PCDD, PCDF, and PCB baseline levels in air near a waste incineration plant site in Southern Italy

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Introduction

Combustion processes related to a variety of anthropogenic activities are recognized sources of organic micropollutants. For many years, emissions from waste incineration plants made important contributions to atmospheric polychlorinated dibenzodioxins and dibenzofurans (PCDDs+PCDFs) as well as other substances.[1,2] As a consequence of the Italian regulatory system, a survey programme, still underway, was begun in late 2001 to investigate the local environmental impact of a hazardous and hospital waste municipal incineration plant ("Fenice") set within a small industrial area near the city of Melfi, southern Italy. The investigation is a joint work of the Italian National Institute for Health and the Regional Agency for Environmental Protection of the Basilicata Region (ARPAB). For the survey, many samples of plant emissions, ambient air, topsoil, and local farm products are being collected and analyzed. In this paper, we report upon a first group of atmospheric pollution data obtained during the 2003–2004 winter season and concerning PCDDs+PCDFs and PCBs.

Experimental

Ambient air contamination was measured through the settleable particulate (fallout) deposition rate and the PM_{10} fraction of airborne particulate matter.

Deposition was monitored at seven locations (Figure 1), to represent areas exposed to possibly different emission sources. The Lamiola and Rendina dam sites were in extra-urban areas, with low anthropogenic presence; the Lavello location was next to a small urban conglomerate and presumably under fallout of industrial origin (EPA SCREEN 3 model); the Consorzio, railway station, and S. Nicola sites were at the edge of the industrialized area; a default background site was identified at the Bizzarro farm in the open range. Sampling was performed by means of dust-fall glass jar samplers.[3]

Airborne particulate matter was sampled by means of high volume (HV) samplers equipped with PM_{10} probe and glass fiber filters.[4] Samplers were placed at the Consorzio, Lamiola, and railway station sites.

Settleable particulate was quantitatively recovered from dust-fall jars by filtering out the collected meteoric water on fiber filters. Extraction of the (dry) filters was performed by means of a Dionex accelerated solvent extractor (ASE), with a 1:1 *n*-hexane-acetone mixture (100 °C; 10^7 Pa). Acetone was removed from extracts by evaporation. The concentrated *n*-hexane residues were first eluted on columns filled with Extrelut impregnated with 96% sulphuric acid, and then purified by means of a Power-Prep™ unit: this automatic clean-up comprises three sequential steps with multilayer silica, alumina, and carbon chromatographic columns. Quantitation was carried out by high-resolution gas chromatography coupled with high- or low-resolution mass spectrometry (HRGC-HRMS or -LRMS) to quantitate respectively PCDDs+PCDFs and PCBs with the single ion monitoring (SIM) technique. ^{13}C-labelled internal standards were used for recovery correction.[4]

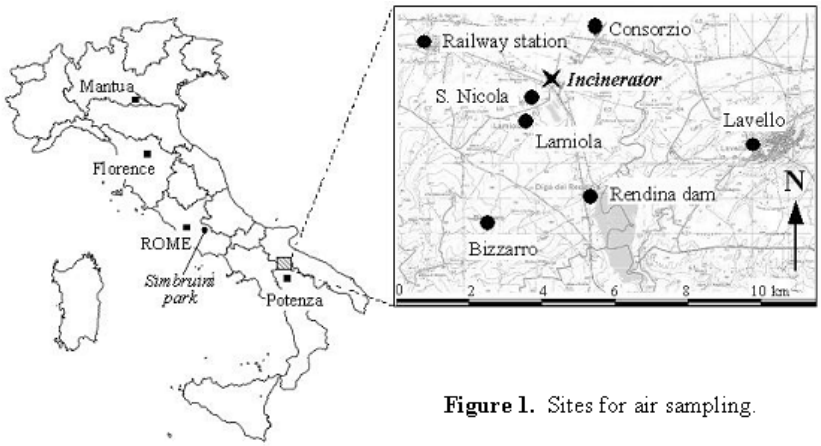

Figure 1. Sites for air sampling.

Results and discussion

Deposition rates are summarized in Table 1. PCDD+PCDF cumulative values are expressed in analytical units and WHO-TEQs (the parallel I-TEQ values are indistinguishable). It may be readily observed that, throughout the area explored (six sites), rates cover the rather narrow range of 35–55 pg m^{-2} day^{-1} or 1.5–2.3 pgWHO-TE m^{-2} day^{-1}. These values, detected in a winter period at sites exposed to different emission sources and distant even kilometers from one another, are among the lowest findings in Italy and comparable to deposition values found in rural areas in the EU.[5] PCB cumulative values are reported based on a large number of congeners and the sum of the six canonical indicator PCBs 28, 52, 101, 138, 153, and 180 (Σ_6(PCB)); on average, the two estimates differ by a factor of 3.4. Again, inter-site variability is rather small: 3.6–8.6 and 1.1–2.4 ng m^{-2} day^{-1}, respectively. These PCB deposition rates appear to be intermediate between those found in remote areas such as European mountain lakes[6] and US forest background.[7] Typical examples of PCDD+PCDF and PCB congener profiles recurring in the area under investigation are exhibited in Figure 2.

