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ASSESSMENT OF EMISSIONS OF ORGANIC MICROPOLLUTANTS AFTER AN ACCIDENTAL FIRE IN A COAL BURNING ELECTRICAL POWER PLANT

D. Voutsas¹, H. Terzi¹, C. Samara¹, Th. Kouimtzis¹, L. Muller²

¹Environmental Pollution Control Laboratory, Dept. of Chemistry, Aristotle University of Thessaloniki, 541 24 Thessaloniki, Greece

²Meß-u. Prufstelle Technischer Umweltschutz (MPU) GmbH, *Kolonnenstr. 26, D-10829 Berlin, Germany*

Introduction

PCDD/Fs, PCBs and PAHs are hazardous organic micropollutants usually formed during combustion processes. These compounds are widely distributed in the atmosphere of industrialized and heavily polluted environments and may accumulate to the soil through dry or wet deposition¹. A major issue associate with the emission of these compounds is the zone of influence which determines whether the source has predominately local impacts or contributes to regional or global background.

The occurrence of PCDD/Fs, PCBs and PAHs have been currently investigated in the Eordaia basin, NW Greece, a location where intensive coal burning for power generation takes place. Four (4) lignite-fired power plants (total power ~4000 MW) are located in the area producing approximately 70 % of the country's electric power (Fig. 1).

Small cities (<50,000 inhabitants) and several residential communities are also located in the area. In December 2001, an accidental fire broke out in one of the generators of the power plant. During this fire 20 tn of a mineral oil (Mobil DTE), 250 L of electrical plastic wire, 12 kg transformer oil (15.5 % in Arochlor) and other materials were burned in a closed room (68 x 30 x 38 m). It is known that fires involving mineral oils and other materials can produce various organic compounds²⁻⁴. Combustion

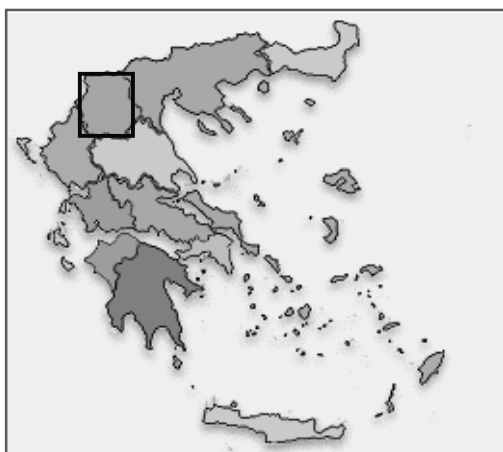


Figure 1. Map of the studied area

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products containing toxic chemicals may partially deposit on indoor surfaces (walls, floor, etc.) or be transported outdoors through windows and other openings. Therefore, the question raised is which was the zone of the local environment that was affected by the fire. For this purpose, soot samples from indoor walls and soil samples in the vicinity of the building of fire were collected about one month after the episode.

This paper presents concentrations and profiles of PCDD/Fs, PCBs and PAHs in post fire samples (indoor soot, soil) in comparison to pre-fire samples of atmospheric particles, power station fly ash and soil.

Materials and Methods

Indoor soot samples were collected from internal wall surfaces in the room where the fire broke out. Samples were put in solvent cleaned aluminum trays using stainless steel spoons. Post-fire soil samples were collected from 10 points at distances 0.5, 1 and 5 km as much as possible downwind the point of fire.

Ambient particulate matter (TSP) was collected at 10 sampling sites located in the basin during the period October 2000 – November 2001. TSP were collected on glass fiber filters (203 x 254 mm) by High Volume air samplers (General Metal Works) with 99 % collection efficiency for particles with aerodynamic diameter 0.3 μm . Samples were collected from a height of about 3 m above ground level for 24 h with an average flow rate of 40 CFM. Loaded and unloaded filters were weighted after conditioning in a desiccator.

Composite superficial soil samples were collected from the same sampling sites where TSP sampling was conducted. The fraction 100 μm was subjected to further analysis. Mean monthly fly ash samples were collected from the electrostatic precipitators of the 4 power plants for the period October 2000–2001. The fraction <100 μm was subjected to further analysis.

PCDD/Fs and PCBs were recovered from the samples after Soxhlet extraction with toluene. The analysis was carried out using HRGC/HRMS for PCDD/Fs and GC/MSD for 6 PCBs (28, 52, 101, 138, 153, 180). PAHs were recovered from filter or soil samples after ultrasonic extraction with CH_3CN . Reversed phase HPLC with programmable fluorescence detection was employed for analysis. PAH species included in the US EPA's priority pollutant list were quantified. The extraction procedure and the method of analysis are described in detailed elsewhere⁵⁻⁷.

Results and Discussion

The range, mean and median concentration of PCDD/Fs, I-TEQ, ΣPAHs and PCBs in TSP, fly ash, soil and indoor soot samples are shown in Fig. 2. The concentrations of PCDD/Fs and ΣPAHs (sum of 13 PAHs) in TSP ranged from 8 – 336 pg I-TEQ/g and 4.7–219 ng/g respectively, towards the lower values reported for Greece and worldwide⁵⁻⁸.

