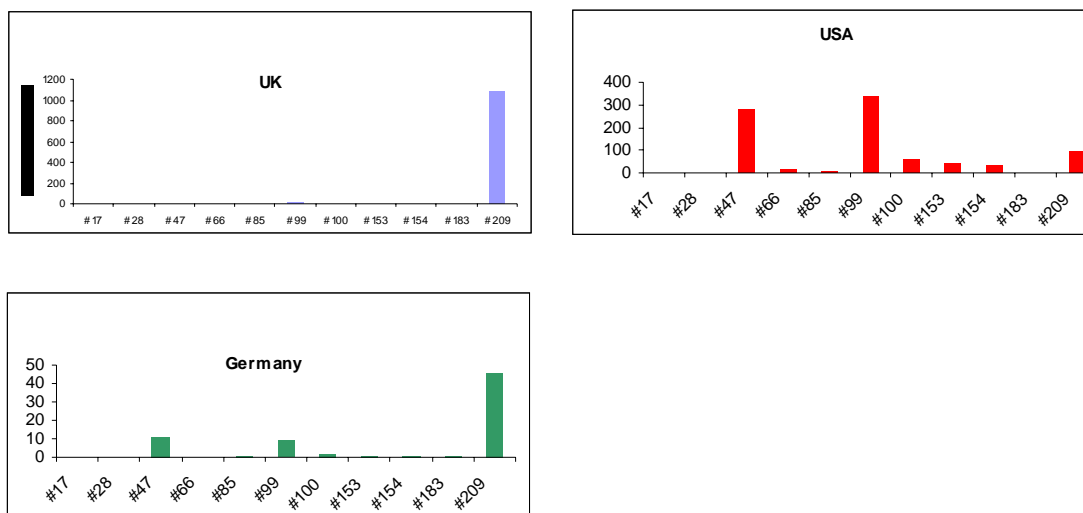
Table 2 shows the median levels of PBDE in lint and dust samples comparing the 2005 and current samples. Figure 1 plot three typical examples of PBDE congener patterns of samples containing approximately average overall concentrations for their country of origin.

Table 2 Median levels of PBDE in lint and dust samples [ng/kg]

BDE												
	#17	#28	#47	#66	#85	#99	#100	#153	#154	#183	#209	total
Dust												
USA 05*	N/A	N/A	430	N/A	N/A	880	150	140	80	70	2,000	4,200
UK 2005	N/A	N/A	22	N/A	N/A	28	4	5	3	5	10,000	10,000
D 2005	N/A	N/A	<14	N/A	N/A	10	<6	<6	<6	<6	63	74
UK 2006	0.1	0.29	16.3	1.0	2.8	35.8	5.7	6.5	4.0	8.9	3,796	3,933
Lint												
USA 06	0.4	2.5	226	6.7	7.6	270	54.4	28.0	22.92	2.4	437	880
UK 06	0.06	0.16	6.2	0.3	0.5	9.9	1.7	1.4	0.8	3.0	953	983
D 06	0.05	0.26	10.6	0.2	0.5	9.5	1.6	1.2	0.7	1.0	45.7	71

*7

Figure 1 PBDE congener pattern in lint in the UK, USA and Germany



We found levels of PBDE in UK vacuum dust to be in the same order of magnitude as was reported recently and in the same order of magnitude as US samples⁷. This is in contrast to previous reports from other European countries and Australia which reported levels well below those from the United States. The distribution of UK vacuum cleaner samples was highly skewed with a mean of 11,325, median of 3933ng/kg, and a very large range: 1599-54857ng/kg. Most PBDEs were detectable in the large majority of samples, but the highly predominant BDE in UK dust samples was the deca-brominated BDE #209. This is consistent with previous reports from sediment and household dust. US and UK samples had total PBDE levels that were two orders of magnitude higher than those from Germany, but US samples showed a wider spectrum of BDE congeners contributing to the total amount.

Lint samples had lower levels than vacuum cleaner dust samples, the distribution was less skewed, and the range not as large as for dust samples. For US lint the mean was 1290, the median 878ng/kg (min 382, max 3073ng/kg). BDE #47 and BDE #99 made substantive contributions to the total level in US samples (21%, 22% respectively) (see figure 1). UK lint samples had a near normal distribution with BDE #209 making by far the

Brominated Compounds - Sources and environmental levels

largest contribution (97%): mean 940, median 983ng/kg. German lint samples had a mean of total PBDE of 361, median 71ng/kg with the skewed distribution explained by a single sample that had a high contribution of BDE #209 more typical of US or UK samples. The congener patterns in lint differed from those in dust in that the higher brominated congeners were detected at proportionately lower concentrations (i.e. lower % of BDE #209 in all three countries). We interpret this to mean that it is likely that lint contamination reflects the air pathway more clearly than household dust.

Conclusions

- **PBDE levels in vacuum cleaner dust and lint in the UK and the USA were of the same order of magnitude and much higher than German samples**
- **Lint samples showed levels of at least one order of magnitude below dust levels**
- **Levels of PBDE in dust and lint differ between countries by several orders of magnitude but within country variation is also large**
- **Because of differences in levels and congener patterns between lint and vacuum dust we hypothesise that lint contamination is a reflection of airborne contamination with PBDE of a households**
- **In order to fully assess the contribution of indoor contamination with PBDE for human body burden comparative studies assessing both exposure and body burden should be carried out across a range of countries and including the potential determinants of such levels.**

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