MEETING THE 0.1 ng TOXIC EQUIVALENT LIMIT USING SPRAY DRYER ABSORBER AND FABRIC FILTER FOR FLUE GAS CLEANING ON INCINERATORS

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ABSTRACT

No modification in normal operation parameters are necessary for a flue gas cleaning system consisting of a spray dryer absorber followed by a fabric filter to secure emission level below 0.1 ng Nord.tox.eqv./Nm^3.

INTRODUCTION

Flue gas cleaning equipment has traditionally been designed for removal of acid gases. In order to investigate how requirements to the removal of chlorinated dioxin and furan would influence the operation parameters of a flue gas cleaning system, funding was received from the Danish Ministry of Energy. The investigation was carried out in co-operation between the Danish Boiler Owner's Association dk-Teknik, Amagerforbrænding I/S, a large Danish municipal waste incinerator, and A/S Niro Atomizer.

EXPERIMENTAL

Location: The investigation was carried out on Amagerforbrænding, a municipal waste incinerator plant located nearby Copenhagen. The incinerator consists of 3 rotary kilns, each with a capacity of 12 t/h. Each kiln is followed by a boiler for district heating and an electrostatic precipitator. The semi-dry flue gas cleaning system is installed on one kiln in parallel to the existing electrostatic precipitator and consists of a spray dryer absorber (SDA) with a rotary atomizer, followed by a pulse-jet fabric filter (PJF). The system treats a flue gas amount of 70,000 - 95,000 Nm^3/h at a spray dryer absorber outlet temperature of 140°C. The system operates in single pass mode and uses a suspension of hydrated lime as absorbent.

In some tests, addition of dry additive was used. The additive was injected just before the atomizer. Fig. 1.

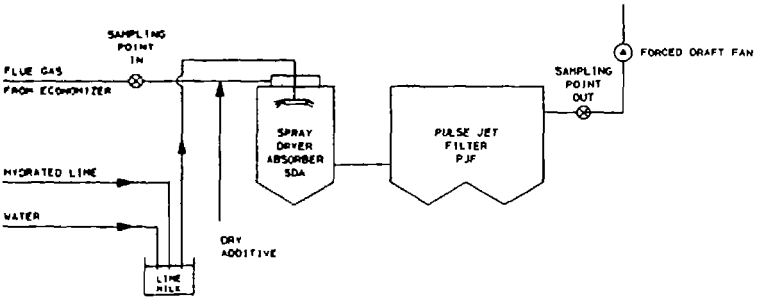

FIG.1

Sampling: 2 sampling points were used during the test. The SDA inlet samples were taken between the boiler and the spray dryer absorber before injection of additives. The PJF outlet samples were taken after the filter and before the forced draft fan, Fig. 1. Sampling of PCDD and PCDF was done by dk-Teknik, using the method recommed by the Nordic countries (1) with the modification that the sampling filter was kept at 120°C as recommended in ref. (2). Sample preparation and analyses was made by "Danmarks Miljoundersøgelser", a laboratory under the Danish Ministry for Environmental Protection.

Test program: The test program was designed to investigate the effect of spray dryer absorber outlet temperature as well as the effect of using 2 different dry additives on removal of PCDD and PCDF. The additive used was activated carbon and active hydrated lime with a high surface area. A simulated start-up of the kiln expected to result in high concentrations of PCDD and PCDF was included in order to show the influence of high levels on the removal. During test periods, simultaneous measurements were made on SDA-inlet and PJF-outlet for PCDD and PCDF, mercury, HCl, SO_2, O_2, CO, dust and flue gas temperature. Furthermore, water content and CO_2 were measured. Detailed results are reported in ref. (3).

RESULTS AND DISCUSSIONS

Results of the PCDD and PCDF and the calculated Nord.tox.eqv. for the different cases investigated are shown in table 1. Inlet values of PCDD and PCDF and of Nord.tox.eqv. are on the same level as reported in the Danish Environmental Agency's investigation of Danish incinerators (4) for normal operation as well as for start-up conditions. Reduction of total PCDD and PCDF is higher than 98 % and for Nord.tox.eqv. higher than 99.5 % in all cases. Outlet values are in all cases significantly below 0.1 ng Nord.tox.eqv./Nm^3 at 10 XO_2.

In calculation of ng Nord.tox.eqv./Nm^3 all values below detection limits were assumed to be zero. If all values below detection limits were assumed to have a value corresponding to the detection limit, all outlet values would still be below 0.1 ng Nord.tox.eqv. This is shown as the value Nord.tox.eqv. max. in table 1.

When comparing the corresponding tests, there seems to be a tendency that decreased outlet temperature is followed by a decrease in the outlet concentration levels of dioxin and furans. This tendency is not statistically significant, probably due to the few numbers and the very high removal efficiencies.

Neither addition of activated carbon nor of active hydrated lime seems to have an effect on removal of dioxin and furans.

Earlier results (5) have shown that for SDA followed by electrostatic precipitator removal of PCDD and PCDF depends on both SDA-outlet temperature and addition of activated carbon. The better results by using the fabric filter are probably due to a longer reaction time for PCDD and PCDF on the high surface area particles, as the flue gases pass through the layer of particles in the fabric filter.

Conclusion: Using a spray dryer absorber followed by a fabric filter requires no modification in normal operation parameters for the acid gas control system to secure an emission level of 0.1 ng Nord.tox.eqv./Nm^3 at 10 $\%O_2$. Even during start-up conditions, where an inlet level of 50 ng Nord.tox.eqv./Nm^3 was measured, the outlet level was below the 0.1 ng limit.

REFERENCES

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Table 1: Operation parameters and results

SDA temp.	140 °C						127 °C			
Additive										
Carbon kg/h		4.5*	0.5	1.5	4.5			1.5	4.5	
Active lime kg/h						14				14
SDA_{in} Σ PCDD+PCDF	132	2170	283	276	201	278	254	154	154	307
PJF_{out} Σ PCDD+PCDF	2,1	3,2	1,2	2,4	1,1	3,5	1,3	0,37	0,65	2,8
% Rem Σ PCDD+PCDF	98,4	99,9	99,6	99,2	99,5	98,8	99,5	99,8	99,6	99,1
SDA_{in} N.t.e. TCDD	2,8	50	4,8	8,3	4,0	7,6	7,7	5,0	4,5	4,9
PFJ_{out} N.t.e. TCDD	0,0076	0,050	0,0075	0,045	0,035	0,015	0,0047	N.D.	0,002	0,043
% Rem. N.t.e. TCDD	99,7	99,9	99,8	99,5	99,1	99,8	99,9	=100	=100	99,1
PFJ_{out} N.t.e. max. TCDD	0,027	0,079	0,022	0,060	0,052	0,033	0,020	0,016	0,026	0,056

All numbers in ng/Nm^3 dry at 10 % O_2

N.t.e. = Nordic toxic eqvivalents

N.D. = Non detectable

* = Simulated start-up