PCDD/F mass concentration in residues from incineration of medical wastes in Poland

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1. Introduction

From 1992 hospital wastes are incinerated in Poland under controlled processes. Some of the new incinerators were built as new instalations mainly imported from West Europe countries but some of them are Polish constructios. Older incinerators which were built twenty years ago and even earlier are still in operating. They are obsolete, producing stack gases containing up to 1g of fly ash in $1m^3$. Problem of cleaning of stack gas from incineration of medical wastes in old plants will be solved in Poland until the end of 1997. However, this is a problem which should be solved concerning the residues from incineration processes. Because of lack of any polish regulations concerning disposal of toxic residues from incineration processes including medical waste incineration many of these residues are collected and landfilled in Poland so far.
From economical point of view and for environmental protection mixing the residues from medical waste combustion in concrete compositions is considered.
For this purposes residual bottom ash and saturated sorbent samples taken from selected incinerators were analyzed in our laboratory for the determination of PCDD/F mass concentration.

2. Experimental

The series of samples of bottom ash were obtained from local medical waste incinerators in Poland. They were taken from chambers of the incinerators when thermal processes were finished for periodical incineration processes or from removal pipeline of bottom ashes from continuously operated incinerators. Additionally saturated sorbents were sampled after replacing beds with fresh ones. In this case active carbon, coke and Sorbalit compositions as saturated sorbents were investigated.
Single stack gas samples for PCDD/F mass concentration analysis were also taken for comparison. For this purposes isokinetical sampling of stack gases were performed with EMIOTEST system (EMIO, Wrocław) addapted for simultaneously filtration of solid particles on quartz wool of pore size of 0.2 μm placed in preheated compartment, cooling gas stream in glass condenser (condensate collected) and sorption of PCDD/F from gas phase on XAD-2 resin with gass stream velocity control.

All of the incinerators were small-scale pyrolytic primary chamber with secondary thermal oxidation types of average capacity of 50 kg/h. Cleaning gas systems were based on wet scrubing, semi-dry scrubing with soprtion on activated carbons and fabric or ceramic filters for fly ash and Sorbalit precipitation. There are no catalytic reduction of PCDD/F systems in medical waste incinerators in Poland yet.
Samples of bottom ashes and sorbents were delivered to laboratory and analyzed as follows:
After separation of solid glass and metal parts samples were homogenized and weighed. Each of 5g portions of individual sample was spiked with ^{13}C-labelled 2,3,7,8-chlorosubstituted PCDD/F (Cambridge Isotope Laboratories cat no: EDF-957) in ammount of 1ng of individual congener in 1g of sample.
Then samples were washed with hydrochloric acid, dried and extracted 24 hours with toluene in Soxhlet apparatus. Afterwards extracts were concentrated and solvent was replaced with heptane. Then extracts were purified following standard analytical procedures[1)] based on acid/base silica, carbon/celite, and basic ICN Alumina Superactiv BI columns.
The last column eluates were evaporated up to 100 µl and analyzed by GC-MS technique.
Capillary column gas chromatograph HP 5890 series II equipped with quadrupol mass detector MSD 5971 was used for PCDD/F quantitative analysis and confirmation.
Two different columns were used for chromatografphic separation of PCDD/F congeners: SP-2331 for TCDFs separation and confirmation and RTX-5MS as routinely used capillary column.

3. Results and Discussion

In table 1 there are presented data from analysis of PCDD/F in eleven samples of bottom fly ash from eleven medical waste incinerators installed in Polish towns.
The experimental data proved, that mass concentration of PCDD/F in bottom ashes as well as in saturated sorbents are relatively high. In comparison to the data presented for municipal waste incineration pyrolytical plants produce more toxic bottom ashes. The explanation of such high concentration of PCDD/F in residues can be elucidated by theory of formation of these toxic organics from precursors during process of heating incinerated wastes in pyrolytic chambers. Average temperature of pyrolysis process in the investigated plants was about 600°C.
However, the level of stack gas concentration of PCDD/F in new type of incinerators installed in 1992-1996 is in good accordance with appropriate regulations concerning maximum acceptable limit in West Europe countries e.g. 0.1 ng TEq/m^3. This was achieved mainly by removing of organics from stack gases on surface of activated sorbents placed in huge compartments.
For two of the investigated plants PCDD/F mass concentration in stack gases was above this limit In stack gases emitted from Warszawa medical waste incinerator PCDD/F mass concentartion was extremely high, but the result of this work caused force local government to close this old plant which was succesfully performed.
PCDD/F mass concentration in bottom ash samples were higher but comparable to MSW incineration fly ash PCDD/F concentration found in the incinerators in West Europe countries. This
Figure1 shows the PCDD/F congener profile obtained in bottom ash samples from pyrolytic chambers. The distributions of individual congeners were similar for all analyzed samples.

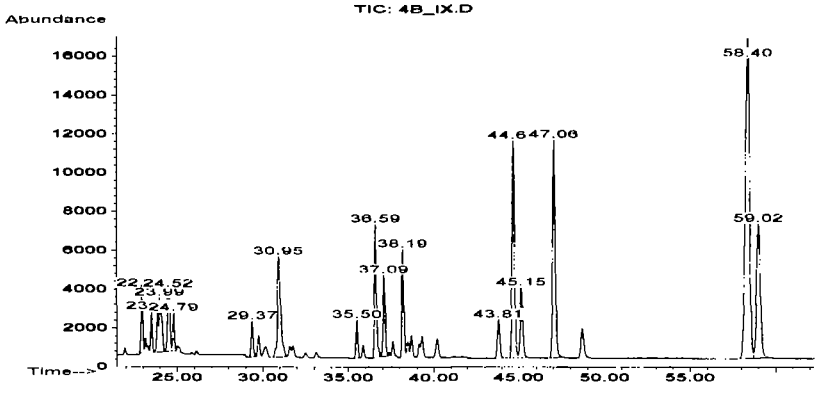
4. Conclusions

Significantly high amounts of PCDD/F in bottom ash can cause toxicity problem when mixing with concrete.
Solidifiction by cementation into concrete composition of bottom ash from medical waste incineration is simple operation but can produce toxic concrete bricks. Commercial use of the products of this solidification should be avoided. Thermal decomposition of PCDD/F in bottom ash should be considered as a method for detoxication [2), 3), 4)].

Table 1: PCDD/F mass concentration in bottom ashes and stack gases from incineration of medical wastes in plants installed in Polish towns.

Town where incinerator is installed	Type	**TEq** in bottom ash ng/g	**TEq** in stack gas ng/m^3
Bydgoszcz	New	14.5	0.015
Dąbrowa Górnicza (Silesia Region)	Old type, actually in modernization	9	2.1
Gdańsk	New	20	0.025
Gliwice	New	7.8	0.027
Gorzów Wielkopolski	New	12.1	0.047
Kraków (Cracow)	New	9.5	0.13 - 0.32
Lublin	New	12.5	0.06
Łódź	New	15	0.05
Skierniewice (Central part of Poland)	New	18 - 22	0.08
Sochaczew (Central part of Poland)	Old type, no stack gas cleaning, to be closed	35 - 43	15 - 18
Warszawa	Old type, incinerator just closed	28 - 35	23

Figure 1: GC-MSD SIM chromatogram of typical PCDD/F distribution in bottom ash from incineration of medical wastes. Performed on RTX-5MS column.



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