

LEVELS OF PBDE IN EFFLUENTS AND SLUDGE FROM SEWAGE TREATMENT PLANTS IN AUSTRIA

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Introduction

In 2001 the Federal Environment Agency Austria on behalf of the Chemical Inspectorate carried out a first survey of the use of Brominated Flame Retardents in Textiles and Plastics. As a follow up in 2002 a study on the occurrence of BFR in the aquatic environment of Austria was carried out. This presentation gives an overview of concentrations of BFR in the effluents of wastewater treatment facilities and in selected sewage sludges.

Methods and Materials

In the following a short description of the analysed samples is given

samples

Overall Austria 36 sewage treatment plants were investigated. The samples originate from 22 urban sewage treatment plants, 12 industrial sewage treatment plants and two facilities cleaning mixed, industrial and urban wastewater. The sewage covered by this study represents effluents of electronic industry, paper mills, textile industry, metal working industry, food industry and photographic industry.

A total of eight sewage sludge samples has been analysed. Two sewage sludge samples, one dewatered and one activated sludge were taken from sewage treatment plants of leather producing industries and six sludge samples were taken from urban sewage treatment plants with a high percentage of industrial input.

analysis

The sample amounts used for analysis were 10 g freeze-dried solid sample or 0.5 l water sample. The analytic method used, described by W.Knoth et al.¹, includes Soxhlet extraction and a 4 step column chromatographic cleanup. Samples were spiked with 7 ¹³C-labeled standards prior to extraction. The sample solution was measured by GC/HRMS at resolution 8000. The detection limits depending on matrix were in the range of 0.1 and 2.0 ng/kg for sludge and between 0.001 and 0.1 ng/l for effluents. A total of 18 PBDE congeners were analysed, comprising BDE-11, BDE-17, BDE-25, BDE-28, BDE-47, BDE-49, BDE-77, BDE-99, BDE-100, BDE-116, BDE-138, BDE-140, BDE-153, BDE-154, BDE-155, BDE-166, BDE-181, BDE-183.

Results and Discussion

The concentrations of PBDE in effluents of urban and industrial sewage treatment plants, shown in Table 1, are in a similar range. PBDE concentrations in effluents of urban sewage treatment plants are below 1 ng/l except the congeners BDE-47, BDE-99, BDE-100, BDE-153, BDE-183 which show concentrations up to 19 ng/l. The concentrations of PBDE in effluents of industrial sewage treatment plants are also below 1 ng/l with the exceptions of BDE-47, BDE-49, BDE-99, BDE-100, BDE-183 with concentrations up to 6.7 ng/l. One sample from textile industry showed clearly higher levels in the range of 11 ng/l to 75 ng/l for the most abundant congeners.

Table 1. Concentration ranges of PBDE in all analysed effluents of sewage treatment plants. The concentrations of one single effluent belonging to a textile factory, clearly exceeding the maximum concentrations of all other samples are given in paranthesis

ng/l	effluents					
	urban sewage plant			industrial sewage plant		
# 11	n.d.	-	0.21	n.d.	-	0.0068 (n.d.)
# 17 / 25	n.d.	-	0.24	0.0072	-	0.044 (n.d.)
# 28	n.d.	-	0.39	n.d.	-	0.56 (0.89)
# 47	0.8	-	15	0.21	-	6.4 (17.00)
# 49	0.024	-	0.34	n.d.	-	4 (11.00)
# 77	n.d.	-	0.31	n.d.	-	0.11 (0.18)
# 99	0.37	-	5.7	0.037	-	2.7 (16.00)
# 100	0.091	-	1.6	0.098	-	2 (3.30)
# 116	n.d.	-	0.14	n.d.	-	0.57 (0.27)
# 138	n.d.	-	0.2	n.d.	-	0.19 (3.10)
# 140	n.d.	-	0.04	n.d.	-	0.68 (n.d.)
# 153	0.086	-	1.6	0.086	-	0.91 (12.00)
# 154	n.d.	-	0.45	0.026	-	0.61 (5.30)
# 155	n.d.	-	0.13	n.d.	-	0.18 (0.64)
# 166	n.d.	-	0.042	n.d.	-	0.054 (1.40)
# 181	n.d.	-	0.16	n.d.	-	0.39 (40.00)
# 183	0.29	-	19	n.d.	-	6.7 (75.00)

As can be seen in Figure 1 and Figure 2 the average congener patterns show, with one exception, no significant differences between urban and industrial sewage effluents.

The concentrations of PBDE in sewage sludge samples are shown in Figure 3. The highest concentrations, ranging from 5.5 µg/kg up to 65 µg/kg for the most abundant congeners, were found in a sewage sludge sample from a treatment plant with mixed inputs from textile industry and metal working industry. The sewage sludge samples taken from sewage treatment plants of the leather industry showed the lowest concentrations, 0.02 µg/kg up to 0.37 µg/kg for the most abundant congeners, of all analysed industrial sewage sludge samples. Looking at the congener pattern it is obvious that in sewage sludges influenced by metal working industries the concentrations of the congener BDE-181 are higher than those of congener BDE-183. Effluents and sludge samples,

drawn from the same sewage treatment plant showed a effluent / sludge concentration ratio of 1 / 1000 for nearly all PBDE congeners investigated.

