PCDD/F REMOVAL FROM FLUE GASES USING ADIOX

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Introduction

A new process for removing PCDD/Fs from gases has been developed[1]. Results from several full-scale installations at MSW (Municipal Solid Waste) incineration plants were presented.

In wet flue gas cleaning equipments, polymers are widely used as construction material. Significant amounts of PCDD/Fs can initially be transferred from the flue gas to the polymers until an equlilibrium loading is reached. An increase of the temperature or decrease of the gas phase PCDD/F concentration will result in a desorption of PCDD/Fs back to the gas phase[2]. This is commonly referred to as the "Memory Effect". The desorpton rate of lower chlorinated PCDD/Fs, which contribute more to the TEQ value, is higher than that of the higher chlorinated ones[3].

In order to avoid the PCDD/F release from the polymers, a new construction material was developed, in which carbon particles are dispersed in a polymer matrix, such as PP (polypropylene). In this new material, called Adiox (patent pending), the PCDD/Fs are first absorbed in the polymer and then they diffuse to the surfaces of the carbon particles where they are adsorbed. Several types of components, such as tower packings and demisters, can be produced from Adiox and employed in conventional wet scrubbers.

The absorption of PCDD/Fs in PP and Adiox respectively was tested in laboratory experiments[4]. Gas containing PCDD/Fs was passed through a fixed bed of pure PP granules at 80 °C. A break-through of the lower chlorinated PCDD/Fs was detected after one month. Upon heating the granules to 120 °C, a substantial part of the PCDD/Fs were desorbed. The experiment was repeated with Adiox granules. No break-through was detected and the desorption at 120 °C was negligible.

Methods and Materials

Adiox has been installed at several full-scale waste incineration plants in the form of test rods, tower packings and demisters. A test rod assembly, shown in Figure 1, was used to expose different polymer materials to flue gas and scrubbing liquid in a waste incineration plant. The mechanical properties as well as PCDD/F concentrations of the test rods were measured after different times of exposure.

The tower packings of existing wet scrubbers for HCl, HF and SO_2 removal were replaced by Adiox tower packings in a number of plants. As per April 2003, Adiox tower packings had been installed in ten full-scale incineration lines at one hazardous waste and five MSW incineration plants with gas flows ranging from 30 000 to 100 000 m^3/h (n., d.g.). Three of the plants have ESPs (electrostatic precipitators) and three have bag house filters upstream of the Adiox scrubbers. The PCDD/F concentrations before and after the scrubbers were measured according to EN1948.

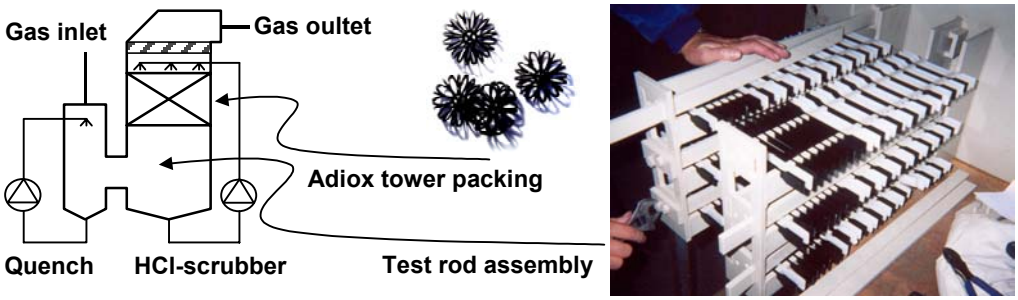

Figure 1. Test rod assembly placed downstream of the quench, below the tower packing in a wet HCl-scrubber of a MSW incineration plant. The saturation temperature varied in the range of 60-65 °C and the pH-value was approximately 1.

The first full-scale installation[1] has been in operation since September 2001 at the Thisted MSW incineration plant in Denmark. The flue gas cleaning device, in operation since 1991, consisted of an ESP and two wet scrubbers in series. The tower packings of the existing scrubbers were replaced by Adiox tower packings. A removal efficiency of the scrubbers for PCDD/Fs of 70% has been measured during the first year of operation, except during start-up conditions, which yielded much higher removal efficiencies[1]. After one year of operation, a bag house filter with activated carbon injection was installed upstream of the scrubber system: Adiox now serves to absorb PCDD/Fs desorbing from the contaminated scrubber walls and the piping.

The second Adiox installation was made in a two-stage scrubber after an ESP at the Kolding MSW incineration plant in Denmark. A pilot scrubber, shown in figure 2, has been installed in series with the full-scale scrubber, in order to carry out further research.

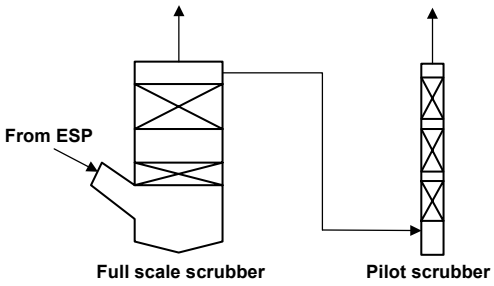

Figure 2. The full-scale scrubber at the Kolding MSW incinerator was equipped with Adiox tower packing. A pilot scrubber, also with Adiox tower packing, was installed.

