

# POLYCHLORINATED NAFTALENES AND DLPCBs

## ATMOSPHERIC CONCENTRATIONS OF PCNs AT TWO UK SITES

Robert G. M. Lee, G. O. Thomas, and K. C. Jones

Department of Environmental Science, Institute of Environmental and Natural Sciences, Lancaster University, Lancaster, LA1 4YQ, UK.

### Introduction

In recent years polychlorinated naphthalenes (PCNs) have been recognised as ubiquitous environmental pollutants, that are assuming a greater importance as levels of other compounds are decreasing, and the toxicological affects of PCNs are more fully understood<sup>1-3</sup>. Generally there is a lack of atmospheric PCN data. Two previous studies in the UK<sup>4,5</sup> have measured atmospheric levels of PCNs and have suggested factors that may influence concentrations of PCNs in the UK. This study was undertaken to provide a more extensive temporal and geographical data set of PCNs in the UK atmosphere, from which inferences could be made with regard to ambient levels and the factors that control them. Sample were taken at two sites simultaneously, a total of 43 samples were taken at each site between January 2001 and September 2001. One site, Hazelrigg (HR), is situated on the northwest coast of the UK, at Lancaster University's Field Station (54° 2' N, 2° 45' W). The second site, Chilton (CH), is situated to the southwest of Oxford (51° 40' N, 1° 20' W). Both sites are representative of ambient background conditions.

### Materials and Method

The sampling train, media and artefacts associated with both have been described and discussed elsewhere<sup>6-7</sup>. The sampling strategy was determined by four factors: the necessity to avoid breakthrough of the vapour phase from the sampling media; the need to collect sufficient air to be able to detect a range of PCN congeners; the need for a short sampling time to minimise meteorological variables; the maximum flow rate of the samplers. These constraints lead to a sampling period of one day, in order to ensure a large air volume two samplers were run concurrently at each site and the samples bulked to yield ~750 m<sup>3</sup>.

Samples were extracted in DCM for 18 hours, the extract was reduced in volume and passed through a column containing activated silica (2 g) and alumina (1 g), then through a GPC column, and reduced to a final volume of 40 ml. Seven <sup>13</sup>C<sub>12</sub> labelled PCB congeners and three PCDD/F congeners were added to the samples prior to extraction and were used to monitor the extraction and clean up procedures. A further two <sup>13</sup>C<sub>12</sub> labelled and one <sup>12</sup>C<sub>12</sub> PCB congeners were added to the sample prior to injection and were used as internal standards. The samples were analysed on a Fisons MD800 MS operating in EI, the following PCNs were routinely monitored: PCN 19, 24, 15, 16, 17/25, 23, 42, 33/34/37, 47, 36/35, 29, 4-11\*, 35, 38, 46, 52/60, 58, 61, 50, 57, 62, 53, 59, 66/67, 64/68, 69, 71/72, 63, 65, 73, 74, 75.

### Results and Discussion

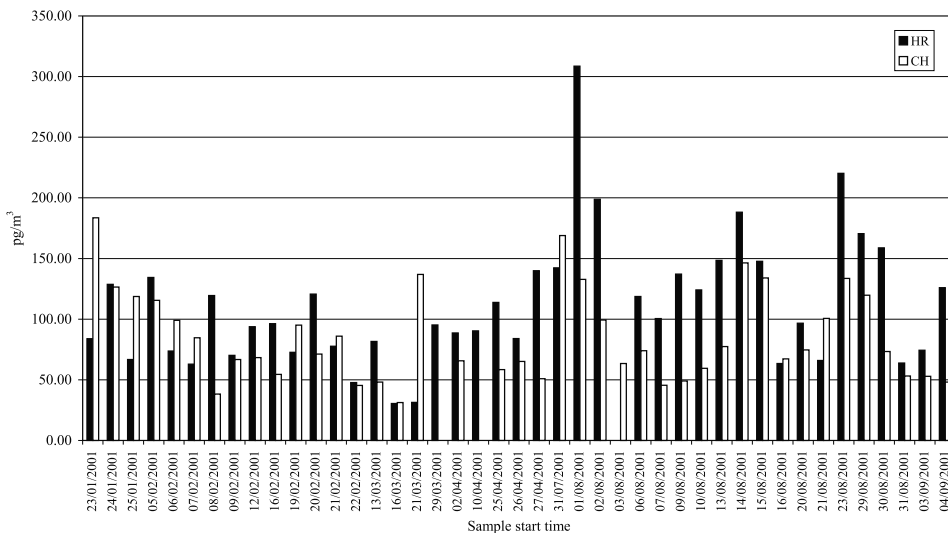
Figure 1 displays the SPCNs for all samples at both sites, and Table 1 provides a summary of the data. The concentrations of PCNs at both sites are comparable to levels found in previous studies<sup>4,5</sup>

\* Identified in the manner used by Harner and Bidleman, 1997<sup>1</sup>.

# POLYCHLORINATED NAFTALENES AND DLPCBs

particularly the mean concentrations. The mean and minimum values at both sites are similar. However the maximum concentration measured at Hazelrigg is ~33 % greater than that measured at Chilton and greater than the maximum measured in previous studies <sup>4,5</sup>. From Figure 1 it can be seen that concentrations of PCNs at the Chilton site remain more constant throughout the sampling period than they do at Hazelrigg, where there is a general increase in concentrations during the summer months.

