NILU TR : 5/86
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M. Oehme

S. Manø

A. Mikalsen

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NORWEGIAN INSTITUTE FOR AIR RESEARCH
P.O. BOX 130, N-2001 LILLESTRØM
NORWAY

ISBN 82-7247-721-1

ABSTRACT

Polyhalogenated compounds included polychlorinated dibenzo-p-dioxins and dibenzofurans were identified and quantified in the emissions of small (batch-wise operated) and continuous operated municipal wast incinerators. In addition, the amount of emitted polycyclic aromatics was determined. The results are represented and possible correlations between the concentration levels of the different compound groups are discussed.

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FORMATION AND PRESENCE OF POLYHALOGENATED AND POLYCYCLIC COMPOUNDS IN THE EMISSIONS OF WASTE INCINERATORS

1 INTRODUCTION

In the past years various investigations have been carried out to determine selected organic components in the emissions of municipal incinerators (1-3). Polychlorinated dibenzo-p- dioxins (PCDD) and dibenzofurans (PCDF) as well as polycyclic aromatic hydrocarbons (PAH) were usually analysed. However, in a few more extended studies it was shown that these compond groups represent only a minor part of the total organic emissions (5-8). Both other halogenated substances and substituted PAH could be identified. Normally no or incomplete quantitative results are given.

The aim of the presented work was to identify and quantify as many halogenated compounds as possible in the emissions of various municipal incinerators. These results allow to compare the concentration levels of different compound groups. Furthermore, they should give further information about formation processes. To cover a wider range of combustion conditions both continuous incinerators and smaller units, which are operated in a batchwise mode, were investigated.

2 EXPERIMENTAL

Investigated incinerators. Table 1 gives a survey over the size of the investigated incinerators.

Table 1: Survey of the municipal incinerators studied.

No	Incinerator type	Capacity (tons/hour)	Combustion temperature[1] (°C)	Literature
1	Bruun & Sørensen SR-100 batch-wise operated	1.1	850-950	(9, 12)
2	Thune-Eureka batch-wise operated	1.1	760-800	(10, 12)
3	Norsk Hydro BB4-4000 batch-wise operated	0.4	800	(10, 12)
4	Saniterm 1968 batch-wise-operated	1	?	(13)
5	Widmer & Ernst 1985 Zürich Switzerland	2.0	900-1000	(14)
6	Widmer & Ernst 1985 Zürich Switzerland	7	7800	(14)

[1]) Temperature measured during sampling at outlet of combustion chamber or after-burner.

Sampling and incineration conditions. Sampling was carried out with a stack-gas sampler as described in ref. (13) by Center for Industrial Research. More details about sampling and incineration conditions are given elsewhere (9-13).

Quantitative analysis. Filters and XAD-2 were precleaned as reported before (15). Toluene was used for soxhlet-extraction of filters and XAD-2. The sample extracts from filter, condensate and XAD-2 were collected together and divided into two aliquots. One part was used for the determination of polycyclic aromatic hydrocarbons (PAH) as described in (16). The second part was employed for PCDD/PCDF quantification and identification of polyhalogenated compounds. Quantification of PCDD/PCDF was carried out as described in (17). The method is similar to that used for ambient air samples. For most samples ^{13}C-marked isotopes were added as internal standards during sample clean-up and quantitative analysis (see also (18)). For very dirty samples a clean-up similar to that described by Smith (19) or Marklund (18) was used. Table 2 summarizes the procedure.

Identification of polyhalogenated compounds was carried out after sub-fractionation of the collected sample extracts using the set-up shown in Figure 1.

