090901
Cremation

Process description

A crematory furnace consists of a refractory chamber in which the mortal remains to be cremated are placed. The coffin is forwarded into the furnace by a conveyor fixture. In the so-called "cold type" furnaces, the coffin is placed inside at a temperature of about 300 °C. In the "warm types", the temperature is 800 °C or higher. The cremation is carried out in furnaces which are fired using oil or natural gas. There are also some which run on electricity. In more modern installations the remains are transported to a post burning chamber located beneath where they are post-fired (minimum temperature 850 °C). The cremation time is about 1.2-1.5 hours in the warm types and lasts for 2-2.5 hours in the cold types.

The oxygen demand of the cremation process varies during the process; particularly during the disintegration of the coffin, the air demand is greatest. The air supply in the furnace is regulated according to an adjustable time schedule. The after burners are often still regulated as to temperature, in which process the gas/air ratio has been pre-set. More modern systems regulate the air supply in the after burners using an oxygen meter in the flue gases.

Abatement technologies:

The average volume of waste gases is approximately 1200 N m^3/h for gas and oil fired furnaces and approximately 600 N m^3/h for electrically heated furnaces. The waste gases from the muffle are transported via the post-firing chamber and the recuperator and are subsequently purified by cyclones and fabric or electro filters. As far as the route that the flue gases pass after the after burner is concerned, a distinction can be made into the following three systems:

1. The flue gases are brought into the atmosphere without cooling.
2. The draught is regulated using an air blast by which the flue gases are cooled with ambient air to a temperature between 200-350 °C, before being emitted.
3. The flue gases are cooled as under 2, followed by further cooling to about 150 °C in an indirect air cooler. Subsequently, they pass a fabric filter in which the dust carried along is collected.

Plant data/European situation

Throughout all European countries crematoria are likely to be operated to a various extent. Unfortunately it was not possible to get a complete overview on the number of cremations and of the corresponding crematoria; following data could be obtained:

country	number of facilities
B	10
D	103
NL	43
S	75
UK	700

090901—Table 1 numbers of crematoria provided by the national dioxin inventories

Activity data

The activity data (shown in 090901—Table 5) were taken from the national inventories and national statistics (annual death rate and percentage of incinerations; if a percentage of incinerations was not provided an incineration rate of 50 % was assumed). These data allowed a calculation of the number of incinerations per year for each considered country.

Emission factors

The emission factors for crematoria as reported by the national dioxin inventories are shown in 090901—Table 4; most of them had been gained by measurements. Except

for the British results being notably higher a rather narrow range of flue gas concentrations was found.

From these studies the following default emission factors were derived to be used for the emission estimation:

typical	minimum	maximum
8.0	3.0	40.0

090901—Table 2 Default emission factors for crematoria [µg I-TEQ/t]

Emission estimation

On the basis of the selected emission factors and activity rates the standardised annual PCDD/F emissions were derived. The values obtained were compared to those reported in the national inventories and revealed a remarkable agreement. For all 17 countries considered the following results are obtained (090901—Table 3):

	TOTAL
national invent. min	3.1
national invent. max	28.3
national invent. typic.	9.8
Re-evaluation, min	4.6
Re-evaluation, max	72.8
Re-evaluation, typical	14.9
Combination, min	**5.5**
Combination, max	**65.7**
Combination, typical	**16.8**

090901—Table 3 Summary of re-evaluated typical PCDD/F air emissions [g I-TEQ/a] from crematoria

If those countries which did not provide any data or emission inventories for crematoria are included into the total estimation the European total emission increases by a factor of more than 2.

Conclusions/recommendations

Crematoria are certainly not of high relevance for the total emission of PCDD/F in Europe. In this connection the data from crematoria up to now indicate that in most cases these installations may be disregarded. However, from the local view crematoria without or low quality flue gas cleaning might have adverse environmental impact. Therefore some spot-check measurements might be necessary to assess the possible emissions and confirm the currently available data, especially in those countries which did not provide any data.

	Flue gas conc. [ng I-TEQ/m³]			Emission factors [µg/Cremation]			Remark
	typ	min	max	typ	min	max	
A	2			8			
B				6	2	28	
CH				10	2	28	based on 1 measurement in CH, German results and literature data
D	1.520	0.11	14.4	7.2	0.4	87.4	
Dk							
E							
F							
Gr							
I							
Irl							
L							
N							
NL	2.3	1.6	3.3	3.4	2.4	4.9	
P							
S		10	20	8.49	6	12	EFs recalculated
Sf							
Uk	46	25.4	71.3	14	2.4	80	
Chosen values				**8**	**3**	**40**	

090901—Table 4 PCDD/F air emission factors for cremations from national dioxin inventories

	Activity rates [Cremations/a]			Cremations/a
	nat. Inventories	**total deaths (1993)**	**Crem. [% of total deaths)**	**used for calc.*)**
A	11970	51000	23	11970
B	32035	107000	30	32035
CH	41500	62000	67	41500
D	292034	897000	33	292034
Dk		63000	0	31500
E		339000	0	169500
F		530000	0	265000
Gr		97000	0	48500
I		541000	0	270500
Irl		31000	0	15500
L		4000	0	2000
N				0
NL	59143	183000	32	59143
P		106000	0	53000
S	61237	97000	63	61237
Sf		51000	0	25500
Uk	437000	658000	66	437000
Total	**934919**			**1815919**

*) 50% of total deaths assumed if no other data available

090901—Table 5 Activity rates releated to cremations

	national inventories			re-evaluation			combination		
	typ	min	max	typ	min	max	typ	min	max
A	0.1			0.1	0.0	0.5	0.1	0.0	0.5
B	0.2	0	0.9	0.3	0.1	1.3	0.2	0.1	0.9
CH	0.4			0.3	0.1	1.7	0.4	0.1	1.7
D	2.1	0.7	6.6	2.4	0.7	11.7	2.1	0.7	6.6
Dk	0.2			0.3	0.1	1.3	0.2	0.1	1.3
E				1.4	0.4	6.8	1.4	0.4	6.8
F				2.2	0.7	10.6	2.2	0.7	10.6
Gr				0.4	0.1	1.9	0.4	0.1	1.9
I				2.2	0.7	10.8	2.2	0.7	10.8
Irl				0.1	0.04	0.6	0.1	0.0	0.6
L				0.02	0.01	0.08	0.0	0.0	0.1
N	0.1	0.03	0.2	0.00	0.00	0.00	0.1	0.0	0.2
NL	0.2	0.1	0.6	0.5	0.1	2.4	0.2	0.1	0.6
P				0.4	0.1	2.1	0.4	0.1	2.1
S	0.5	0.4	0.7	0.5	0.2	2.5	0.5	0.4	0.7
Sf				0.2	0.1	1.0	0.2	0.1	1.0
Uk	6.1	1.9	19.1	3.6	1.1	17.5	6.1	1.9	19.1
TOTAL	9.8	3.1	28.3	14.9	4.6	72.8	16.8	5.5	65.7

090901—Table 6 Comparison of PCDD/F air emission estimates [g I-TEQ/a] for cremations (reference period: 1993-1995)

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References to 090901

see national inventories for further information