DIOXIN INHIBITION TEST AT SWISS WASTE TO ENERGY INCINERATOR

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1. Abstract

A plant test was conducted to demonstrate on a commercial scale the potential of the Dioxin inhibition technology (DIT) to prevent the formation of polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) in both the flue gas and the flyash of a 100 ton per day (TPD) boiler burning municipal solid waste. The basis of the DIT is to inject chemical formulations in to the incinerator train, one to destroy dioxins formed in the combustion process, the second to inhibit the reformation of dioxins on the fly ash by catalytic activity as the flue gas cools in the post combustion zone and the air pollution control train. The reduction of dioxins and furans at about 95% in flyash and 90% in stack gases has been achieved by injection of these mixtures.

2. Introduction

The formation of PCDD and PCDF in municipal solid waste incinerators (MSWI) is a universal phenomenon. The release of PCDD, PCDF and organohalogen compounds (OHC) by MSWI through the stack emissions and flyash is of great public concern. Hence, there is the need of a method or technology for safe incineration of waste materials[1-5].

There are two approaches by which the introduction of PCDD, PCDF and OHC into the atmosphere and in the earth from the incinerators can be controlled. one by removal of PCDD/PCDF from stack emissions of MSWI prior to their emission into the atmosphere and destruction or removal of PCDD/PCDF from flyash collected at the post combustion zone using various techniques. The second is the prevention of formation and destruction of PCDD/F and precursors at the post combustion zone using various inhibitor/destroyer mixtures. The first approach involves two separate technologies, one for stack emissions and other for flyash. The second approach is easy to implement, involving the addition of inhibitor/destroyer mixtures in the post combustion zone. This paper describes three plant tests conducted in a Swiss incinerator and results of reduction of PCDD/PCDF levels in flyash and stack emissions during those commercial scale tests.

3. Description of the Swiss municipal waste incinerator

The Swiss waste incinerator plant has three independent incineration lines, which contains an incineration grate, a waste to heat boiler and a multi-stage flue gas purification plant. From a refuse bunker, the waste is supplied to the incineration grate (Martin reciprocating grate) where it is burned at temperature of about 1000°C. The inhibitor/destroyer injection technology used by Techform is an essential part of the process. Flue gases flow through the boiler of the waste incineration plant at velocity of 6-12 m/second. This high rate of flow places high demand on the injection technique, which has the objective of obtaining a homogenous distribution of the inhibitor on the flyash surface. Water is used as the carrier medium for inhibitor/destroyer, which, contrary to steam or compressed air , has a positive effect on the operating costs and allows the drop size to be adapted to the operating conditions in the incineration plant. An in situ laser measures the amount of flyash in the flue gases and thus regulates the quantity of inhibitor that is injected in portion to the concentration of the flyash in the flue gas.

4. Specifications of the injection points

Temperature measurements were taken at several locations in the boiler over a period of several days prior to plant tests in order to determine the injection points. Based on the laboratory studies of stability of destroyer/inhibitor mixtures, the destroyer was injected in the temperature window of 590 + 50°C, and the inhibitor was injected in the temperature window of 375 + 50°C. The amount of each of inhibitor and destroyer injection was determined (7-10 % to the flyash) from the amount of flyash produced. An injection nozzle unit contains a pressure atomizer with a mixing chamber, in which the destroyer or inhibitor is mixed with 13 times the amount of water. This extensive dilution was necessary to distribute the small amount of destroyer/inhibitor uniformly into the flue gas. The nozzles, which have an outside diameter of 12 mm and an opening of 1.6 mm, were operated with water and an injection pressure of 6-8 bar.

5. Test procedures

The overall experimental procedure for the dioxin inhibition was planned in such a way that the two inhibitor/destroyer mixtures were injected for four days. Plant test I was conducted where inhibitor/destroyer combination 1 (PSEGC) was used. Plant test II was conducted using inhibitor/destroyer combination 2 (SMEGC). In plant test III combination 1 was used, in addition to that activated carbon was also introduced in gas purification train. Usually, at the fourth day of the test, flue gas samples were collected for PCDD/PCDF measurements prior to shut down of the plant for the week end. Several flyash samples were collected from the electrostatic precipitate on third and fourth day of the each test prior to shutting down of the plant at the end of fourth day. Sampling and analysis of the flue gases for PCDD/PCDF concentration were done with standard techniques.