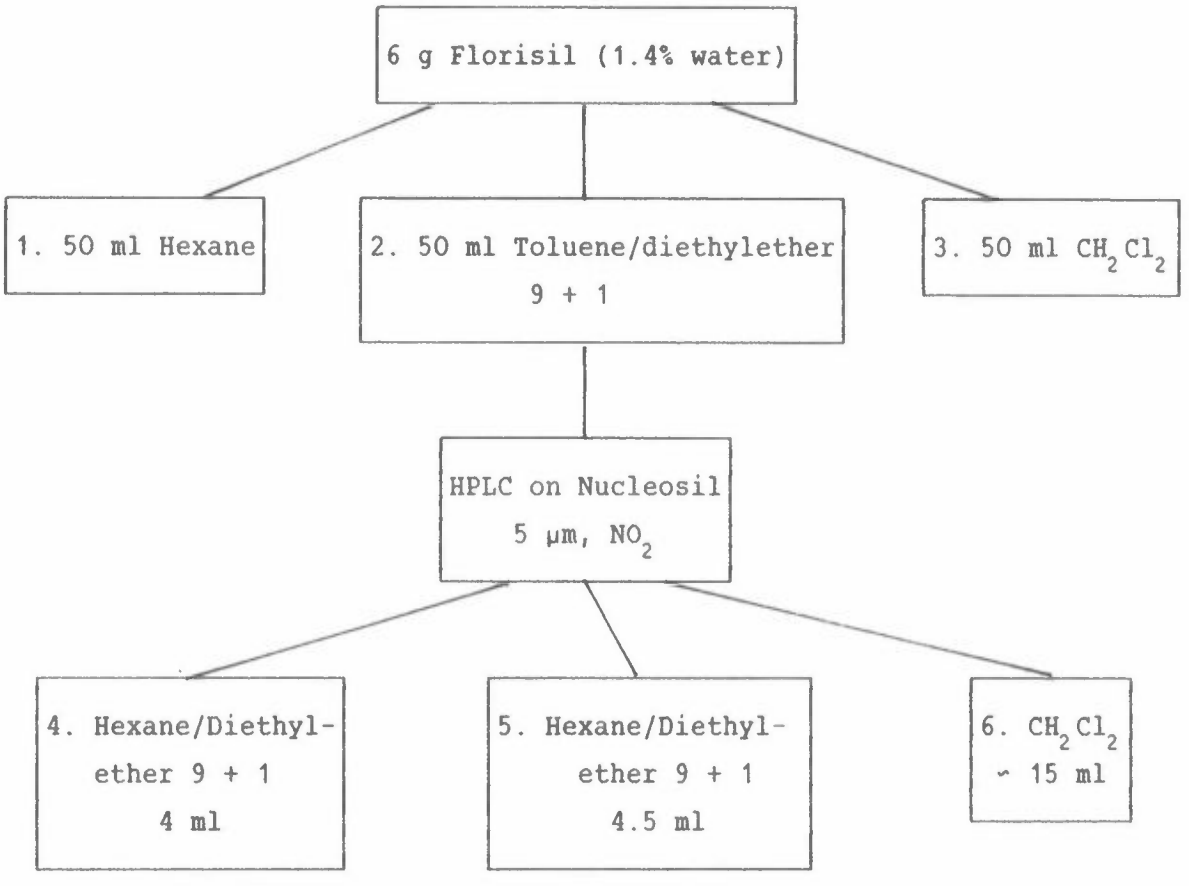

Figure 1: Fractionation scheme for identification of halogenated compounds.

Fractions 1, 3, 5 and 6 were afterwards concentrated to about 100 µl and separated by high resolution gas chromatography on a 30 m x 0.3 mm i.d. capillary (SE 54, 0.15 µm film thickness). Mass spectrometric detection using electron impact and negative ion chemical ionization was employed for identification (see also (20)).

Table 2: Analytical procedure for quantification of PCDD/PCDF in incinerator emissions.

(1) Cleaning of glass filters at 400^0C for 4 hours.
XAD-2: Soxhlet-extraction with methanol, acetonitrile, diethylether (6 hours each). ^{13}C-marked PCDD/PCDF are added as sampling standard to filter surface.

(2) Sample extraction: Filter, 72 h with toluene (soxhlet). XAD-2, 8 h toluene (soxhlet).
Condensate, 4 x 10 ml toluene.
Concentration of extracts to 0.5 ml.

(3) Clean-up: Elution of PCDD/PCDF with 50 ml diethylether/toluene 10 + 90 after 50 ml hexane from 6 g Florisil (1.4% H_2O).

(4) Solvent transfer to cyclohexane. High performance liquid chromatography on 25 cm x 4.6 mm Nucleosil 5 NO_2 with hexane (17).

(5) Additional clean-up on carbon particles for very dirty samples (18, 19).

(6) Isomer-separation on SP 2330 (30 m x 0.25 mm, fused silica) and quantification by electron impact or negative ion chemical ionization mass spectrometry using the selected ion mode (15, 17).

3 RESULTS AND DISCUSSION

Chlorinated benzenes (CLB), biphenyles (PCB) as well as PCDD/PCDF and PAH were quantified in the emission samples from all incinerators. A list about the selected PAH (26 compounds) is given in (16). The results are summarized in Table III. Results for single compounds are available in a separate report (21). Maximum values for the batch-wise operated incinerators (no. 1-4) were normally obtained during the starting period (see 13)).

In addition, the sample extracts from incinerator 4 (highest PAH-level) and 5 (highest PCDD/PCDF-values) were screened for other polyhalogenated compounds. Only traces of such compounds were found in the emissions of incinerator 4. However, a large variety and high levels of substituted PAH and related compounds could be identified (see additional information in (13)).

Table 3: Concentration of polychlorinated compounds and PAH in the emissions of the investigated incinerators.

Incinerator no.	n	Concentration level (ng/Nm^3)				
		Σ CLB	PCB	ΣPCDD/PCDF	2,3,7,8-TCDD EQ[1]	ΣPAH
1	3	160/171/540	<0.03/4.5/6.5	47/58/133	3)	13/51/210 10^3
2	1	3800	5.4	530	3)	30 10^2
3	3	34/42/46	<0.03	2)	3)	56/47 10^3
4	2	95/110	0.7/0.8	97/97	1.9/2.6	5.9 10^6
5	3	730/860/2300	35/45/60	934/1070/1820	9/12.7/20	840/960/-
6	2	360	14	73.5/225	2.0/2.4	1.78/14.1 10^3

n: number of parallels

[1]) according to Eadon (23)

[2]) not complete quality assurance

[3]) not all 2,3,7,8-substituted isomers determined

Abbreviations: CLB: chlorobenzenes
PCB: polychlorinatd biphenyls
PAH: polycyclic aromatic hydrocarbons

The sample extracs from incinerator 5 contained high concentrations of various polyhalogenated compounds. Figure 2 shows the total current ion chromatograms of fraction 1 and partly fraction 5. Table 4 gives a survey of identified compound groups. The results can be summarized as follows:

- Chlorobenzenes and PCDD/PCDF were the most pronounced compound groups. This is possibly also valid for chlorophenols (not determined).