Higher concentrations of PCDD/Fs and PCBs were observed in indoor samples, with extreme peak values (66-1428 pg I-TEQ/g and 45-935 ng/g, respectively), due to the release of these compounds during the fire. Post-fire soil samples exhibited low concentrations of PCDD/Fs, PCBs and ΣPAHs , similar to concentrations in pre-fire local soil, towards the lower end of the range reported by other investigators^{1,9-12}.

The PCDD/Fs homologue profiles of representative samples of TSP, fly ash, soil and indoor soot are illustrated in Fig. 3. TCDF and PeCDF showed the higher contribution to $\Sigma\text{PCDD/Fs}$ in indoor soot. PCDFs are the dominant compounds in most TSP samples, with almost equal contribution of PCDF homologue groups. PCDDs and PCDFs homologue groups contribute equally to $\Sigma\text{PCDD/Fs}$ in fly ashes, although TCDF has slightly higher percentage. Soil samples exhibited different homologue profiles with PCDDs being the dominant compounds.

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As a conclusion it seems that the emissions of PCDD/Fs, PCBs and PAHs during the fire were limited in the close indoor area with negligible impact on the outdoor environment.

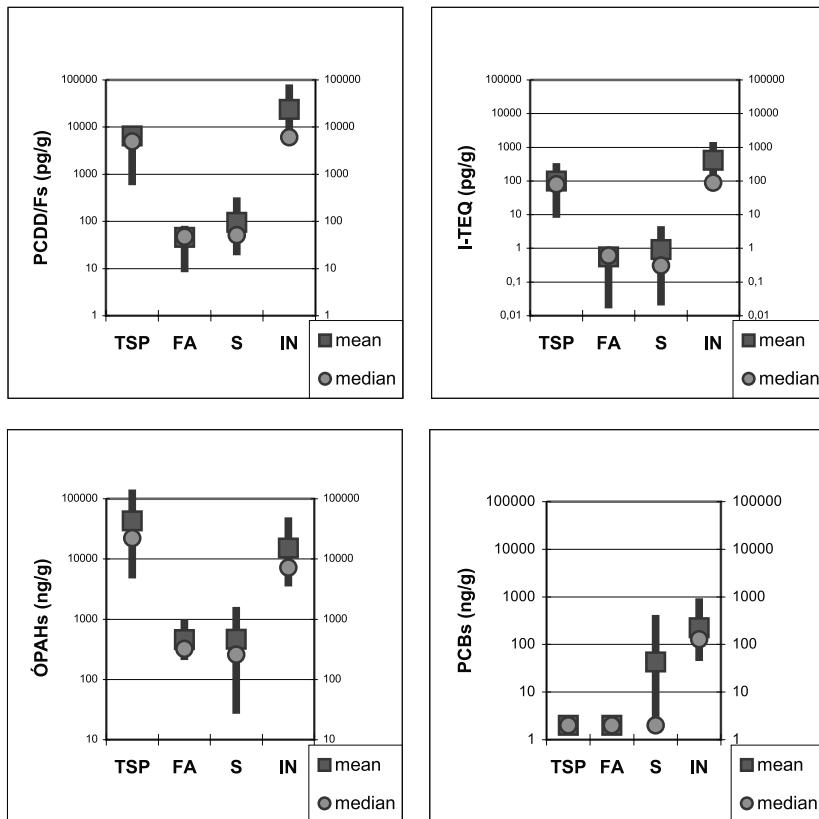


Figure 2. Concentrations of PCDD/Fs, I-TEQ, PCBs and Σ PAHs in Total Suspended Solids (TSP), fly ash (FA), soil (S) and indoor samples (IN)

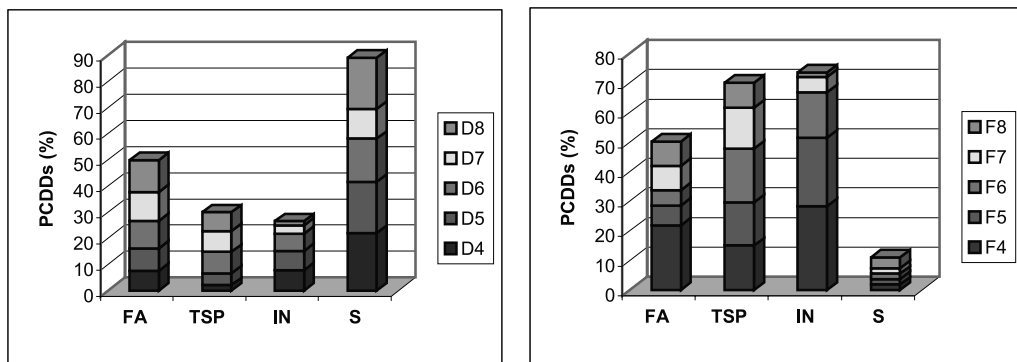


Figure 3. PCDD/Fs homologue profiles of different environmental samples (concentrations are normalized to Σ PCDD/Fs)

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