PCDD/PCDF EMISSIONS FROM STATIONARY SOURCES – FIRST RESULTS FROM THAILAND

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Introduction

In 1997 the Pollution Control Department (PCD) of the Ministry of Science, Technology, and Environment of the Government of Thailand in Bangkok initiated a dioxin program, which with the financial support of GTZ, UNEP Chemicals, and Euro Chlor included an emission inventory for polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF). In order to establish a better basis for this inventory a sampling campaign was proposed to sample and analyze dioxin emissions from sources that were known to be potential emitters of PCDD/PCDF. The results from this program would then help to identify the major PCDD/PCDF sources in the country and serve as a basis for measures to reduce dioxin releases. The reduction of releases will consequently reduce the risks resulting from dioxin emissions in Thailand.

Methods

The following seven facilities were chosen for sampling of stack emissions and where appropriate liquid or solid residues: Municipal solid waste incinerator (MSWI, one unit), secondary lead smelter (two rotary kilns A and B), secondary steel plant (2 electric arc furnaces, gaseous emissions directed into one flue gas duct plus indoor air from working hall), cement plant (kilns A and B; with and without co-combustion of tires or liquid hazardous wastes), secondary brass smelter (one unit stack emissions and indoor air from working floor), crematory (one unit), and a hospital waste incinerator (two units A and B).

The sampling and analysis was performed by GfA of Münster-Roxel, a laboratory with accreditation according to EURO NORM 45001 and accreditation according to ISO/IEC NORM 17025; all PCDD/PCDF samplings and analyses were performed in full compliance with EN 1948 [1]. To a large extent, the work was monitored by either GTZ, UNEP Chemicals, and/or E&EC of Waldbröl to ensure compliance with the respective QA/QC protocols.

Sampling was performed with the cooled probe method, one of the three methods approved in the European Standard EN 1948. Typically, the sampling times were 6 hours per sample.

Results

The results of the stack samples are shown in Table 1. All PCDD/PCDF concentrations are given in International Toxic Equivalents as established by the NATO/CCMS group (= I-TEQ). It should be noted, that with the sensitivity and selectivity of the methods chosen, almost all 2,3,7,8-substituted congeners could be quantified. The concentrations of PCDD/PCDF were normalized to standard conditions, which are 273 K, 101.3 kPa, dry gas. For the municipal solid waste and the hospital waste incinerators, the concentrations have been corrected to 11 % O_2, the European standard for waste incinerators; the same reference conditions have also been applied for the crematorium. For cement plants the reference O_2-concentration is 10 %. All data were compared with the European emission limit value for waste incinerators of 0.1 ng I-TEQ/m³ [2]. This value is also an orientation and target value for PCDD/PCDF emissions from other combustion sources and industrial installations, although the conditions in these plants differ from those of waste incinerators.

Municipal solid waste incinerator

The plant consisted of one 250 ton per day unit. Technologically, it had a reciprocating grate, a heat recovery steam boiler, a quench cooler, a dry lime injection system, and baghouse. The flue gas concentrations @11 % O_2 ranged from 0.65 to 3.10 ng I-TEQ/m³ with an average of 1.71 ng I-TEQ/m³. The concentrations of total PCDD/PCDF (Cl_4-Cl_8) were between 41.3 and 239 with a mean of 122 ng/m³. The measured average concentration of 122 ng PCDD/PCDF/m³ is above the Thai standard for municipal waste incinerators of 30 ng/m³; the mean of 1.7 ng I-TEQ/m³ is also above the European standard of 0.1 ng I-TEQ/m³.

Cement plant

The technology was state-of-the-art utilizing the dry process, the equipment was well designed, maintained, and operated. Dioxin measurements at both kilns were performed under normal operation at full load, secondary fuels were introduced at the calciner end of the rotary kiln in the high temperature zone. The stack concentrations were all below 0.02 ng I-TEQ/m³ and as low as 0.0001 ng I-TEQ/m³; the means were 0.0105 ng I-TEQ/m³ and 0.0008 ng I-TEQ/m³ for the normal operation conditions and 0.003 ng I-TEQ/m³ and 0.0002 ng I-TEQ/m³ for the tests performed with substitute secondary fuels, respectively. Thus, all test results were far below the orientation value of 0.1 ng I-TEQ/m³. The results clearly revealed that the addition of tires and/or liquid hazardous waste had no effect on the emission results keeping in mind that the dry cement kiln process employed in the cement plant is state-of-the-art technology.

Secondary steel plant

The plant consisted of two electric arc furnaces (EAF) at 35 ton per batch each; all feed material was scrap metal. The flue gases from each EAF were combined with a secondary duct carrying all the air vented from the work-floor. The stack emissions ranged from 0.32 to 0.61 ng I-TEQ/m³ with an average of 0.50 ng I-TEQ/m³.