The pilot scrubber operates with a fraction of the total gas flow (approximately 1400 m^3/h). The aim of this flexible installation is to demonstrate how economical and operational benefits can be gained by a complete integration of the PCDD/F removal into the wet scrubbing process down-stream of an ESP.

Adiox acts as a police filter at the following two plants in case of operational disturbances:

- The flue gas cleaning at the Dåva MSW incineration plant in Umeå, Sweden, consists of a bag house filter with activated carbon injection and a wet flue gas cleaning system. Adiox has been installed in the last scrubber.
- Adiox was installed in a scrubber downstream of a bag house filter equipped with catalytic bags for PCDD/F destruction at a hazardous waste incineration plant in France.

Results and Discussion

The main objective of the first full-scale installation was to determine the lifetime of Adiox tower packings considering the mechanical properties and PCDD/F absorption capacity. The TCDF concentration in the PP and Adiox test rods is shown in Figure 3. For pure PP, an equilibrium concentration was reached after 6 months, while Adiox continuously absorbed TCDF during the test period of one year. The results were similar for TCDD and PnCDD/Fs. As expected, the trend was similar for Hx- and HpCDD/Fs but the difference between PP and Adiox was smaller.

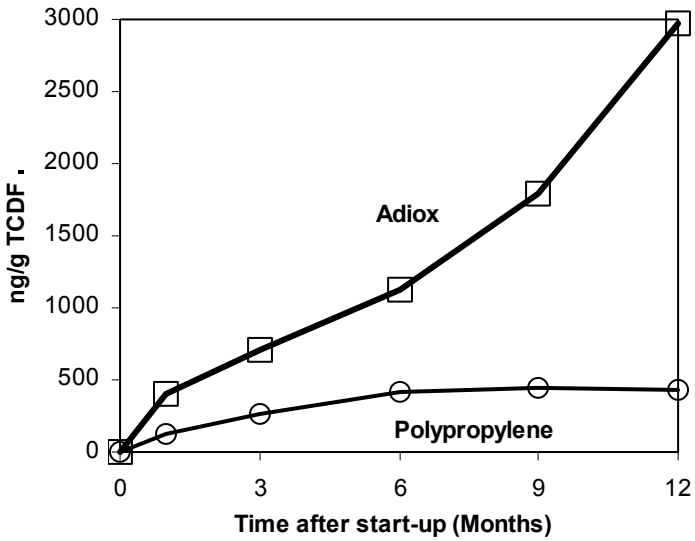

Figure 3. The concentration of tetra-chlorinated DFs in the test rods shown in Figure 1 after different times of exposure.

The tensile strength, yield strength, E-modulus and Charpy impact strength were tested for Adiox and pure PP after 0, 3, 6 and 12 months. All measured values varied within ±10% and no trends indicating degradation could be recognised.

The different full-scale installations of Adiox tower packings operate at a wide range of input concentrations. The removal efficiency seems to be independent of the inlet gas concentration as indicated in Figure 4.

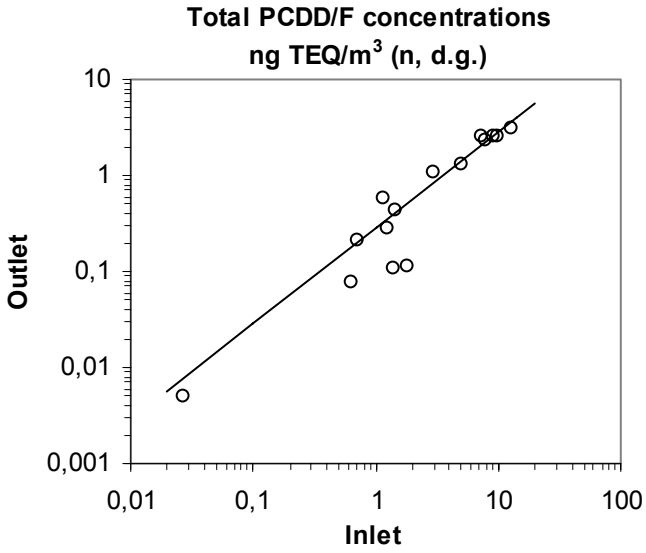

Figure 4. Outlet total PCDD/F-concentrations (ng TEQ/m^3 (n., d.g)) as a function of the inlet concentrations at the various full-scale Adiox installations, consisting of one or two packed beds. The regressed curve corresponds to 72% removal efficiency.

The first results from the pilot installation in Kolding indicate that emission values below 0.1 ng TEQ/m^3 can be realised by using only a combination of an ESP and wet scrubbers equipped with Adiox tower packings. Such a system would require a more elaborate scrubber installation than commonly used. On the other hand it is possible to integrate more functions in the scrubber such as energy recovery by condensation and mercury removal with the MercOx process[5].

The use of Adiox tower packing as a police filter in a scrubber downstream of a primary PCDD/F removal system, such as a bag house filter, will result in additional security of the air pollution control system. In that case, Adiox will increase the margins in the case of e.g. carbon dosage failure, filter leakage or increased PCDD/F-concentrations during start-up.

References

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