- The concentration level of chlorinated PAHs decreased strongly with increasing number of ring systems. Polychlorinated napthalenes are present at 3-4 times higher concentrations than PCB. Only traces of the latter were found in all samples. Other chlorinated PAHs such as fluoranthene/pyrenes were only present at concentration levels below that of PCB.

- The highest concentrations of single compounds were found for the completely chlorinated species such as hexachlorobenzene, -benz-1,4-dioxin, and -benzofuran. From these compounds the monobromo-polychloro substances were present too.

- Not chlorinated compounds such as parent PAH and aliphatic hydrocarbons were present at minor levels compared to the polyhalogenated representatives.

- Both oxygen- and nitrogen-containing chlorinated compounds were found in fraction 6. However, the lack of standard compounds and sufficiently interpretable mass spectrometric information made a proper identification impossible in most cases.

- Negative ion chemical ionization mass spectrometry was very useful to obtain information about mixed polyhalogenated compounds (presence of both Cl^- and Br^- in the mass spectrum).

Table 4: Identified polyhalogenated compound in the emission of incinerator No. 5. The identification number for Figure 2 is given in parantheses.

Fraction 1
Chlorobenzenes (2,6,8), penta(10)-, hexachlorobenzene (13)
Bromo-tricholoro-(8,9), Bromo-tetrachloro-(11), Bromo-pentachlorobenzene (17)
Tetrachloro-(20,23,25), Pentachloro-(32-34,37), Hexachloronaphthalene (41,42,47,57)
Pentachloro-(36,38,41,45); Hexachloro-(42,44,45,47,50,56),
Heptachloro-(47-50,53,57,61),
Octachloro-(55,59,60,62,65,72), Nonachloro-(63,69) and Decachlorobiphenyl (72)
Pentachloro-(26,28), Hexachlorohexahydro-naphthalene (38)
Pentachloro-(59,60), Hexachloropyrene/fluoranthene (70,74?)

Fraction 3
Hexachloronapthalenes
Hexachlorobenz-1,4-dioxin
Tetrachloropyrenes
Pentachloro-, Hexachlorofluorenones

Fraction 4
Traces of compounds as found in Fraction 1

Fraction 5
Polychlorinated dibenzo-p-dioxins and dibenzofurans
Hexachlorobenzofuran (80)
Pentachloro-(81-83,85), Hexachloronaphthalenes (94-97, 99)
Tetrachloropyrene (90)
Bromo-pentachlorobenzofuran (84)

Fraction 6
Mainly oxygenated cyclic chlorinated compound (difficult to identify due to insufficient mass spectrometric information) Tetrachloro-(128),
Pentachlorobenzonitrile (133) $C_8H_8OCl_5$ (136,142) $C_7H_6OCl_5$ (acetophenone?, 136)

The quantitative results for the different compound groups (see also Table 3) allowed the following conclusions:

- The total amount of polychlorinated benzenes (CLB) formed seems to correlate with the observed levels for PCDD/PCDF (see Figure 3). However, more data have to be collected before a proper statistical analysis can be carried out. Hexachlorobenzene (HCB) has been proposed earlier as an indicator for the presence of PCDD (23). According to our data a better correlation is obtained for the total quantity of CLB. This opens the possibility to substitute rather expensive PCDD/PCDF quantifications by analysing CLB in a routine surveillance program, where often only low-cost parameters are controlled.

- Incineration conditions which favor the formation of PAH do obviously suppress production of PCDD/PCDF. Griffin (24) has earlier postulated that the availability of Cl_2 in the emissions is important for the formation of PCDD/PCDF. The presence of reducing species such as SO_2 transform Cl_2 to HCl which only can undergo chlorination reactions when an excess of O_2 is present (24). The results in Table III indicate that reductive combustion conditions (O_2-defficiency, high PAH emissions) also suppress the formation of PCDD/PCDF. Rather moderate PCDD/PCDF emissions could be observed when high PAH amounts were present. There were no indications for a lower recovery of PCDD/PCDF due to a higher amount of soot present in these samples.

- More than 90% of all PAH were found in the condensate or were adsorbed to XAD-2. Chlorobenzenes were only found in the XAD-2 extracts. Less volatile chlorinated compounds were mainly present in the condensate extract. About 10% of all PCDD/PCDF were found on the filter surface. This is in accordance with earlier reported results (25,26).

Furthermore, the occasional burning of spill oil sludge was found to be the major source for bromine (brominated compounds formed during combustion of fuel additives such as dibromoethane). This explains the presence of monobromo-polychloro compounds in the emissions of the continuous incinerator No. 5.

