PCDD/F REMOVAL WITH CATALYTIC FILTERS IN A MUNICIPAL SOLID WASTE INCINERATOR

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Introduction

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/F) are some of the most toxic environmental contaminants. They have never been produced intentionally but are emitted in trace quantities as by-products of different industrial and thermal processes like waste incineration. The public acceptance of waste incineration changed dramatically in 1977, one year after the Seveso accident, when Kees Olie from the University of Amsterdam found traces of PCDD/F in flue ashes of a municipal solid waste incineration plant [1]. From the ideal solution, waste incineration became a synonym of worst environmental pollution. After recognizing this finding, several studies on remediation and abatement technique [2,3,4] finally lead to technical solutions allowing waste incineration without high emission of PCDD/F. The present work shows how PCDD/F emissions of a municipal waste incinerator can effectively be reduced to levels far below current national emissions limits.

Materials and methods

The waste incinerator of Bolzano is located in one of the most famous tourist areas of Italy.
Therefore special attention was paid to the environmental impact of the plant. Since 2003 an automatic sampling system has been installed, which is suitable to monitor the dioxins emission during the complete operation time of the waste incinerator, to have a complete control of the dioxins emission.
The plant is designed on two parallel almost identical lines, with a total capacity of up to 400 t/day of urban waste with lower heating values between 1500 and 3000 kcal/kg. Line 1 was built in 1988 and line 2 in 1994. The combustion takes place on a roller type grate with a secondary combustion chamber; energy is recovered through a water tube boiler and a steam turbine, providing up to 3.3 MW of electricity and up to 8 Gcal/h for district heating at the design refuse feed rate. Flue gas cleaning is performed by a fabric filter (working temperature 210 – 220 °C) and a two-stage wet scrubber, in line with a final SCR (Selective Catalytic Reduction) unit for NOx and trace organics (PCDD/Fs) conversion (Fig.2). In 2007 on combustion line 1 dust filters were replaced by catalytic filters (REMEDIA ™ of W.L. Gore & Associeates, Inc)) and after the very positive experience with this in 2009 also line 2 was upgrades with the same catalytic filters.

