REMOVAL AND DESTRUCTION OF PCDD/F FROM CREMATORIES BY REMEDIA™ CATALYTIC FILTER SYSTEM

Zhengtian Xu[1], Edward Wedman[1], Rick Bucher[1], Ole Petzoldt[1], Toru Sasamoto[2], and Michael Wilken[3]

[1] W.L. Gore & Associates, Inc., 101 Lewisville Road, Elkton, MD 21921, USA
[2] Japan Gore-Tex, Inc., 1-42-5 Akazutsumi Setagaya-Ku, Tokyo 15600, Japan
[3] MWC - Michael Wilken Consulting, Florastr. 8, D-12163 Berlin, Germany

Introduction

PCDD/Fs are emitted from crematories during cremations. It is estimated that the average dioxin emission per cremation is 9,200 ng TEQ/body; the annual dioxin emission from crematories in Japan is about 8.9 g TEQ/year[1]. Controlling emission of dioxins from existing crematories is challenging, due to their small sizes and the cost of the additional equipment.

The REMEDIA Catalytic Filter System was developed in 1997 by W. L. Gore & Associates, Inc. for destruction of PCDD/Fs in flue gases. The system has been successfully used in municipal waste incinerators[2], medical waste incinerators[3], and hazardous waste incinerators[4]. Recently, the REMEDIA Catalytic Filter System was applied to a number of crematories in Europe and Japan. The catalyst in the filter destroys gas phase dioxins nearly completely. Here we report the performance of the REMEDIA Catalytic Filter System for dioxin control from crematories in Germany and Japan.

Methods and Materials

The REMEDIA Catalytic Filter System incorporates micro-porous PTFE fiber with the catalyst particles built into the fiber structure. In this process, PTFE particles are mixed with the catalyst and processed to produce fibers. A micro-porous ePTFE membrane is laminated to the ePTFE/catalyst micro-porous fibers to produce the filtration media. This material is then sewn into filter bags, which can be installed in a baghouse. The sampling and analysis procedures for the European plants followed the European standard method EN 1948, which is binding upon Europe. The measurements at the Japanese waste incinerator were performed according to the JIS K 0311-method. Both methods differ only in some details, therefore the results are comparable.

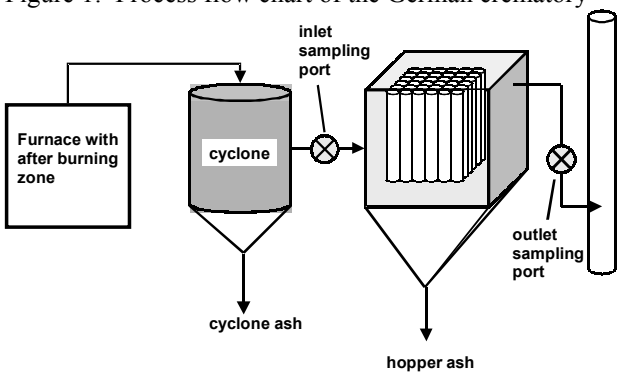
Results and Discussion

Crematory in Germany

In 1997, Germany adopted a new dioxin (0.1 ng I-TEQ/Nm^3) and particulate (10 mg/Nm^3) regulation for crematories. The existing plants had 3 years to meet the regulation. Before installation of REMEDIA Catalytic Filters for dioxin control, the crematory in Germany already had one baghouse per line using conventional felt bags operating at around 150°C and at a flow rate of 1300 Nm^3/hr per line. The plant had considered using other control technologies, such as powdered activated carbon injection; however, the limitation for additional space and requirement for new equipment, plus additional maintenance made the choice less attractive. The crematory then decided to install REMEDIA Catalytic Filter System in its baghouse, only changing the

temperature in the baghouse to 220°C. The first installation was completed in 1998 at one line, the second line was completed two years later. The process flow chart is shown in Figure 1.

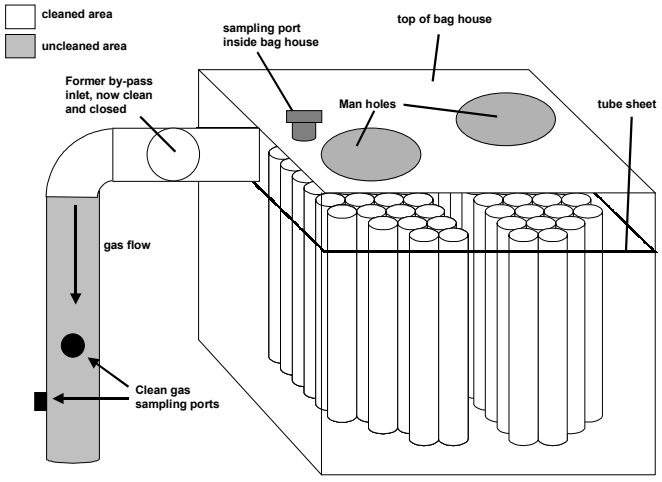
Figure 1: Process flow chart of the German crematory