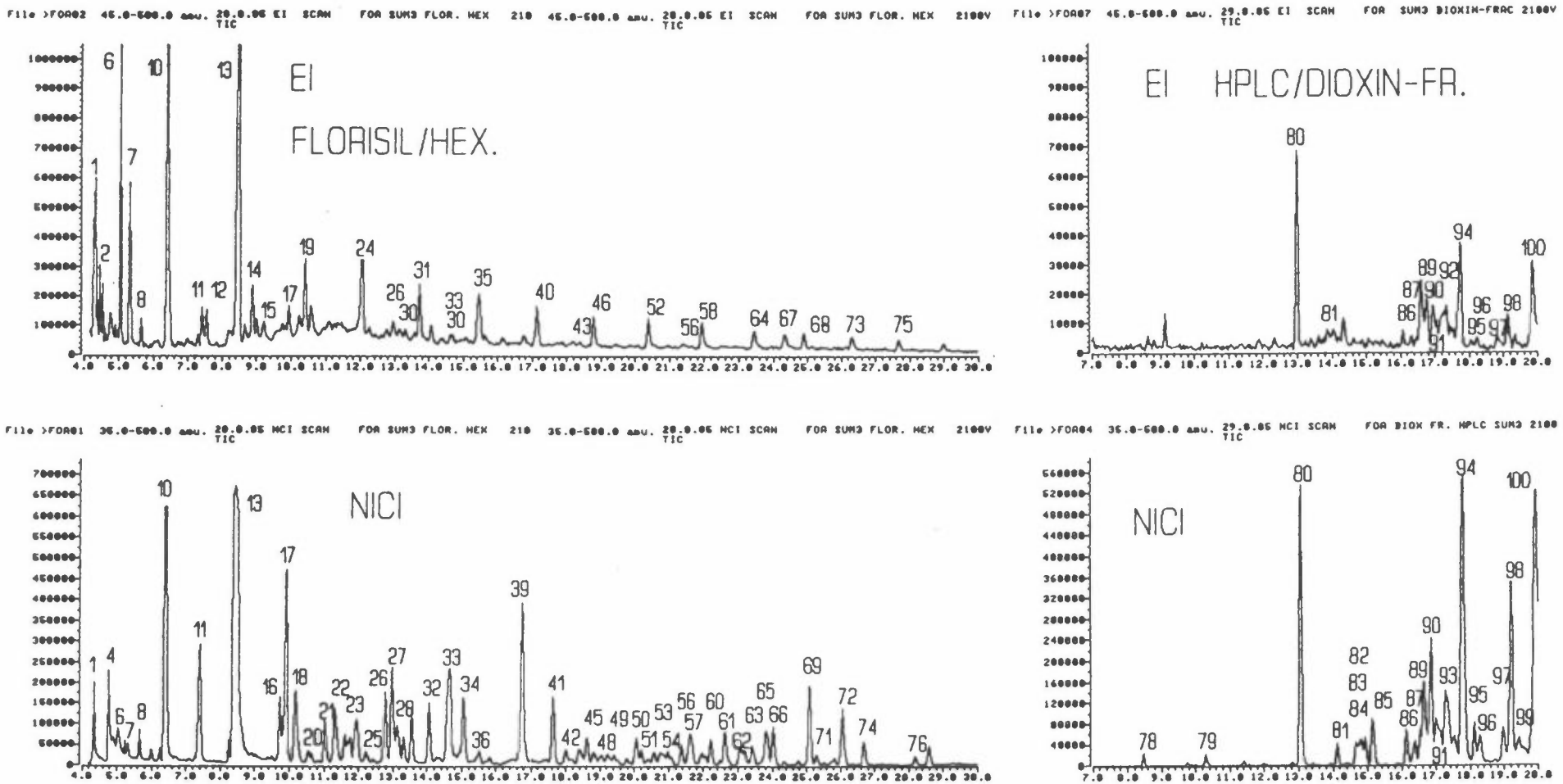

Figure 2: Total ion current chromatograms of fraction 1 and 5 (first part). EI: electron impact ionization, NICI: negative ion chemical ionization.

