REDUCING THE PCDD/F EMISSION FROM CREMATORIES IN THE FLEMISH REGION (BELGIUM): A SUCCESSFUL PREVENTIVE EN-FORCEMENT APPROACH

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Introduction

In the Flemish Region of Belgium, the Environment Inspection Section (EIS) of the Ministry of the Flemish Community is responsible for the enforcement of the environmental health legislation. The EIS aims to reach a high-level, planned and co-ordinated enforcement, by combining a preventive and a repressive approach. In the field of air pollution, PCDD/F emissions have received particular attention during the past decade, due to high public concern for their possible health effects. Efforts to reduce the dioxin emission have been focussed on incineration plants for solid municipal waste and industrial waste, iron sintering plants and non-ferrous metals plants, respectively. The actions of the EIS resulted in a very significant emission reduction within a couple of years. Since 1999, the dioxin emission from crematories has raised some concern. This paper highlights the preventive approach of EIS, leading to a substantial dioxin emission reduction at the Flemish crematories in a short time frame.

Methods and Materials

Environmental legislation and enforcement

In Flanders, the integrated environmental hygiene legislation is covered by the Environmental Licence Decree (1985). This decree has been implemented through 2 orders of the Flemish Government: Vlarem I (1991), listing the objectionable establishments by type and Vlarem II (1995), containing the general and sector-related conditions for these establishments. The legislation is based upon the principle of prevention of pollution, nuisance and damage. Its integrated approach is fully in line with the European IPPC Directive. Vlarem II contains a legally binding dioxin emission limit value (ELV) for waste incinerators, oil refineries, crematories, ferrous and non-ferrous metals plants and iron sintering plants [1]. The tasks and general approach of the EIS, as the authority being responsible for the enforcement of the environmental legislation, have been described in earlier papers [2,3].

Main dioxin sources in Flanders

According to the most recent Flemish dioxin emission inventory, as published in the Environmental Report MIRA-T 2002 [4], the total dioxin emission in Flanders amounts to 97,3 g TEQ/year. About 73% of this emission is attributed to “household” sources, i.e. the heating of buildings and the waste incineration in barrels and open fires. The total emission from industry (iron & steel and non-ferrous metals) and incineration amounts to about 23 g TEQ/year. For crematories, a figure of 94 mg TEQ/year is mentioned for the year 2001, which was based on international emission data.

Dioxin emission reduction: approach of the EIS

The Flemish environmental legislation gives a great importance to self-monitoring by the plant operators, certainly in the field of stack emission measurements. However, the EIS has always chosen to additionally perform its own emission measurements, both as a check of the self-monitoring results and as an independent way of checking compliance with the legal prescriptions. Often, such emission measurements are part of a more extensive and integrated inspection. Since 1993, the EIS has organised stack emission measurement campaigns at various types of plants. Since long, the sampling and analysis of PCDD/F has received a lot of attention. Based on the results of such measurements, the EIS has used its authority to obtain the necessary sanitation. This way, the yearly PCDD/F emission of the municipal solid waste incinerators was lowered to less than 1 g TEQ by the year 2000 [1]. At the 2 iron sintering plants in Flanders, huge research, measurement and sanitation efforts led to an emission reduction by over 95% between 1998 and the end of 2000 [2]. At the major dioxin emitting sources in the non-ferrous metals plants, a similar emission reduction was obtained between 1998 and 2001 [3].

Results and Discussion

Crematories in Flanders

Although the first cremation in Belgium already took place in 1933, it is only since the late 1970s that cremation has been opted for on a larger scale. Since 1971, cremation and burial are legally considered as equal. In the last decade, cremation is becoming more and more popular. Between 1991 and 2001 the yearly number of cremations in the Flemish crematories has more than doubled: from about 10,000 to over 23,000. Since 1992, there are 6 crematories in Flanders. Each of them has between 2 and 5 ovens. Three crematories are operated by a private company, while the three others are public. The crematories operate 5 or 6 days per week, during 8 to 10 hours.

Environmental conditions for crematories

Crematories have been classified as “objectionable establishments” of class 1 (potentially having the largest environmental impact) within the Flemish environmental legislation only since 1999. Before, there were no legally binding conditions concerning their environmental impact. In 1999, specific emission limit values were established for the emissions of particulate matter, mercury, sulphur oxides, nitrogen oxides and PCDD/F. The PCDD/F emission limit value of 0,1 ng TEQ/Nm^3 (at the reference level of 11% oxygen) became operational on 1 January 2003 for existing plants. This gave the operators of the crematories sufficient time for a technological updating of their ovens in order to comply with this new emission limit value. However, in the meantime, they were already obliged to perform a yearly dioxin emission measurement, in order to control the operation and environmental impact.

