PCB RELEASES FROM INCINERATION AND POWER GENERATION PROCESSES IN THE UK

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Introduction

The heightened concern over potential health effects of selected PCB congeners which exhibit "dioxin-like" toxicity has led the UK Environment Agency to study sources of these compounds to the environment. In assessing population exposure against the tolerable daily intake the UK Government has included an assessment of "dioxin-like" PCB as well as polychlorinated dibenzodioxins and polychlorinated dibenzofurans since 1997 and levels of PCB in food have been monitored and reported for some years.

In the past there have been only limited measurements of releases of PCB in combustion gases and there was no consistent monitoring or reporting protocol with different approaches and different groups of congeners reported depending on the aims of the work.

In 1998 the Environment Agency initiated a project to gather and review data on releases of PCB from processes which they regulated to assist in developing an appropriate regulatory framework to achieve the best practicable environmental option for individual processes and to see that releases were controlled using best available techniques not entailing excessive costs. The first processes considered were incineration and power generation since these had been identified as potentially large sources of air pollution.

Methods

The project consisted of two distinct stages. In the first a review was carried out of existing literature to gather data on releases of PCB from incineration and combustion processes, where possible looking for data from processes equivalent to the larger-scale modern facilities which would be regulated by the Environment Agency.

The second phase of the project was to extend the existing routine regulatory monitoring programme to generate new data on releases of PCB to air in incinerator and combustion plant stack gases. Tests were carried out on levels of selected PCB congeners in the stack gases from a coal fired power station tested in the start-up phase using recovered oil and fitted with flue gas desulphurisation equipment, two MSW incinerators (both working to new plant standards and fitted with pollution abatement including activated carbon), one sewage sludge incinerator (fluidised bed, with wet scrubbing and activated carbon addition) and a medical waste incinerator (with dry lime injection, fabric filters and activated carbon addition).

Stack tests were carried out in conjunction with routine monitoring procedures. Since there is no established protocol for sampling PCB the samples collected during sampling for PCDD/F were used for PCB analysis. PCB analysis was carried out by high resolution gas chromatography/high resolution mass spectrometry.

Results and Discussion

The review of literature and regulatory data showed that there were few sets of emissions data for PCB and those that existed were often incomplete from the point of view of calculating emissions on the basis of toxic equivalent concentrations. The combination of data on formation mechanisms and plant tests showed that PCB could be emitted from a variety of combustion processes, the likelihood of PCB being a contaminant in the input materials combined with the formation of PCB in the process increased the probability of finding PCB in the emissions.

Data were so limited that it was not possible to draw definitive conclusions about the magnitude of PCB releases from the processes of interest. The limited data sets tended to indicate that in most (but not all) cases, on a TEQ basis, emissions of PCB contributed less than PCDD/F to total emissions expressed as TEQ.

The lack of a consistent and transparent protocol for the measurement and in particular the reporting of emissions of PCB hinders the comparison of data sets which are often entirely incompatible. A prerequisite for a complete assessment of the importance of PCB emissions is the development of a suitable framework for measuring, analysing and reporting.

Results from the first phase of testing are presented in Table 1. Concentrations of each targeted PCB congener are given as well as the toxic equivalent calculated using the WHO TEFs (1997)[1]. Emissions were low in all cases. In all cases the majority of congeners were not detected above the method detection limits. In seven of the twelve test runs no congeners were present above detection limits. PCB 118, 123 and 180 were the most frequently present above the detection limit, PCB 114 and 169 were each detected in just one test. PCB 126 was detected only in one run for the medical waste incineration plant and this accounts for the highest emissions calculated as TEQ.

In all cases concentrations of individual congeners were under 1 ng/Nm^3. The calculated TEQ emissions are greatly influenced by the way in which non-detected congeners are handled. The minimum of the range of results for TEQ is based on calculating the TEQ taking non-detected congeners to be absent, the maximum by assuming they are present at the detection limit.

In all cases the TEQ concentration due to PCB is well below the figure of 0.1 ng/Nm^3 which is often regarded as a bench mark concentration in setting regulations for PCDD/F emissions.

Table 1 PCB emissions from selected sources (ng/Nm^3)

	Coal fired power station (using recovered oil)		MSW incinerator (fitted with SD/FF + Ac C)		MSW incinerator (ESP/DI/FF + Ac C)				Sewage sludge incinerator (wet scrubber + Ac C)		Medical waste incinerator (DI/FF + Ac C)	
	Run 1	Run 2	Run 1	Run 2	Stack 1, Run 1	Stack 1, Run 2	Stack 2, Run 1	Stack 2, Run 2	Run 1	Run 2	Run 1	Run 2
PCB number	3% O_2	3% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2
77	<	<	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
81	<1.49	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
105	<	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
114	<1.49	<1.49	<0.117	0.704	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
118	<1.49	<1.49	0.164	<0.110	0.170	<0.143	<0.137	<0.160	<0.121	<0.120	0.208	0.300
123	<1.49	<1.49	0.257	<0.110	0.313	<0.143	<0.137	<0.160	<0.121	<0.120	0.540	0.986
126	<0.075	<0.075	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	0.214
156	<1.49	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
157	<1.49	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
167	<1.49	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
169	<0.075	<0.075	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
170	<1.49	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	1.80
180	1.49	<2.98	<0.117	0.132	0.256	<0.143	<0.137	<0.160	<0.121	<0.120	0.208	2.23
189	<1.49	<1.49	<0.117	<0.110	<0.142	<0.143	<0.137	<0.160	<0.121	<0.120	<0.208	<0.214
TEQ WHO (PCB)	0-0.010	0-0.011	0.00004-0.012	0.0003-0.012	0.00005-0.015	0-0.015	0-0.014	0-0.016	0-0.012	0-0.012	0.00007-0.022	0.022-0.022
I-TEQ (PCDD/F) – ND=DL	0.007-0.040	0.004-0.035	0.02-0.02	0.03-0.03					0.0001-0.002	0.0006-0.003	0.07-0.07	0.05-0.05

Notes: Concentration data presented in ng/Nm^3, values corrected to the oxygen concentration given
Gas conditions – 273K, 101.3 kPa, dry. SD=spray drier, FF=fabric filter, Ac C=activated carbon, ESP=electrostatic precipitator, DI=dry injection.
PCB TEQ expressed using WHO TEFs (1997). Range gives ND=0 to ND=DL
Oxygen levels in power station start-up mode were >19% therefore large corrections are used adding to uncertainty

Conclusions

Additional data is clearly required on emissions of PCB from a wide variety of processes in order to compile detailed inventories and to provide a first step in assessing the contribution of on-going sources to human exposure.

Much of the PCB emission data that is available was not collected using consistent measurement or reporting protocols and is consequently likely to relate to outmoded equipment, is hard to compare and may not be representative of current emissions.

A consistent, transparent and demonstrated methodology for sampling, analysing and reporting of PCB emissions is required to enable meaningful comparisons of generated data sets and to support further work in this area.

Limited data available in the literature and the results of the tests carried out on UK incinerators and a power station (burning recovered oil) indicate that for well controlled processes, fitted with comprehensive pollution controls (in particular optimised combustion and activated carbon injection for PCDD/F control) emissions of "dioxin-like" PCB are low and contribute less to total TEQ than the PCDD/F.

More data are required and it is not possible to generalise these findings to other processes which may be poorly controlled or have significant amounts of PCB entering the process.

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