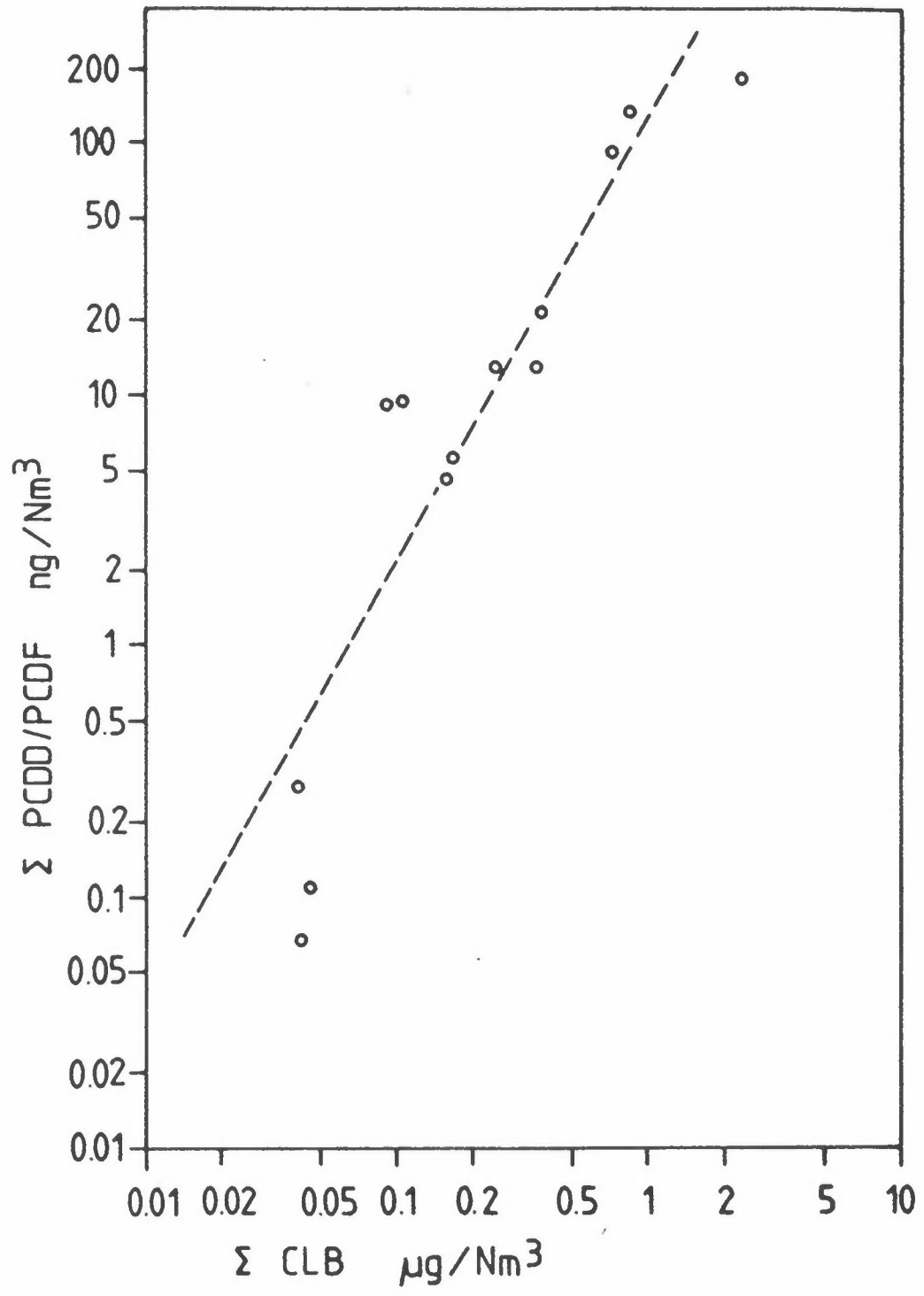

Figure 3: Comparison of the total amounts of chlorobenzenes (CLB) and polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) in the emission of the investigated incinerators.

The presented investigation shows that a large variety of halogenated substances are formed. PCDD/PCDF are only a small part of the total emission of such compounds. A considerable amount of more polar oxygen- or nitrogen-containing substances with a cyclic but non-aromatic structure are present too. However, more sample material and other techniques than mass spectrometry are necessary to obtain sufficient information for proper identification.

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ENCLOSURE

Single compound results for quantified substances
in the emissions from municipal incinerators.

Survey about identified halogenated compounds.

Table 1: Quantitative results for polychlorinated dibenzo-p-dioxins (PCDD) and dibenzo-furans (PCDF) in emissions from Tveita heat central. Concentrations are given in ng/Nm^3

Compound	Sample 1 ("bad" combustion)		Sample 2 ("good" combustion	
	Filter	Condensate	Filter	Condensate
Σ TCDF	6.2	5.6	1.8	10.2
1,3,6,8-TCDD	0.04	0.03	trace	0.11
1,3,7,9-TCDD	0.05	0.05	trace	0.17
1,3,6,9-TCDD	0.03	0.02	n.d.	trace
1,2,3,7/1,2,3,8-TCDD				
1,2,3,4/1,2,3,6-TCDD	0.16	0.30	trace	0.56
1,2,6,9-TCDD				
2,7,7,8-TCDD	0.05	0.06	trace	0.07
1,2,3,9-TCDD	0.03	0.03	n.d.	0.14
1,2,7,8-TCDD	0.24	0.37	trace	0.12
1,2,6,7-TCDD	0.045	0.05	n.d.	trace
1,2,8,9-TCDD	0.02	trace	n.d	trace
Σ TCDD	0.67	0.91	-	1.2
Σ PeCDF	19.3	30.6	10.4	39.7
Σ PeCDD	1.6	2.5	trace	4.3
Σ HxCDF	6.7	8.7	5.6	10.7
Σ HxCDD	1.6	1.5	2.1	1.7
Σ HpCDF	0.49	1.3	3.7	2.6
Σ HpCDD	0.8	0.4	0.9	0.8
OCDD	trace	trace	trace	trace
OCDF	trace	trace	trace	trace

Table 2: Concentration level of chlorobenzenes in the emissions of various incinerators. TrCB: trichlorobenzenes, TeCB: tetrachlorobenzenes, PeCB: pentachlorobenzene, HCB: hexachlorobenzene.