Table 2 shows the rather homogeneous PCDD+PCDF concentration findings (86–150 fg m^{-3} or 2.7–3.2 fgWHO-TE m^{-3}) obtained from PM_{10} HV samplings at three of the seven locations. These winter atmospheric concentrations are significantly lower than those measured in urban locations such as Rome[8] and Florence[9] and are in line with the PCDD+PCDF levels measured in air at open range sites such as the national park of Simbruini mountains (41–160 fg m^{-3} or 2.1–6.6 fgWHO-TE m^{-3})[8] or the Castagneto hills near Florence (140–270 fg m^{-3} or 2.6–10 fgWHO-TE m^{-3}),[9] both in the Apenines mountain chain. Based on the amounts of PM_{10} particulate matter collected with the HV samplers, the PCDD+PCDF concentrations on such matrix may be estimated in the order of 200–260 pgWHO-TE g^{-1}.

Table 1. Summary of PCDD+PCDF and PCB cumulative results obtained from the 2003–2004 winter dust-fall jar samplings of settleable particulate matter in the Melfi area. Rounding off to three figures.

	Bizzarro	*Consorzio*	*Rendina dam*	*Lamiola*	*Lavello*	*Railway station*	*S. Nicola*
PCDDs+PCDFs							
pg m^{-2} day^{-1}	36.7	55.1	—	48.4	41.2	48.2	35.1
pgWHO-TE m^{-2} day^{-1}	1.47	2.03	—	2.33	1.76	2.11	1.79
PCBs							
Total, ng m^{-2} day^{-1}	8.55	4.57	3.61	5.38	4.04	5.29	6.11
Σ_6(PCBs), ng m^{-2} day^{-1}	2.40	1.37	1.10	1.68	1.21	1.65	1.63

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Table 2. Summary of PCDD+PCDF cumulative results obtained from the 2003–2004 winter HV samplings of suspended PM_{10} particulate matter in the Melfi area. Rounding off to three figures.

	Consorzio	*Lamiola*	*Railway station*
PCDDs+PCDFs			
fg m^{-3}	124	146	86.2
fgWHO-TE m^{-3}	2.97	3.20	2.67

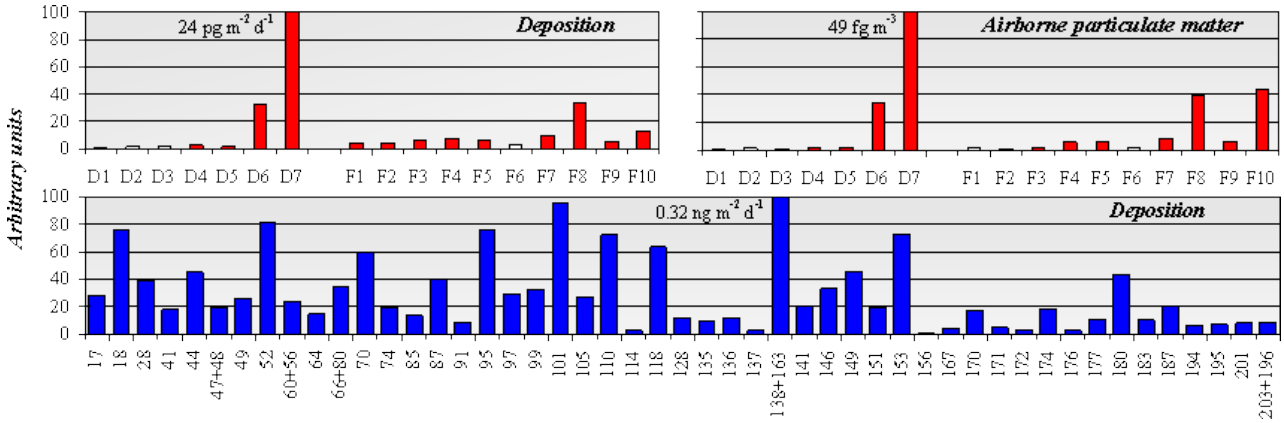

Figure 2. PCDD+PCDF and PCB profiles detected in Melfi ambient air (Consorzio sampling site) in the December 2003–February 2004 campaign. Analytical data are normalized on the most prominent congener set equal to 100. White bars indicate limits of detection.