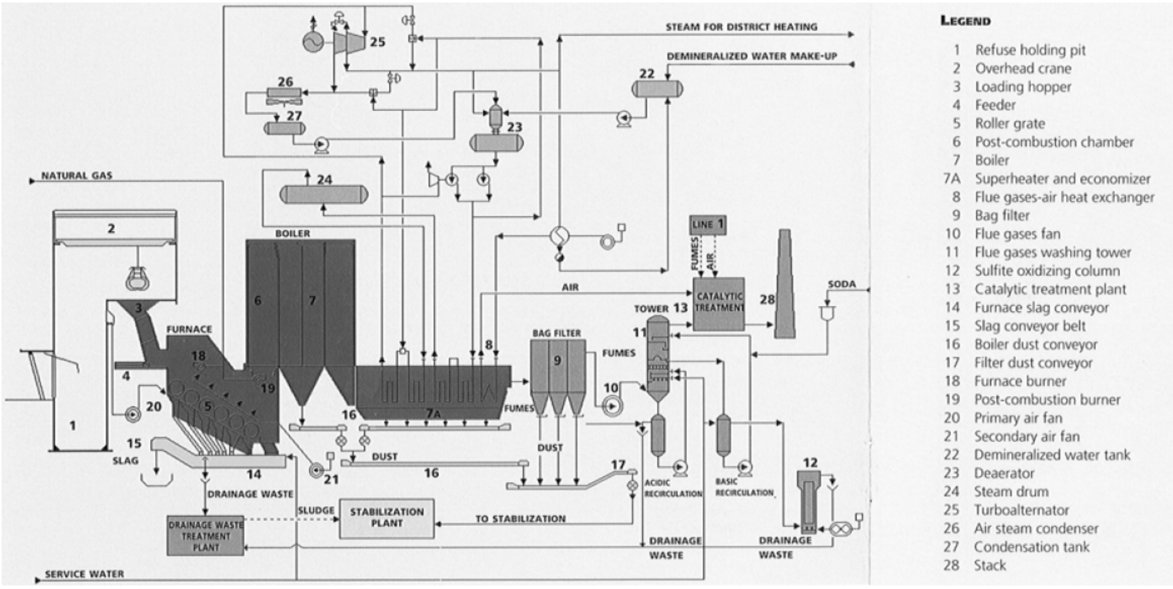


Fig.: Schematic of the Bolzano incineration plant

PCCD/Fs sampling, clean up and quantification were conducted in accordance with the present European Standard Protocols using $^{13}C_{13}$ labelled standards (EN 1948, CEN, 2006). Flue gas sampling was performed by the filter-cooler method. Extraction of filter media was done by soxhlet with toluene, extraction of aqueous liquid by liquid/liquid extraction with dichloromethane. An automatic system was used for chromatographic sample clean up (FMS). Pre-packed teflon disposable columns, containing multilayer silica and alumina were utilised. The analytes were separated by HRGC using a DB-5 ms capillary column (Agilent) and quantified by HRMS (Thermo MAT 95 XP) using selected ion monitoring (SIM) at 10,000 resolving power.

Results and discussion:

The physical and chemical processes governing the combustion are complex. Temperature, composition, oxygen content of flue gas are important variables. Small variations can cause huge variation of the pollutant concentration in the flue gas. In table 1 are summarized the results of the PCDD/F analysis in entrance end exit of the catalytic filters on line 1. The concentration levels in the flue gas are not constant and can vary between 0,29 and 2,97 ng I-TEQ/Nm^3.

In all cases the concentration detected downstream the filters was very low.

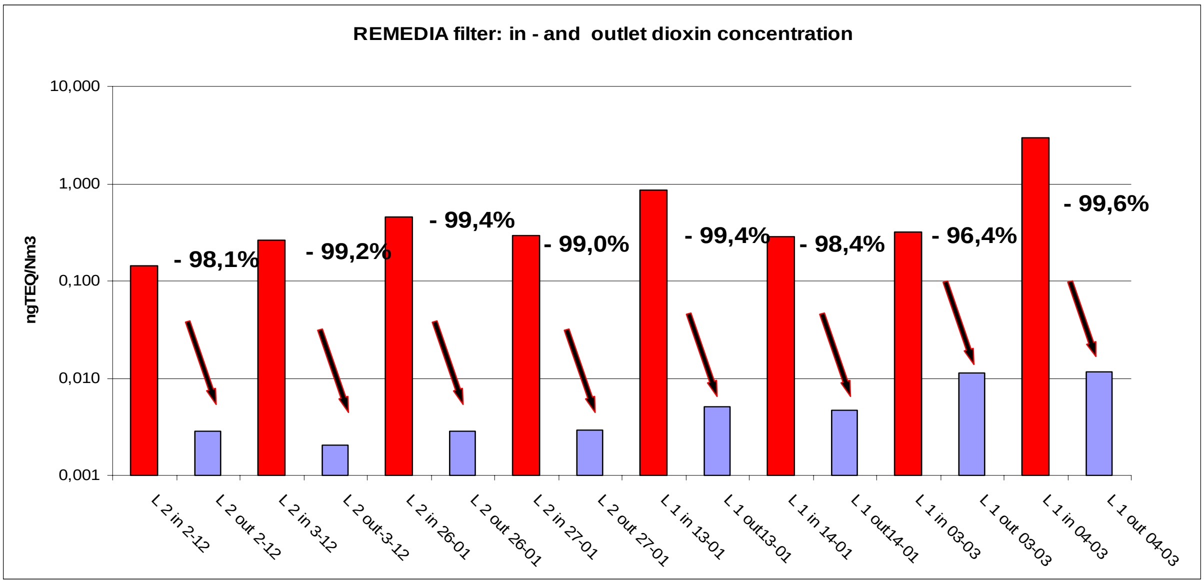
	L 1 in 13-01	L 1 out13-01	L 1 in 14-01	L 1 out14-01	L 1 in 03-03	L 1 out 03-03	L 1 in 04-03	L 1 out 04-03
2378 TCDD	57,2	0,1	32,6	0,1	12,2	<0,1	80,6	<0,1
12378 PCDD	137,9	0,6	84,6	0,5	39,9	0,6	372,7	0,7
123478 HxCDD	108,8	0,7	61,8	0,9	35,5	1,5	323,9	0,7
123678 HxCDD	234,3	2,4	161,8	2,7	77,8	4,6	520,8	1,6
123789 HxCDD	181,7	1,4	98,2	1,6	53,1	2,4	414,5	1,1
1234678 HpCDD	1718,5	16,0	1190,0	21,8	773,6	45,3	4648,8	12,8
OCDD	3968,0	34,7	2395,9	43,3	3875,0	118,6	12976,1	30,8
2378 TCDF	192,2	0,7	110,8	0,5	46,5	1,4	542,2	1,7
12378 PCDF	262,1	0,8	173,5	0,9	98,5	3,3	1129,0	3,4
23478 PCDF	244,0	1,7	180,9	1,5	183,2	5,7	1849,1	6,0
123478 HxCDF	278,9	2,5	174,7	2,9	228,9	11,2	2567,0	12,4
123678 HxCDF	293,3	1,9	195,6	2,4	304,1	16,1	3038,9	16,8
234678 HxCDF	261,6	2,1	168,3	2,6	729,6	23,8	6384,0	28,8
123789 HxCDF	30,0	0,2	18,4	0,4	39,4	0,7	401,2	1,4
1234678 HpCDF	826,0	7,7	498,2	10,0	1960,3	101,8	17820,7	115,9
1234789 HpCDF	135,5	1,3	101,9	1,7	395,8	8,4	3608,7	9,4
OCDF	529,7	5,4	327,0	7,7	3380,1	52,7	31843,3	48,7
ng I-TEQ/Nm3	**0,451**	**0,003**	**0,294**	**0,003**	**0,319**	**0,011**	**2,973**	**0,012**