Incinerator	Concentration [ng/Nm^3]			
	Σ TriCB	Σ TeCB	PeCB	HCB
Ulsteinvik				
Condensate	not measured		0.009	0.020
XAD-2 extract			2.60	1.18
Vadsø 6				
Condensate	n.d.	n.d.	n.d.	n.d.
XAD-2 extract	n.d.	n.d.	0.018	0.024
Vadsø 7	n.d.	n.d.	0.012	0.022
Vadsø 8	n.d.	n.d.	0.014	0.032
Senja 1	< 0.001	< 0.001	0.04	0.12
Senja 2	< 0.001	0.04	0.03	0.101
Senja 6	< 0.001	0.02	0.11	0.23
FOA sum 1	0.088	0.151	0.161	0.326
FOA sum 2	0.091	0.147	0.183	0.440
FOA sum 3	0.138	0.291	0.388	1.48
Rafnes				
Flue gases	0.239	0.152	0.040	0.063
Scrubber water (ng/l)	< 0.001	< 0.001	< 0.001	< 0.001
Tveita				
"bad" comb.	< 0.001	< 0.001	0.035	0.06
"good" comb.	< 0.001	< 0.001	0.045	0.065
REO	0.02	0.041	0.126	0.172
REO	0.02	0.041	0.126	0.172

Table 3: Concentrations of polychlorinated biphenyls in the emissions of various incinerators. Cl_5 : pentachloro-, Cl_6 ; hexachloro-, Cl_7 : heptachloro-, Cl_8 : octachlorobiphenyl.

Incinerator	Concentration [ng/Nm^3]			
	Σ Cl_5	Σ Cl_6	Σ CL_7	Σ Cl_8
Ulsteinvik	4.9	0.3	n.d.	n.d.
Vadsø 6 Vadsø 7 Vadsø 8		< 0.03		
Senja 1	←	< 0.03	→	
Senja 2	3.42	1.05	< 0.03	< 0.03
Senja 3	6.5	< 0.03	< 0.03	< 0.03
Tveita				
"good" comb.	0.46	0.15	< 0.03	< 0.03
"bad" comb.	0.4	0.18	< 0.03	< 0.03
FOA sum 1	i	i	33.6	21.3
sum 2	5.9	9.7	12.7	8.45
Sum 3	10.6	13.1	12.7	8.45

i: interference

Table 4: Identified compounds in the sample extract from incinerator 5, fraction 1.

Nr.	RT (min)	EI	NCI	Mol. wt.	Compound name
1	4.33	+	(+)	128	Napthalene
2	4.46	+	-	180	Trichlorobenzene
3	4.61	+	-	?	Aliphatic hydrocarbon
4	4.75	-	+	222	Cl_4-compound, aromatic
5	4.90	+	-	142	Methylnaphthalene
6	5.06	+	+	214	Tetrachlorobenzene
7	5.31	+	+	214	"
8	5.66	+	+	258	Bromotrichlorobenzene
9	6.04	+	+	258	"
10	6.42	+	+	248	Pentachlorobenzene
11	7.40	+	+	292	Bromotetrachlorobenzene
12	7.56	+	-	226	Hexadecane
13	8.48	+	+	284	Hexachlorobenzene
14	8.90	+	-	240	Heptadecane
15	9.20	+	-	178	Phenanthrene/Anthracene
16	9.73	+	+	288	Tetrachlorobiphenylene or tetrachloroacenaphthylene
17	9.92	+	+	326	Bromopentachlorobenzene
18	10.23	+	+	288	Tetrachlorobiphenylene
19	10.42	+	-	254	Octadecane
20	10.57	-	+	264	Tetrachloronaphthalene
21	11.12	+	+	264	"
22	11.34	+	+	288	Cl_2Br or Cl_3Br compound, aromatic
23	11.96	-	+	264	Tetrachloronaphthalene
24	12.04	+	-	268	Nonadecane
25	12.25				Tetrachloronaphthalene
26	12.80	+	+	304	Pentachlorohexahydronaphthalene *)
27	12.99	+	+	322	Cl_6, aromatic keto-compound
28	13.12	+	+	304	Pentachlorohexahydronaphthalene
29	13.31	-	+	304	"
30	13.34	+	-	202	Fluoranthene
31	13.75	+	-	282	Eicosane
32	14.06	+	+	298	Pentachloronaphthalene
33	14.64	+	+	298	"
34	15.09	+	+	298	"
35	15.47	+	-	296	Uncosane
36	15.54	-	+	324+?	Pentachlorobiphenyl + unknown
37	15.83	-	+	298	Pentachloronaphthalene
38	16.48			324+ 338	Pentachlorobiphenyl + hexachlorohexahydronaphthalene, not Cl_4-pyrene
39	16.74	+	+	338	hexachlorohexahydronaphthalene not Cl_4-pyrene

Table 4: Cont.