Atmospheric PCN concentrations at two UK sites



**Figure 1.** Air concentrations of PCNs at two sites in the UK. Hazelrigg (HR) northwest UK, Chilton (CH) south UK.

**Table 1.** A summary of the results from both sites ( $\text{pg}/\text{m}^3$ ).

IUPAC	HR Mean	HR Max.	HR Min.	CH Mean	CH Max.	CH Min.
19	2.4	6.6	0.6	3.5	7.7	1.2
23	15	46	4.0	15	30	6.1
24	20	62	6.0	22	450	9.1
15	1.7	3.8	0.5	3.4	7.8	1.2
16	1.1	3.3	0.3	2.7	6.1	0.7
17/25	2.9	11	0.6	4.8	11	1.2
42	2.4	6.9	0.6	1.6	4.3	0.5
29	9.9	26	2.5	4.7	12	1.1
4-11*	1.0	2.5	0.3	0.6	1.5	0.2
35	7.5	19	1.7	3.1	11	0.7
38	15	37	3.6	6.9	23	1.2
46	5.9	15	1.5	2.8	11	0.6
33/34/37	15	43	3.8	8.9	21	2.4

## POLYCHLORINATED NAFTALENES AND DLPCBs

47	4.3	12	1.1	2.5	6.6	0.6
36/35	2.7	6.8	0.7	1.8	7.7	0.6
52/60	0.6	1.3	0.2	0.4	0.8	0.1
53	0.4	1.0	0.2	0.2	0.7	0.1
59	0.7	1.6	0.2	0.4	1.7	0.1
58	0.1	0.2	0.1	0.1	0.2	<DL
61	0.9	2.0	0.2	0.4	1.5	0.1
50	0.2	0.5	0.1	0.2	0.4	0.1
57	0.3	0.7	0.1	0.3	0.7	0.1
62	0.5	1.1	0.2	0.3	1.0	0.1
66/67	0.1	0.2	<DL	<DL	<DL	<DL
64/68	0.1	0.1	<DL	<DL	0.1	<DL
69	0.1	0.1	0.1	0.1	0.2	<DL
71/72	0.2	0.5	0.1	0.2	0.5	0.1
63	0.1	0.2	0.1	0.1	0.2	0.1
65	0.1	0.2	0.1	0.1	0.1	0.1
73	0.1	0.1	0.1	0.1	0.2	0.1
74	0.1	0.1	<DL	0.1	0.1	0.1
75	0.1	0.1	0.1	0.1	0.1	0.1
ΣTri-CN	43.4	133.19	12.6	51.1	101	20.9
ΣTetra-CN	63.6	166.71	15.7	31.5	82.0	7.66
ΣPenta-CN	3.60	8.09	1.01	1.90	6.97	0.00
ΣHex-CN	0.30	0.65	0.06	0.38	0.64	0.07
ΣHepta-CN	0.07	0.17	<DL	0.08	0.31	<DL
Octa-CN	<DL	0.09	<DL	<DL	0.06	<DL
ΣPCN	111	309	30.5	85.0	184	31.2

\* Identified in the manner used by Harner and Bidleman, 1997<sup>1</sup>.

**Table 2.** Percentage contribution of the PCN homologue groups to the SPCNs.

	HR Mean	HR Max.	HR Min.	CH Mean	CH Max.	CH Min.
% cont. Tris.	40	50	29	61	78	43
% cont. Tetra.	57	67	48	36	54	20
% cont. Penta.	3.3	4.5	2.0	2.2	4.1	0.0
% cont. Hex.	0.3	0.7	0.1	0.5	0.9	0.1
% cont. Hepta.	0.1	0.2	0.0	0.1	0.6	0.0
% cont. Octa.	0.0	0.0	0.0	0.0	0.1	0.0

From the data in Table 2 it can be seen that the contribution of the PCN homologue groups to the ΣPCNs is different at the two sites. At Hazelrigg (as in a previous study <sup>4</sup>) the tetra-CNs contribute more to the total than the tri-CNs. However, at Chilton the reverse is seen.

# POLYCHLORINATED NAFTALENES AND DLPCBs

The results show that daily levels at the two sites can vary considerably and that different sources or degradation processes may be influencing the sites. Further work will investigate how meteorological parameters and advection influence the concentrations of PCNs at the two sites.

## Acknowledgements

We are grateful to the Department of the Environment, Food and Rural Affairs (DEFRA), Air Quality Division for financial support. We would also like to thank employees of NETCEN, Peter Coleman for administrative support and Keith Playford and Christopher Conolly for assistance with operating the Chilton site.

## References

1. Harner, T.; Bidleman, T. F. *Atmos. Environ.* (1997), 31, 4009-4016.
2. Falandysz, J. *Environ. Pollution.* (1998). 101, 77-90.
3. Harner, T.; Bidleman, T. F.; Lee, R. G. M.; Jones, K. C. pp 223-234. In: Lipnick, R. L.; Jansson, B.; Mackay, D.; Petreas, M. (Editors) *Persistent, Bioaccumulative and Toxic Chemicals II: Assessment and New Chemicals: ACS Symposium Series 773*. American Chemical Society Washington 276 pp.
4. Lee, R. G. M.; Burnett, V.; Harner, T.; Jones, K. C. (2000). *Environ. Sci. Technol.* 34, 393-398.
5. Harner, T.; Lee, R. G. M.; Jones, K. C. (2000). *Environ. Sci. Technol.* 34, 3137-3142.
6. Lee, R. G. M.; Jones, K. C. (1999). *Environ. Sci. Technol.* 33, 3596-3604.
7. Lee, R. G. M.; Green, N. J. L.; Lohmann, R.; Jones, K. C. (1999). *Environ. Sci. Technol.* 33, 2864-2871.