The first emission measurement after the installation of the REMEDIA™ catalytic filter system was performed after a 1.5 month operation. The samples were taken at the inlet and the outlet of the baghouse (locations shown in Figure 1) in parallel. The analysis result showed that the PCDD/Fs level at the outlet of the baghouse was 0.317 ng I-TEQ/Nm^3, exceeding the emission regulation (Table 1). The removal efficiency of the system was less than 60%. Analysis of a filter bag sample from the baghouse showed no reduction of the catalytic activities; it was concluded that the catalyst was fully functional without any deactivation. Further investigation of the baghouse and the ductwork revealed that a significant amount of dust and black soot deposited along the ductwork, a potential source for "memory effect". A hypothesis was proposed that the high level of PCDD/Fs at the baghouse outlet was the result of release of PCDD/Fs in the soot and dust in the ductwork prior to the catalytic system installation, due to the significantly increased operation temperature. A dust sample removed from the duct after the baghouse showed a high level of PCDD/Fs.

A new campaign was performed after 2.5 months operation to determine the cause of the high PCDD/Fs emission at the baghouse outlet. Two samples were taken simultaneously; one was taken from the clean side inside the baghouse and just above the tube sheet, another sample was taken at the baghouse outlet (Fig. 2).

Figure 2: Diagram of the sampling ports and ductwork at the German crematory



It was found that the PCDD/F concentration inside the baghouse was 0.032 ng I-TEQ/Nm^3; the level at the baghouse outlet was 0.157 ng I-TEQ/Nm^3, nearly five times higher than that at the inside of the baghouse. A separate measurement with only natural gas showed the similar trend. The results confirmed that the "memory effect" was the reason for the high dioxin emission at

the baghouse outlet. A cleaning procedure was performed to reduce the "memory effect" at the baghouse outlet (Figure 2). During this procedure, all the catalytic filter elements were removed from the baghouse. All accessible parts of the outlet of the baghouse were cleaned with a metal scrubber and all the loose dust was removed with a vacuum cleaner. Four months after the ductwork cleaning and re-installation of the REMEDIA™ Catalytic Filter System, a new measurement was performed. Samples were taken at three locations: inlet of the baghouse, inside the baghouse, and the outlet of the baghouse, simultaneously. The PCDD/Fs level at the baghouse inlet was 0.73 ng I-TEQ/Nm^3 during 3 cremations; it was 0.016 ng I-TEQ/Nm^3 from inside the baghouse; it was 0.05 ng I-TEQ/Nm^3 at the outlet of the baghouse. The concentrations of PCDD/Fs both inside the baghouse and at the outlet of the baghouse were significantly below 0.1 ng I-TEQ/Nm^3. The level at the baghouse outlet was slightly higher than that at inside of the baghouse, indicating that small "memory effect" still exists. Another measurement performed one month later showed that the PCDD/Fs emission at the baghouse outlet was stable at 0.05 ng I-TEQ/Nm^3.

Table 1: PCDD/F Data after installation of the REMEDIA Catalytic Filter System

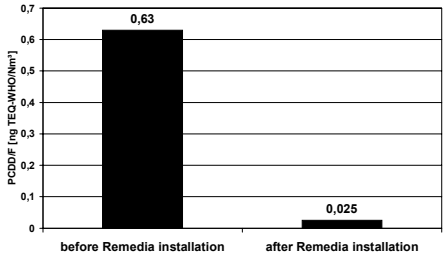
Months after Remedia installation	Incineration	Baghouse inlet	Inside Baghouse (clean side)	Baghouse outlet
1.5	3 cremations	0.72	n.i.	0.317
2.5	3 cremations	n.i.	0.032	0.157
2.5	Natural gas	n.i.	0.019	0.171
6.5	3 cremations	0.73	0.016	0.05
7.5	6 cremations	1.27	n.i.	0.054

All concentrations in ng I-TEQ/Nm^3 @ 11% O_2; n.i. = not investigated

Crematory in Japan

The crematory in Japan has several lines; each line has its own combustion chamber, after burner, gas cooling, and baghouse. The flue gas flow rate at each line is 1,500 Nm^3/h, the temperature in the baghouse is 200°C, the operation time is 40 hours/month. Before installation of the REMEDIA Catalytic Filter System, a dioxin measurement at the baghouse outlet showed a PCDD/F emission of 0.63 ng TEQ-WHO/Nm^3.