Nr.	RT (min)	EI	NCI	Mol. wt.	Compound name
40	17.15	+	-	310	Docosane
41	17.64	-	+	332+ 324	Hexachloronaphthalene + Pentachlorobiphenyl
42	18.03	-	+	332+ 358	Hexachloronaphthalene + hexachlorobiphenyl
43	18.42	+	-	226	Benzo(ghi)fluoranthene
44	18.42	-	+	358	Hexachlorobiphenyl
45	18.65	-	+	324+ 360	Pentachloro-, hexachlorobiphenyl
46	18.80	+	-	324	Tricosane
47	18.84	-	-	332+ 392	Hexachloronaphthalene + heptachlorobiphenyl
48	19.07	-	+	392	Heptachlorobiphenyl
49	19.26	-	+	392	Heptachlorobiphenyl
50	20.07	-	+	358+ 392	Hexa- + heptachlorobiphenyl
51	20.23	-	+	392	Heptachlorobiphenyl
52	20.45	-	+	338	Tetracosane
53	20.59	-	+	392	Heptachlorobiphenyl
54	20.78	-	+	392	"
55	21.10	-	+	426	Octachlorobiphenyl
56	21.39	+	+	358	Hexachlorobiphenyl
57	21.62	-	+	366+ 392	Hexachloronaphthalene + heptachlorobiphenyl
58	21.97	+	-	352	Pentacosane
59	21.97	-	+	426+ 372	Octachlorobiphenyl + pentachloropyrene
60	22.23	-	+	426+ 372	Octachlorobiphenyl + pentachloropyrene
61	22.65	-	+	392	Heptachlorobiphenyl
62	23.07	-	+	426	Octachlorobiphenyl
63	23.43	-	+	460	Nonachlorobiphenyl
64	23.49	+	-	366	Hexacosane
65	23.85	-	+	426	Octachlorobiphenyl
66	24.04	-	+	426	"
67	24.38	+	-	?	Aliphatic hydrocarbon
68	24.92	-	+	380	Heptacosane
69	25.08	-	+	460	Nonachlorobiphenyl
70	25.34	-	+	406	Hexachloropyrene
71	25.82	-	+	454	Cl_7-compound, heptachloromethyl-pyrene?
72	26.08	-	+	494	Decachlorobiphenyl
73	26.34	+	-	394	Octacosane
74	26.69	-	+	440	Heptachloropyrene (?)
75	27.67	+	-	408	Nonacosane
76	28.18	-	+	488	Cl_6/Cl_8-compound
77	28.60	-	+	510?	Bridged $>Cl_8$-compound

Table 5: Identified compounds in the sample extract from incinerator 5, fraction 5.

Nr.	RT (min)	EI	NCI	Mol. wt.	Compound name
78	8.48	-	+	282	Trace hexachlorobenzene
79	10.28	-	+	288	Tetrachlorobiphenylene (?)
80	13.06	+	+	322	Hexachlorobenzofuran or other $C_8H_2OCl_6$ compound
81	14.13	+	+	298	Pentachloronaphthalene
82	14.68	-	+	298	"
83	14.80	-	+	298+ 366	Pentachloronaphthalene + trace bromopentachlorobenzofuran ?
84	14.93	-	+	366	Bromopentachlorobenzofuran or $C_8H_2OCl_6Br$
85	15.16	-	+	298	Pentachloronaphthalene
86	16.13	+	+	304	Tetrachlorodibenzofuran
87	16.39	+	+	304	"
88	16.59	-	+	304	"
89	16.68	+	+	304	"
90	16.84	+	+	304+ 338	Tetrachlorodibenzofuran + tetrachloropyrene
91	17.00	+	+	304+ 322	Tetrachlorodibenzofuran + tetrachlorodibenzo-p-dioxin
92	17.26	+	+	304+ 322	Tetrachlorodibenzofuran + tetrachlorodibenzo-p-dioxin
93	17.52	+	+	304	Tetrachlorodibenzofuran
94	17.78	+	+	332+ 304	Hexachloronaphthalene
95	18.13	+	+	332	"
96	18.26	+	+	332+ mix	"
97	18.97	+	+	332	"
98	19.17	+	+	338	Pentachlorodibenzofuran
99	19.42	+	+	332	Hexachloronaphthalene
100	19.91	+	+	338	Pentachlorodibenzofuran
101	20.14	+	+	338+ 354	Pentachlorobenzofuran + -dioxin
102	20.27	+	+	338	Pentachlorodibenzofuran
103	20.43	+		338+ 354	Pentachlorodibenzofuran + -dioxin
104	20.65	+	+	338+ 354	Pentachlorodibenzofuran + -dioxin
105	21.01	+	+	338+ 354	Pentachlorodibenzofuran + -dioxin
106	21.24	+	+	354	Pentachlorodibenzo-p-dioxin
107	21.49	-	+	354+ mix	"
108	21.72	+	+	366	Heptachloronaphthalene
109	22.63	+	+	372	Hexachlorodibenzofuran
110	22.72	+	+	372	"
111	22.92	+	+	372+ 420	Hexachlorodibenzofuran + $C_{13}H_3OCl_7$ (Cl_7-Benzophenone)

Table 5: Cont.