6. Results and discussion

The amount of PCDD/PCDF detected on the flyash samples collected during three tests are shown in Table 1. With all other conditions remaining the same, injecting the destroyers and inhibitors in to the post combustion zone at temperatures 550°C and 350°C

respectively caused marked reduction in the amount of PCDD/PCDF on the flyash samples from the electrostatic precipitator. A comparison between the individual tests shows that the best reduction of PCDD/PCDF, of 99 % was achieved in Test III. Overall reduction in PCDF, about 80 to 94 %, was achieved in Tests I-III, **Table 1.**

The amount of total PCDD/PCDF detected in flue gases in background samples and samples collected during tests I-III are shown in **Table 2.** From Table 2 it can be seen that the PCDD/PCDF concentration related to the toxic equivalent (TE) of USEPA could be reduced in the tests I-III up to 91% in raw gas, and up to 95 % in pure gas.

TABLE 1. AMOUNT OF PCDD/PCDF (ng/g) ON THE FLYASH SAMPLES COLLECTED PRIOR TO AND DURING TESTS 1-3 IN THE SWISS INCINERATOR.

Test No.	Sample No.	PCDD		PCDF	
		ng/g	% Reduction	ng/g	% Reduction
Background sample	1	150	-	85	-
Test 1	1	27	82	17	80
	2	25	84	12	86
Test 2	1	27	82	15	82
	2	13	91	5	94
Test 3	1	n.d.	>99	15	82
	2	6	96	12	86

n.d. = not detected

TABLE 2. AMOUNT OF PCDD/PCDF (ng/m³) AND USEPA TOXIC EQUIVALENTS FOR RAW AND PURE GAS PRIOR TO AND DURING TESTS I-III AT SWISS INCINERATOR. INJECTIONS DURING TESTS I-III AT SWISS INCINERATOR. INHIBITORS USED ARE INORGANIC/ORGANIC COMPLEXES.

Sample No.	PCDD		PCDF		TOTAL (PCDD+PCDF)	
Flue Gas Samples Prior to (Background) and During inhibition Tests I,II & III	ng/m³	USEPA-TE	ng/m³	USEPA-TE	(ng/m³)	USEPA-TE
Background for Test I Raw Gas	23.62	5.10	26.07	0.90	49.67	6.00
Background for Test II Raw Gas	52.42	5.85	48.36	1.42	100.78	7.27
Background for Test III Raw Gas	26.26	3.77	34.17	0.92	60.42	4.69
Background for Test I Pure Gas	29.60	0.76	24.27	0.33	53.87	1.09
Background for Test II Pure Gas	42.29	2.95	40.59	0.92	82.88	3.87
Background for Test III Pure Gas	38.10	2.68	40.86	0.90	78.95	3.58
Inhibition Test I Raw Gas	46.70	0.19	33.46	0.40	80.60	0.59
Inhibition Test II Raw Gas	88.05	0.99	159.76	2.21	247.81	3.19
Inhibition Test III Raw Gas	6.80	0.08	17.15	0.36	23.95	0.44
Inhibition Test I Pure Gas	19.87	0.31	19.43	0.22	39.30	0.53
Inhibition Test II Pure Gas	26.38	0.42	6.49	0.14	32.87	0.56
Inhibition Test III Pure Gas	5.67	0.11	5.54	0.07	11.21	0.18

7. Conclusion

The results of the tests make evident that the formation of PCDD/PCDF during the incineration of waste can be essentially suppressed both in the flyash from the electrostatic filter and in the pure gas by means of the new primary measure of injecting destroyers and inhibitors. It can be expected that, by further optimizing the injection method, in particular by extending the injection time to at least 2 to 3 weeks , the reduction of PCDD/PCDF can be further improved. The method of inhibition includes not only the pollutants on the electrostatic precipitator flyash, but also the PCDD/PCDF in the flue gas. At the present only time consuming and expensive secondary measures have been used to this end. Estimates of costs for the DIT in this type of boiler are $500,000 for capital equipment and $10 per hour. That is well below that of any other method.

References

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