Conclusions

In all investigated samples the most abundant congeners were BDE-47, BDE-99, BDE-100, BDE-153, BDE-154, BDE-181 and BDE-183. The majority of the analysed effluent and sludge samples showed similar congener patterns. Only in a few cases significant deviations from the average pattern could be observed. Sludge samples from leather industry showed lower concentrations for all congeners and especially BDE-181 and BDE-183 were less abundant than in the other sludge samples. PBDE concentrations of effluents were in a similar range for all samples, only one sample from a textile factory showed elevated concentrations. At one sewage treatment plant both effluent and sludge were analysed showing a concentration ration of 1/1000 for effluent/sludge.

References

1. Knoth, W., Mann, W., Meyer, R., Nebhuth, J.; (2002) Organohalogen Compd, 58, 213.

Figure 1. PBDE congener pattern of urban sewage treatment plant effluents

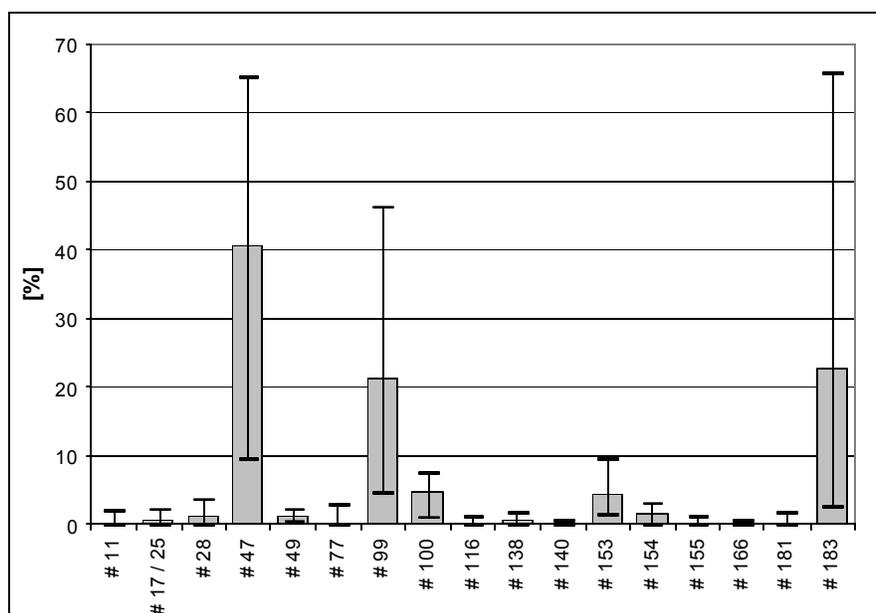


Figure 2. PBDE congenere pattern of industrial sewage treatment plant effluents (papermills, electronic, metal working, photographic)

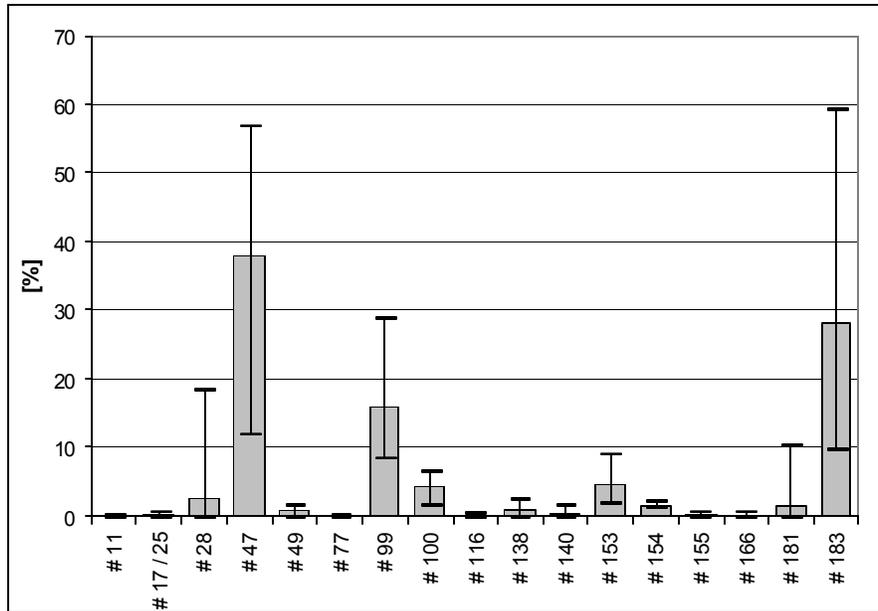


Figure 3. PBDE concentrations of sludge samples of industrial sewage treatment plants