Nr.	RT (min)	EI	NCI	Mol. wt.	Compound name
112	23.14	+	+	388	Hexachlorodibenzo-p-dioxin
113	23.37	+	+	372	Hexachlorodibenzofuran
114	23.69	+	+	372+ 388	Hexachlorodibenzofuran + hexachlorodibenzo-p-dioxin
115	24.21	+	+	388	"
116	24.41	+	+	388+ 416	hexachlorodibenzo-p-dioxin + Cl_5Br-compound (m/z 338 + Br)
117	25.22	-	+	416+ 362	Bromopentachlorodibenzofuran
118	25.96			406	Heptachlorodibenzofuran
119	26.38	+	+	406+ 422	Heptachlorodibenzofuran + heptachlorodibenzo-p-dioxin
120	26.93	+	+	422	Heptachlorodibenzo-p-dioxin
121	27.06	+	+	406	Heptachlorodibenzofuran
122	27.45	-	+	382	Hexachlorophenanthrene ($m/z\ 178 + Cl_6$)
123	28.29	-	+	490	Cl_8-compound ($m/z\ 218 + Cl_8$)
124	28.65	-	+	466	Cl_8-compound ($m/z\ 228 + Cl_8$)
125	29.42	+	+	440+ 456	Octachlorodibenzofuran + octachlorodibenzo-p-dioxin
126	31.04	-	+	488	Cl_8-compound

Table 6: Identified compounds in the sampler extract from incinerator 5, fraction 6.

Nr.	RT (min)	EI	NCI	Mol. wt.	Compound name
127	6.20	+	-	156	Naphthalenecarboxaldehyde
128	7.09	+	+	239	Tetrachlorobenzonitrile
129	8.09	-	+	256	$C_8H_8OCl_4$ (Acetophenone)
130	8.42	+	-	212	Tetradecanol or other alcohol
131	8.67	-	+	180	9H-Fluorenone
132	8.96	-	-	273	Pentachlorobenzonitrile ?
133	9.19	-	+	273	"
134	9.21	+	-	196	$C_{14}H_{12}O$
135	9.61	-	+	276	$C_7H_6OCl_5$
136	9.84	-	+	290	$C_8H_8OCl_5$ (Acetophenone)
137	10.26	-	+	263	$C_6H_7NCl_5$ (Methylpyridin)
138	10.68	-	+	279	Cl_4-compound
139	11.23	-	+	282	"
140	11.58	-	+	282	"
141	11.91	-	+	208	9,10-Anthracene-dione
142	12.42	-	+	290	$C_8H_8OCl_5$
143	12.42	+	-		Phthalate
144	13.27	-	+	---	> Cl_5-compound, DDD-or DDD-like structure
145	13.66	-	+		> Cl_5-compound, DDD-or DDD-like structure
146	13.82	-	+		> Cl_5-compound, DDD-or DDD-like structure
147	14.67	+	+	270	Trichlorobenzofuran

NORSK INSTITUTT FOR LUFTFORSKNING (NILU)
NORWEGIAN INSTITUTE FOR AIR RESEARCH
POSTBOKS 130, 2001 LILLESTRØM (ELVEGT. 52), NORGE

RAPPORTTYPE OPPDRAGSRAPPORT	RAPPORTNR. TR 5/86	ISBN-82-7247-721-1	
DATO JULY 1986	ANSV. SIGN. J. Schjoldager	ANT. SIDER 24	PRIS Kr. 20,00

TITTEL

Formation and presence of polyhalogenated and polycyclic compounds in the emissions of waste incinerators

PROSJEKTLEDER
M. Oehme

NILU PROSJEKT NR.
N-8327

FORFATTER(E)

M. Oehme
S. Manø
A. Mikalsen

TILGJENGELIGHET
A

OPPDRAGSGIVERS REF.

OPPDRAGSGIVER (NAVN OG ADRESSE)
Utvalg for miljøgifter
NTNF, Sognsveien 72
0801 Oslo 8

3 STIKKORD (à maks. 20 anslag)
Utslipp | Organiske forbindelser | Klorert

REFERAT (maks. 300 anslag, 7 linjer)
Polyhalogenerte forbindelser (bl.a. polyklorerte dibenzo-p-dioksiner og furaner) ble identifisert og kvantifisert i utslipp fra små diskontinuerlige og store kontinuerlige søppelforbrenningsanlegg. Polysykliske aromater ble også bestemt.

TITLE

ABSTRACT (max. 300 characters, 7 lines)
Polyhalogenated compounds included polychlorinated dibenzo-p-dioxins and dibenzofurans were identified and quantified in the emissions of small (batch-wise operated) and continuous operated municipal waste incinerators. Polycyclic aromatics were also determined.

* Kategorier: Åpen - kan bestilles fra NILU A
Må bestilles gjennom oppdragsgiver B
Kan ikke utleveres C