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Combined Chemical and Bioanalytical Detection of Dioxin-like Persistent Organic Pollutants in Emissions and Residues (Ash, Slag) from Thermal Processes

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Controlling dioxin-like persistent organic pollutants (POPs) in emissions and residues from thermal treatment of municipal solid waste and assessing their toxicological risk are important environmental and public health issues. In this study, we compare toxicity equivalent (TEQ) values analysed by chemical analysis and two bioanalytical detection methods (Micro-EROD and DR-CALUX bioassays). We analysed thermal residues and emissions from melting and incinerator processes for polychlorinated dibenzo-*p*-dioxins (PCDDs)/polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), and polycyclic aromatic hydrocarbons (PAHs). In the first Part, We established that bioassay-derived TEQs were well correlated with I-TEQs (from PCDD/Fs and PCBs) determined by chemical analysis. Bioassay- derived TEQs resulted in a maximal one magnitude higher value. Comparison of calculated $TEQ_{Micro\text{-}EROD}/TEQ_{chemAnal}$ ratios (R_{ba}) for combustion gas samples (mean R_{ba} 2.7; range of R_{ba} 1.0- 5.7; n = 12; correlation factor R = 0.85) and thermal residues (mean R_{ba} 2.1; range of R_{ba} 0.8-3.9; R = 0.95) indicated that co-PCBs, PAHs, and PCNs have a minor influence on the total dioxin-like toxicity. The level of dioxins contained in slag from melting processes and in residues from incineration processes was 1-2 orders of magnitude lower than that in fly ash. TEQs at the part per trillion (ppt) level were below the detection limit of the Micro-EROD bioassay. In the second part of our study, we analyzed several fly ash samples. The bioassay-derived TEQs were similar to the TEQs determined by chemical analysis (R_{ba} = 0.7-1.9 (Micro-EROD); R_{ba} = 1.1-4.9 (DR- CALUX)).When these fly ash samples were treated under reductive conditions (Hagenmaier drum), the TEQs were reduced by more than 99.2-99.8% (chemical analysis) and 85-99.9% (bioassays). For these treated fly ashes, we calculated R_{ba} Values of 0.9-1.8 (Micro-EROD) and 1.2-24 (DR-CALUX). Combined chemical and bioanalytical detection of dioxin-like compounds could lead to improved risk assessment and monitoring of processing samples (emission, residues) of municipal waste