Initial situation 2000-2001

By the end of 2000, the EIS found out that none of the crematory operators had complied with all of the emission measurement obligations. Therefore, the operators were exhorted to have the dioxin emissions measured as quickly as possible. These first emission measurements in late 2000 or early 2001 gave a good overview of the situation. The results have been compiled in the following table (“initial situation”). It became clear that at most crematories the PCDD/F emission was much higher than the upcoming limit value. From these measurements, the total amount of dioxins emitted yearly by all of the Flemish crematories was estimated at about 1,4 g TEQ. However, the huge variation of the concentrations measured, was very striking. Investigations learned that the emissions were strongly influenced by both the incinerated material and the incineration conditions. The composition of the coffins (board, varnish, decorations, …) as well as its content (e.g. body bags made out of PVC) may cause increased emissions of polluting substances. Some incinerating ovens were of an older type. Due to incineration temperatures being too low or the residence time of the flue gases in the (post)combustion zone being too short, PCDD/F formation was being enhanced. Early 2001, only 1 crematory oven had an end-of-pipe filter device of the amalgamator type installed to remove PCDD/F. Emission measurements at this oven proved that the emission limit value of 0,1 ng TEQ/Nm³ could be complied with.

Preventive enforcement approach of the EIS: 2001-2002
The first measurement results made clear that end-of-pipe measures would be necessary to obtain compliance with the upcoming dioxin emission limit value by the end of 2002. The EIS signalled this to the operators, making clear that, beyond the deadline of 1 January 2003, no further operation would be tolerated without compliance with the emission limit values. The EIS differentiated its preventive approach taking into account the measured emission concentrations. During the intermediate period, before 2003, the crematories had to keep their PCDD/F emissions as low as possible, by taking primary measures. At several ovens, the incineration process was adjusted by extending the incineration chamber and renewing the process control. Discussions arose about the composition and content of the coffins. The operators started negotiating with the undertakers and coffin producers to prevent the input of substances, which are enhancing dioxin formation. A new series of emission measurements, performed in the autumn of 2001 (compiled in the following table), showed an improvement of the dioxin emissions at most crematories, due to the primary measures being taken. Again, the emissions of the various crematories and ovens showed very strong variations. These results confirmed the necessity of end-of-pipe abatement techniques, to comply with the emission limit value of 0,1 ng TEQ/Nm³. Through regular negotiations with the operators, the EIS ensured that the installation of the end-of-pipe measures was not postponed.

Dioxin abatement techniques
The operators of the crematories were quickly aware that investments in flue gas cleaning equipment would be necessary. Based on experiences in other countries, the injection of an adsorbent into the flue gases was generally chosen. Different filtration techniques have been applied, including fabric filters and cyclones. At one crematory (W), the 5 existing electric ovens of an outdated type were completely replaced by 4 brand new ones, including a filter system for dioxin removal. The EIS closely followed the cleanup operations. The modifications took place quickly and efficiently, with respect for the initial time schedule. Due to his effort, all crematories started using the filter systems before the end of 2002, except one crematory, at which the filter was ready for operation in February 2003. The EIS did not allow this oven to be operated in January 2003.

Evolution of the PCDD/F emissions at the Flemish crematories 2000-2003
The following table gives an overview of the dioxin emissions measured in the stack of the various ovens of the Flemish crematories. The flue gas rate of all ovens varies between 1500 and 5000 Nm³/h. The installation of completely new ovens (W) or of an end-of-pipe technique to remove dioxins from the flue gases, resulted in emission concentrations below the limit value of 0,1 ng TEQ/Nm³ (at 11% O_2). Still, the measured concentrations vary over several orders of magnitude. As can be seen from the last two columns, at several crematories, the flue gases of 2 ovens have been connected to a single flue gas cleaning system.

PCDD/F concentrations in the stack of Flemish crematories, ng TEQ/Nm³ dry gas, at 11% O_2				
Oven line	Initial situation 2000/2001	Primary measures 2001/2002	Oven line	End-of-pipe measures 2002/2003
B1	14,8	1,8	B1+2	0,0002
B2	12,3	7,6		
B3	156	17	B3+4	0,001
B4	30	12		
H1	0,12	0,14	H1+2	0,004
H2	0,09	0,7		
			H3	0,0043
L1	0,05	-	L1	0,0065
L2	0,85	-	L2	0,014
L3	1,7	-	L3	0,02
L4	1	-	L4	0,0072
L5	0,7	-	L5	0,072
T1	2,57	-	T1	0,037
T2	4,25	-	T2	0,0026
V1	1,86	9,3	V1	0,006
V2	0,83	2,2	V2+3	0,005
V3	0,51	0,91		
W1	13,9	8,3	W1	0,028
W2	3,1	13,8	W2	0,0052
W3	20,4	14,2	W3	0,153-0,107-0,051
W4	16,1	0,075	W4	0,005
W5	10,4	8,3		

Currently, all crematory ovens are complying with the emission limit value of 0,1 ng TEQ/Nm³. At one oven, it took some additional fine-tuning before this result was obtained. This successful sanitation has been the result of the new strict legislation, a realistic time frame and the professional negotiating and enforcement approach by the EIS. The EIS will follow-up the situation by checking the self-monitoring data and, if necessary, by performing its own emission measurements. In the meantime, new legislation has been published on the composition and content of coffins. The operators of the crematories made an agreement with the coffin producers and undertakers in order to prevent the input of unwanted substances. This will cause a further reduction of the formation of dioxins in the cremation process. From the latest measurements, the total PCDD/F emission from the Flemish crematories is estimated to be clearly less than 5 mg TEQ/year.

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