Figure 3: PCDD/F concentrations before and after REMEDIA installation at the Japanese crematory

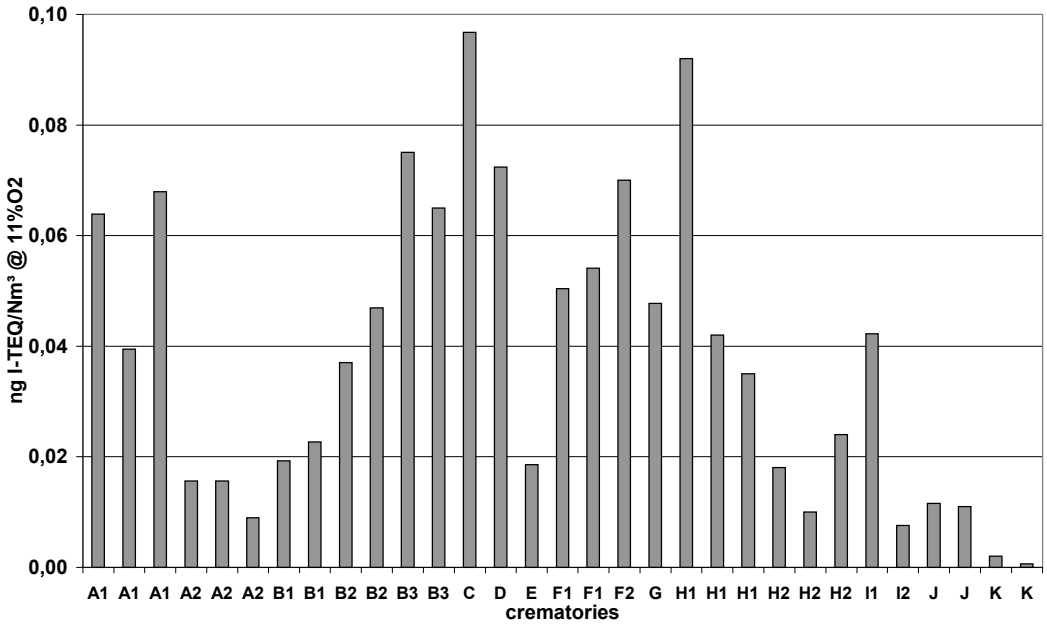


The crematory first installed a number of REMEDIA Catalytic Filters in one of the baghouses for an activity test, which was performed by removing a filter at the end of 1, 2, 3, and 12 months respectively. As the catalyst remains 100% active after 12 months, the plant decided to install the catalytic filter system at one line. A dioxin measurement was performed after one month at the baghouse outlet. The result is shown

in Figure 3. Based on the historical PCDD/Fs emission at this crematory, the REMEDIA™ Catalytic Filter System achieved more than 96% PCDD/F removal efficiency.

Additional Experience with the REMEDIA Catalytic Filter System
Currently, the REMEDIA Catalytic Filter System is being equipped at more than 20 lines of crematories in Germany, 17 of them have been tested so far. The results from the PCDD/Fs emission measurements have shown excellent PCDD/Fs destruction and removal efficiencies by the catalytic filter system (Figure 4).

Figure 4: Results of emission measurements at German crematories



Conclusions
Crematories are significant sources of PCDD/F emissions. The REMEDIA Catalytic Filter System has demonstrated effectiveness in reducing the PCDD/F emission at crematories below the regulatory limit. Additional cleaning procedures should be considered to reduce the "memory effect" when a plant tries to reduce its PCDD/F emissions at the stack.

References
1. Takeda N., Takaoka M., Fujiwara T., Organohalogen Compounds 36, (1998), 167-170
2. Bonte J.L., Plinke M., Dandaraw R., Brinckman G., van Overberghe K., van den Heuvel H.,Waters M., Organohalogen Compounds 40 (1999), 459-464
3. Fritsky K.J., Kumm J.H., Wilken M., Proceedings of the 2000 International Conference on Thermal Treatment Technologies, May 8-12, 2000, Portland, Oregon USA, 1-8
4. Xu Z., Wedman E., Bucher R., Pranghofer G., Mogami Y., Wilken M., Proceedings of Hazardous Waste Combustors 2003, April 1-2, 2003, Charleston, USA, to be published