Catalytic Filtration

Experience in Batch and Continuous Municipal Waste Incinerators in Japan

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Introduction

The stringent emission limit for PCDDs, PCDFs and PCBs in Japan will be effective from December 2002. In order to assure compliance, it is known that both combustion control and emission control are important. This paper discusses a unique catalytic filtration technology for emission control in waste incinerators. The performance of the REMEDIA™ D/F Catalytic Filter System has been reported by J. L. Bonte et. al [1] and Y. Mogami et al[2] in which the PCDD/F emissions have been kept below 0.1 ng TEQ/ Nm^3 in Belgium and Japanese municipal waste incinerators. This paper presents the experience of catalytic filtration in Japanese municipal incinerators in both batch and continuous operation plants. In one case, PCDD/F emission levels were investigated during steady state operation, as well as the traditionally high emission phases of start up and shutdown. In all cases PCDD/F emissions were significantly below the 0.1 ng TEQ/Nm^3 regulation.

Methods and Materials

Description of the Catalytic Filter System

The REMEDIA D/F Catalytic Filter System is an evolution of two proven technologies: catalysis and surface filtration. The system consists of an ePTFE membrane and a catalytic felt substrate. The GORE-TEX® ePTFE membrane captures sub-micron particulate, including heavy metals, thereby reducing emissions while protecting the catalytic felt substrate from contamination/poisoning. Gaseous PCDD/Fs, however, pass through the membrane and into the catalytic felt substrate. This substrate is a needle-punched felt made from ePTFE fibers containing a proven dioxin-destroying catalyst. PCDD/F molecules diffuse on the catalyst surface and react to form trace amounts of CO_2, H_2O, and HCl. The catalysis and surface filtration principles are illustrated in Figure 1.

This catalytic filtration technology has been in use in industrial applications around the world since 1996 and was introduced to Japan in 1998. In typical industrial facilities, the system is operated at temperatures of 180 to 250°C. The filter velocity, approximately 1m/min (the typical range for a cloth filter), allows sufficient residence time for the reactions to occur.

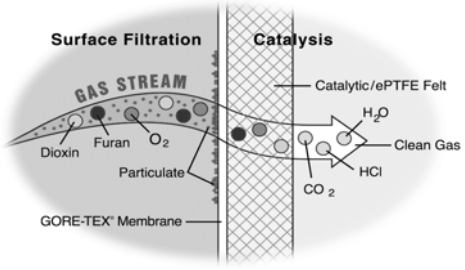

Fig. 1 Cross-section of the catalytic filter. The membrane removes particulate while the catalytic felt destroys gaseous PCDD/F.

Dioxin Measurements

In measurements described in this paper, the dioxin concentrations in the gas and particulate phases were investigated by separately analyzing the particulate filters and the condensate/XAD fraction of the samples. All measurements at the baghouse inlet and outlet were conducted simultaneously.

Results and Discussion

Experience in a batch-type municipal waste incinerator: Ashibe Clean Center

Ashibe Clean Center is a municipal waste incinerator located on Iki Island in Nagasaki prefecture Japan. It has two stoker furnaces, two heat exchangers and one baghouse as illustrated in Figure 2. Each furnace has a capacity of 8.5 tons per 8-hour day and a flow rate of 20,000 Nm^3/h. The baghouse is operated with lime injection at 200°C. Catalytic filter bags were installed in May 2000, replacing conventional filter bags. The total filter area is 500 m^2.

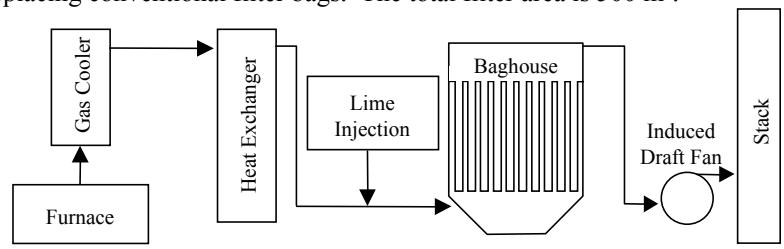

Fig. 2 A plant scheme of Ashibe Clean Center located in Ashibe-cho, Nagasaki

Facility operation starts at 8:30 each day, with municipal waste feed stopping at 14:00. Operation is stopped each day at approximately 17:00, when the furnace is allowed to cool. The flue gas passes through the catalytic filters during the full day of operation.

Dioxin measurements for the Ashibe plant were conducted according to the Euro Norm EN1648, with sampling times of 1.5 hours for start up stage, 3.5 hours for steady-state operation, and 1.8 hours for the shutdown stage. Figure 3 shows the PCDD/F concentrations at the baghouse inlet and outlet over the entire operation cycle from start up to shutdown.