Table 1: Results of the in – out PCDD/F measurements on incineration line 1

	L 2 in 2-12	L 2 out 2-12	L 2 in 3-12	L 2 out-3-12	L 2 in 26-01	L 2 out 26-01	L 2 in 27-01	L 2 out 27-01
2378 TCDD	17,9	<0,1	34,4	<0,1	30,8	0,1	8,2	<0,1
12378 PCDD	38,1	0,1	64,3	<0,1	115,5	0,2	52,3	0,4
123478 HxCDD	22,8	0,1	27,3	0,3	120,5	0,6	76,6	0,9
123678 HxCDD	28,6	0,5	37,1	1,0	369,1	1,3	238,2	2,5
123789 HxCDD	31,9	0,6	37,0	0,2	205,6	0,8	126,0	1,3
1234678 HpCDD	248,4	11,3	260,4	10,1	2947,9	13,8	1628,1	24,1
OCDD	623,7	23,2	619,3	23,4	4827,1	33,0	1759,8	38,2
2378 TCDF	69,0	0,9	139,3	0,8	163,1	1,2	43,4	0,7
12378 PCDF	278,7	2,6	563,0	1,0	791,4	5,4	236,9	3,4
23478 PCDF	88,0	1,9	178,8	1,0	716,2	3,7	184,4	2,9
123478 HxCDF	92,4	2,8	151,4	2,7	529,2	4,6	200,3	4,0
123678 HxCDF	99,7	2,3	158,7	1,6	639,6	5,1	212,0	4,9
234678 HxCDF	88,0	2,7	140,7	1,6	1005,8	7,7	282,9	6,5
123789 HxCDF	6,8	0,1	10,3	0,1	38,0	0,2	16,4	0,4
1234678 HpCDF	265,2	12,6	380,1	9,0	2534,4	29,4	701,0	25,6
1234789 HpCDF	35,7	1,7	51,2	1,2	469,3	2,6	93,1	3,3
OCDF	163,3	8,5	257,1	5,0	3027,9	15,1	501,9	16,3
ng I-TEQ/Nm3	**0,145**	**0,003**	**0,262**	**0,002**	**0,861**	**0,005**	**0,284**	**0,005**

Table 1: Results of the in – out PCDD/F measurements on incineration line 2

On incineration line 2 concentration levels where normally lover and also the variation on the entrance concentration was lower, varying from 0,15 to 0,86 ng I-TEQ/Nm3.



Graph 1: in – and outlet PCDD/F concentration and relative abatement of the REMEDIA filters.

Graph 1 resumes the results.
Despite some relatively high PCDD/F concentrations in the inlet flow it is visible that the filter outlet concentration is always far below 0,1 ng I-TEQ/Nm3, which is the regulatory limit of stack emissions in Europe. Higher inlet concentration result in a higher abatement rate of more than 99%. This means that the catalytic filtration by REMEDIA filters can be a powerful tool to reduce PCDD/F emissions of "critical" plants with high concentration of these pollutants.

References:

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