COMPARISON OF POLYCHLORINATED NAPHTHALENE EMISSIONS FROM WASTE INCINERATIONS AND METALLURGICAL PROCESSES

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Introduction

Metallurgical related processes and waste incinerations are important sources of dioxins [1-6]. Close correlations between polychlorinated naphthalenes (PCNs) and dioxin formation have been reported for many industrial thermal processes [7-9]. Thus, metallurgical related processes and waste incinerations are thought to be potential sources of PCNs. It is important to consider PCN inventories since PCN is currently evaluated as persistent organic pollutants (POPs) in the Stockholm Convention by POPs Reviewing Committee and might need in future global inventory.

In our previous studies, the PCN emissions from many metallurgical related processes were estimated [10-13]. However, emissions of PCNs from various waste incinerations have not been intensively investigated in China. In this study, emissions of PCNs from three types of waste incinerations including municipal solid waste incineration, medical waste incineration and hazardous waste incineration were identified and quantified, and the emissions of PCNs from waste incinerations were compared with that of metallurgical processes. These data and comparison will be useful for prioritizing the sources of PCNs and developing a PCN inventory.

Materials and Methods

In this study, stack gas samples from three types of waste incinerators comprised of municipal solid waste incineration (MSWI), medical waste incineration (MWI) and hazardous waste incineration (HWI) were collected by an automatic isokinetic sampling system. Briefly, the sampling train was mainly composed of a heated probe, a filter box equipped with a quartz fiber filter, a water-cooled XAD-2 adsorbent trap, an ISOSTACK BASIC pump, and an ISOFROST cooler. The glass fiber filter was used to collect particle-bound pollutants, and XAD-2 adsorbent resin was used for trapping the vapor-phase contaminants. PCNs were analyzed by isotope dilution high-resolution gas chromatography coupled with high-resolution mass spectrometry. The analysis of PCNs was carried out using a Trace GC coupled to a DFS mass spectrometer (Thermo Fisher Scientific, USA). A DB-5 fused silica capillary column (60 m × 0.25 mm i.d., 0.25 μm) was used to separate the congeners. The MS was tuned and operated at around 10 000 resolution with 45 eV electron ionization energy. Selected ion-monitoring mode was used for data acquisition. The sampling procedure and analytical method for the stack gas samples are detailed in our previous reports [11, 12].

In our previous studies, we also investigated the emissions of PCNs and other unintentional persistent organic pollutants from ten metallurgical related processes [10-15]. The ten processes included secondary copper smelting (SeCu), secondary aluminum smelting (SeAl), secondary zinc smelting (SeZn), secondary lead smelting (SePb), primary copper smelting (PrCu), primary magnesium smelting (PrMg), iron ore sintering (IOS), electric arc furnace for steel making (EAF), thermal wire reclamation (ThWiR), and coking processes (CoP). These results from metallurgical related processes are also presented in the present study for comparison.

Results and Discussion

The atmospheric concentrations of PCNs emitted from three types of waste incinerations were presented in Figure 1, and were compared with that of the ten previously investigated metallurgical related processes. The geometric means of PCN concentrations from MSWI, MWI and HWI were 348 (range: 20-13008, n=8), 301 (range: 28-2631, n=4) and 327 (range: 282-379, n=2) ng m^{-3}, respectively. The emission levels of PCNs were comparable for MSWI, MWI and HWI. The emission levels of PCNs from waste incineration were generally comparable to that of metallurgical processes except secondary zinc smelting and thermal wire reclamation. The emissions of PCNs from secondary zinc smelting and thermal wire reclamation were far higher than those from waste incinerations and other smelting processes, which suggest that these two processes are major PCN sources. These results also suggest that the impact of PCN emission from secondary zinc smelting and thermal wire reclamation plants on the surrounding environment and human health needs to be evaluated further.

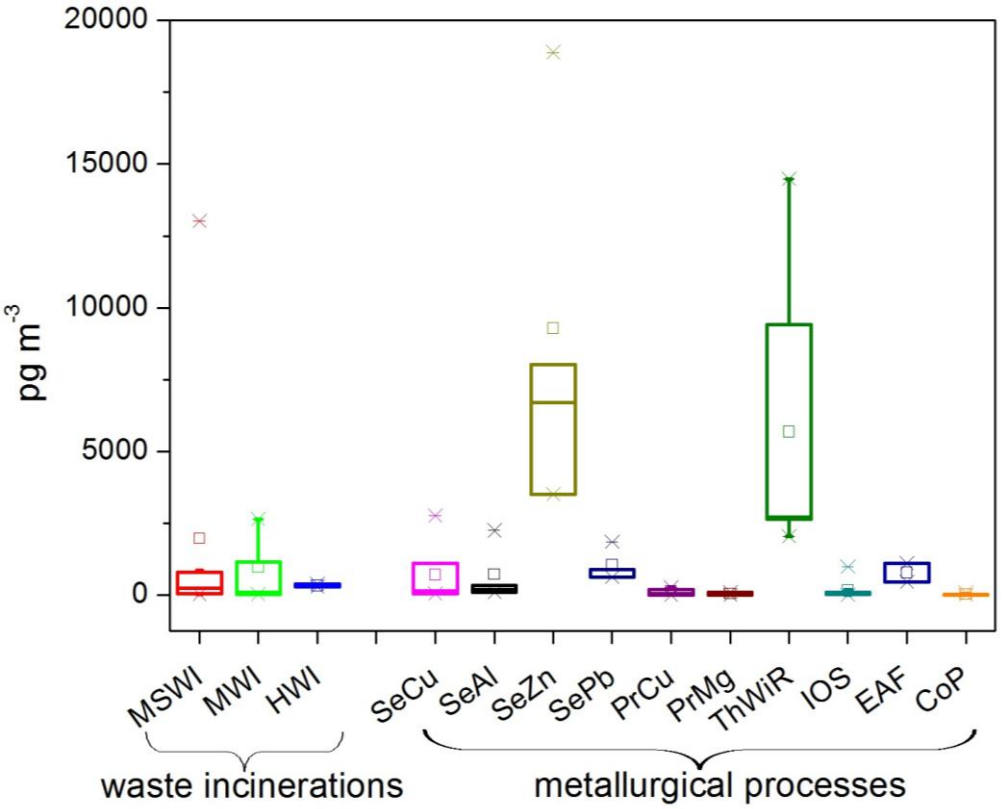

Figure 1. Comparison of PCN emissions from waste incinerations and metallurgical related processes

The concentrations of PCNs emitted from secondary metal smelting were much higher than those from primary metal smelting. This could be attributed to the higher content of organic residues in the raw materials for secondary metal smelting than in the raw materials for primary metal smelting. Electric arc furnace for steel making was also an important source of PCNs (Figure 1). Finally, the emission concentrations of PCNs from coking processes and iron ore sintering were relatively low compared with those from other metallurgical processes. These results will be useful for prioritizing PCN sources and reducing PCN emissions. Further studies on the emission profiles and emission factors of PCNs from various thermal-related processes are underway.

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