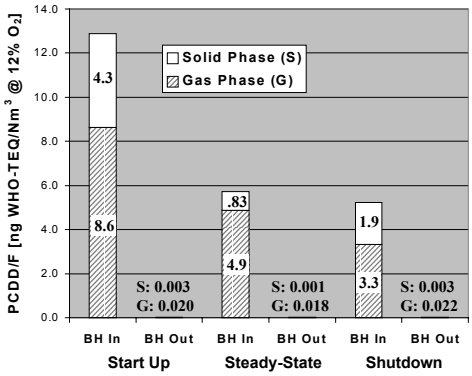

Fig. 3 PCDD/F measurements from Ashibe Clean Center during start up, steady-state and shutdown stages at the baghouse (BH) inlet and outlet.

As the figure indicates, total PCDD/F baghouse inlet values show tremendous variability with process stage. During facility start up procedures, unstable conditions produce a PCDD/F challenge over twice that of steady-state operation. However, even at high inlet values (over 12.0 ng WHO-TEQ/Nm^3) PCDD/F emissions were removed by 99.52 – 99.82%. Considering only the gas phase PCDD/F, the destruction efficiency is 99.33 - 99.77% as a result of the catalytic reaction. During all stages of operation, total PCDD/F emissions were reduced below 0.025 ng WHO-TEQ/Nm^3.

Experience in continuous-type municipal waste incinerators: Clean Center in Aichi Prefecture

The Clean Center, as illustrated in Figure 4, is a two line municipal waste incinerator located in Aichi prefecture Japan. Each furnace has a capacity of 130 tons per 24 hour day and a flow rate of 27,000 Nm^3/h. The baghouse, with a total filter area of 700m^2, is operated with lime injection at 200°C. The catalytic filter bags, which replaced conventional felt filter bags, were installed in November 2000 for line #1 and in February 2001 for line #2. The measurement results discussed in this paper were performed on line #1.

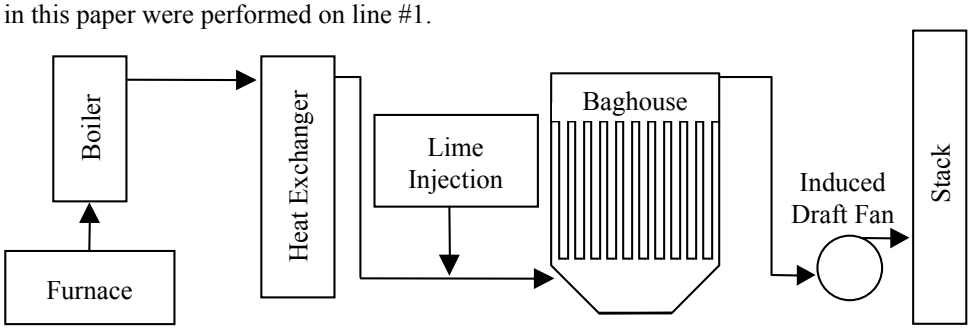

Fig. 4 A plant scheme for each line of a Clean Center located in Aichi Prefecture

Dioxin measurements for this plant were conducted according to the Japanese Industrial Standard JIS K 0311, with a sampling time of 4 hours. Figure 5 shows the results for the inlet and outlet of the baghouse partitioned into solid and gas phases.

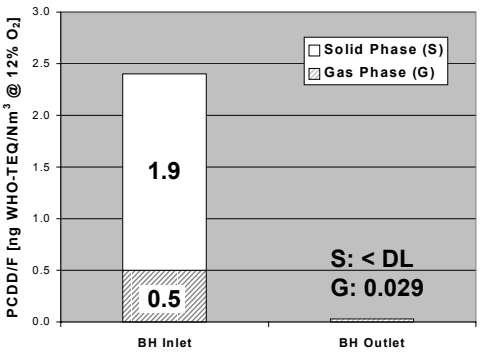

Fig. 5 PCDD/F concentration at the baghouse (BH) inlet and outlet at the Clean Center in Aichi prefecture. The solid phase PCDD/F concentration at the baghouse outlet was below the measurement detection limit (DL).

The results in Figure 5 illustrate the impact of both surface and catalytic filtration. Surface filtration of the ePTFE micro-porous membrane reduced solid phase PCDD/F by over 99%. In addition, the relatively small amount of gas phase PCDD/F was destroyed via catalysis by more than 94%. The concentration of PCDD/F in the baghouse ash was 0.83 ng WHO-TEQ/g.

Conclusion

The catalytic filter system can be successfully applied to both small batch and large continuous incinerators. This study confirmed that highly variable PCDD/F concentrations can be generated over different operating conditions. However these variable concentrations can be controlled with the catalytic filters so that the outlet emissions is relatively constant and well below 0.1 ng WHO-TEQ/Nm^3.

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References

[1] J. L. Bonte, Marc Plinke, Robert Dandarow, Glenn Brinckman, Michelle Waters, Koen van Overberghe, Hein van den Heuvel: *Organohalogen Compounds*, 40, pp 459-464, (1999)
[2] Mogami Y, Fritsky J., Shono K.: *Proc. 11th Annual Conference of the Japan Society of Waste Management Experts*(2000), pp784

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