

Investigation of PCDD, PCDF and PAH evolving from combustion of linoleum

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Introduction

Polyvinylchloride (PVC) is widespread as organic material for production of linoleum, wallpapers, oil clothes, electrical insulation, packing films, hoses, artificial leather etc. From combustion of such materials various chlorinated products are formed including PCDDs and PCDFs. Decreasing of these products formation from combustion is one of the ways improving of such materials.

We studied PCDD/PCDF and PAH forming from combustion of uncombined PVC, mixtures PVC with some plastifiers - commonly using dibutylphthalate (DOP) and a new one - EDOS-a-386 (a mixture of polyfunctional compounds with oxygen containing cycles, hydroxy and ester groups) and samples of linoleum plastified with these plastifiers.

Material and methods

Combustion was carried out in specially constructed unit simulating burning in fire at temperature 600-1100°C and trapping combustion products totally. The sample of the material to be burned was placed in the flame of gas burner, combustion products were vacuumed off and trapped in the filter set (quartz wool filters diameter 200 mm, width 8 mm). Trapped combustion products were extracted by toluene at 100°C after internal standard adding - isotope labelled analogs for PCDD/PCDF and benzo(a)fluorene for PAH. Extract was cleaned up in the columns with modified silica, carbon and alumina. Cleaned extracts were analysed using GC-MSHR for PCDD/PCDF and HPLC for PAH.

Gas chromatograph Varian 3400 equipped with silica capillary column 60m x 0.25mm with stationary phase HP-5 and mass spectrometer Finnigan HSQ 30 were used. Column temperature was programmed from 160°C (1 min) to 220°C with rate 25°C/min and then to 270°C with rate 5°C/min. Molecular ions of PCDDs and PCDFs were registered in MS mode at resolving power about 6000.

Liquid chromatograph HP 1090 with stainless steel column 250 mm x 4.0 mm filled with reverse phase sorbent Nucleosil-100-5C18 (5 µm) and detector-fluorimeter HP 1046 was used for PAH determination.

Results and Discussion

As the analysis results shows (Tabl. 1-3) a lot of PCDD/PCDFs was evolved from combustion of PVC and linoleum. High chlorinated PCDFs were dominated.

In average the relative yield of various PCDDs and PCDFs in combustion products of mixtures of PVC and plastifiers is lesser than the percent of PVC in the mixture. Plastified linoleum gave more abundant yield of PCDD/PCDFs than mechanical mixture of PVC with plastifier.

Linoleum plastified with DOP evolved more PCDD/PCDFs than one plastified with EDOS (84,2 and 46,0 mcg/kg of the combusted material in TEQ, respectively). Very much PAH including benz(a)pyrene was evolved from linoleum combustion (about 160-170 mg/kg of the combusted material).

References

1. Cistmann W., Kasiske D., Kloppel K.D., Partsch H. and Rotard W.; *Chemosphere*. **1989**, 19, 387.
2. Theisen J., Funcke W., Balfanz and Konig J.; *Chemosphere*. **1989**, 19, 423.

Table 1

PAH in combustion products of PVC and its mixtures with plastifiers (mcg/g)

- 1) Combustion products of PVC.
- 2) Combustion products of mixture of PVC and plastifier dioctylphthalate (60:40 w/w).
- 3) Combustion products of mixture of PVC and plastifier EDOS (60:40 w/w)..

Component	1	2	3
Phenantrene	5,35	1,01	1,66
Antracene	18,52	16,32	51,13
Fluorantene	13,16	7,80	6,61
Pyrene	-	-	-
Benzo(a)antracene	142,50	44,48	42,59
Chrizen	143,13	37,74	38,40
Benzo(b)fluorantene	49,76	19,43	19,51
Benzo(k)fluorantene	16,39	4,92	7,14
Benzo(a)pyrene	29,25	7,99	7,32
Dibenzo(a,h)antracene	18,07	8,39	5,76
Indeno(1,2,3-cd)pyrene	30,37	9,19	13,55

Table 2

PCDDs and PCDFs in combustion products of PVC and its mixtures with plastifiers
(ng/g)

- 1) Combustion products of PVC.
- 2) Combustion products of mixture of PVC and plastifier dioctylphthalate (60:40 w/w).
- 3) Combustion products of mixture of PVC and plastifier EDOS (60:40 w/w).

Component	1	2	3
2,3,7,8-TCDD	<0,2	<0,2	<0,2
1,2,3,7,8-PeCDD	<0,2	<0,2	0,40
1,2,3,4,7,8-HxCDD	1,31	0,28	0,19
1,2,3,6,7,8-HxCDD	1,28	0,43	0,23
1,2,3,7,8,9-HxCDD	1,49	0,56	0,24
1,2,3,4,6,7,8-HpCDD	3,28	2,88	0,96
OCDD	1,55	3,39	0,40
2,3,7,8-TCDF	44,75	16,44	25,80
1,2,3,7,8-PeCDF	21,53	3,57	11,06
2,3,4,7,8-PeCDF	34,03	9,4	13,66
1,2,3,4,7,8-HxCDF	74,80	25,45	30,87
1,2,3,6,7,8-HxCDF	29,00	10,64	14,45
2,3,4,6,7,8-HxCDF	29,71	8,31	10,29
1,2,3,7,8,9-HxCDF	35,79	6,50	6,51
1,2,3,4,6,7,8-HpCDF	46,05	31,59	27,11
1,2,3,4,7,8,9-HpCDF	27,09	10,21	8,04
OCDF	26,05	18,97	12,63
Other TCDDs	7,41	9,20	9,20
Other TCDFs	175,35	82,03	97,46
Other PeCDDs	28,64	12,96	2,66
Other PeCDFs	577,11	160,99	111,59
Other HxCDDs	8,92	3,67	1,45
Other HxCDFs	97,26	40,94	56,19
Other HpCDD	3,00	1,48	0,60
Other HpCDFs	41,40	18,97	16,52
TEQ	40,70	12,30	16,81

Table 3

PCDDs and PCDFs in combustion products of linoleum containing PVC
and various plastifiers (ng/g linoleum)

Component	Concentration, ng/g	
	EDOS-a-386	Di(2-thylhexylphthalate
2,3,7,8-TCDD	0.13	0.11
1,2,3,7,8-PeCDD	0.25	0.27
1,2,3,4,7,8-HxCDD	0.085	0.13
1,2,3,6,7,8-HxCDD	0.090	0.14
1,2,3,7,8,9-HxCDD	0.23	0.94
1,2,3,4,6,7,8-HpCDD	0.14	0.29
ICDD	0.44	0.31
2,3,7,8-TCDF	1.44	3.80
1,2,3,7,8-PeCDF	3.18	8.27
2,3,4,7,8-PeCDF	2.14	6.53
1,2,3,4,7,8-HxCDF	5.27	9.31
1,2,3,6,7,8-HxCDF	2.72	3.93
2,3,4,6,7,8-HxCDF	2.09	7.64
1,2,3,7,8,9-HxCDF	0.80	3.67
1,2,3,4,6,7,8-HpCDF	3.23	17.67
1,2,3,4,7,8,9-HpCDF	1.46	7.67
OCDF	2.00	13.48
Other TCDDs	0.26	0.37
Other TCDFs	4.72	9.99
Other PeCDDs	0.38	1.45
Other PeCDFs	5.52	23.01
Other HxCDDs	0.55	0.83
Other HxCDFs	6.14	40.11
Other HpCDD	0.23	0.33
Other HpCDFs	2.33	14.32
TEQ	45.97	84.21