Primary and secondary brass plant

The brass smelter was a small furnace operated on a 250 kg/batch discontinuous mode. The flue gases from the furnace and several surrounding areas passed a wet scrubber and then discharged through the roof *via* a steel flue stack. The stack concentrations ranged between 0.13 and 0.21 ng I-TEQ/m³ with an average of 0.15 ng I-TEQ/m³ at the actual operating O_2 concentration of 19 %.

The *crematorium* consisted of a refractory lined primary combustion chamber and a secondary combustion chamber with an afterburner; both were fired by light fuel-oil. Subsequent followed a refractory lined flue gas duct, which discharged through an underground brick flue gas duct into a brick lined stack, which is about 15 meters away from the furnace. The PCDD/PCDF concentrations at the stack ranged from 10.5 to 28.6 ng I-TEQ/m³ with an average of 17.6 ng I-TEQ/m³ (@11 % O_2).

Hospital waste incinerator

The plant consisted of two identical units, which was started-up every morning and operated until all the hospital waste delivered was incinerated. The furnace had a static grate, was equipped with a secondary combustion chamber and two afterburners. The flue gases passed over an alkaline water bath before being discharged through a flue stack. Overall, the plant was rather poorly designed and poorly maintained. The PCDD/PCDF concentrations were – adjusted to 11 % O_2 – between 21.8 and 43 ng I-TEQ/m³ for line A and 10.7-45.0 ng I-TEQ/m³ for line B; the averages were 33.8 and 28.6 ng I-TEQ/m³, respectively.

Table 1. Summary of the flue gas concentrations (* @ 11 % O_2; # @ 10 % O_2). Mean concentrations of the three individual measurements are shown in italics

	ng I-TEQ/m³		ng ITEQ/m³		ng I-TEQ/m³
MSWI *	*1.71*	Cement A #	*0.0105*	Brass Plant	*0.15*
1	1.38	A-1	0.018	1	0.125
2	0.65	A-2	0.009	2	0.127
3	3.10	A-3	0.005	3	0.206
Lead A	*0.027*	Cement A + Tires #	*0.0029*	Crematory	*17.6*
A-1	0.0321	A-1	0.004	1	28.64
A-2	0.0205	A-2	0.003	2	10.45
A-3	0.0277	A-3	0.001	3	13.70
Lead B	*0.089*	Cement B #	*0.0008*	Hosp. WI A *	*33.8*
B-1	0.0604	B-1	0.0018	A-1	43.00
B-2	0.1063	B-2	0.0004	A-2	36.60
B-3	0.0993	B-3	0.0001	A-3	21.76
Steel (EAF)	*0.50*	Cement B + Liq. Waste #	*0.0003*	Hosp. WI B *	*28.6*
1	0.586	B-1	0.0001	B-1	10.73
2	0.605	B-2	0.0001	B-2	30.12
3	0.317	B-3	0.0006	B-3	44.95

Discussion

The plants analyzed for PCDD/PCDF exhibit a broad spectrum of different activities and the PCDD/PCDF concentrations range over six orders of magnitude (lowest at cement kiln with 0.0003 ng I-TEQ/m³ and highest at hospital waste incinerator with 33.8 ng I-TEQ/m³).

In general, the results are within the expected range; most of them are similar to the situation in industrialized countries about 10–15 years ago. An exception on the positive side is the cement plant where the kilns represent international state-of-the-art technology and operation. As was shown at many European plants that utilize the dry process, the PCDD/PCDF emissions were very low and the co-combustion – well dosed and carefully fed – did not increase the dioxin and furan emissions at all.

Although some of the results, especially those from the hospital waste incinerator, are very high it should be remembered that in the early 1990s, in Germany, municipal solid waste incinerators were shut down when the emissions exceeded 50 ng I-TEQ/m³ and today in Japan, MSWIs are closed down when the limit of 80 ng TEQ/m³ is exceeded. With these two numbers in mind, the results obtained in

Thailand do not seem to be extraordinarily high as much higher emissions have been found elsewhere.

In addition to this program, samplings were also performed at two chemical plants in Thailand, which produce PVC *via* the EDC/VCM process line. This program was performed separately on behalf of the two chemicals' manufacturers but followed in all technical details for sampling and analysis our program. The companies have promised to provide the results of their campaign shortly.

The results of this sampling and analysis program will assist Thailand to better characterize its PCDD/PCDF releases and perform a dioxin and furan emission inventory as requested by the Stockholm Convention on POPs [3]. Most important, the results of this program serve as the basis for focusing on the most efficient risk reduction measures in Thailand. First steps towards this direction have already been initiated and will continue for more years and result in the implementation of dioxin-reducing actions.

Further, this program as carried out in Thailand will assist the international community to learn about PCDD/PCDF emissions in developing countries. The results of this sampling and analysis program will be included when UNEP's Toolkit [4] to establish complete and harmonized dioxin and furan release inventories will be updated.

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References

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