INVESTIGATION ON PCDD/F REMOVAL FROM MWI VIA PILOT-SCALE CATALYTIC FILTER SYSTEM

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Introduction

24 large-scale municipal waste incinerators (MWIs) are in operation in Taiwan. Over 6,000 kiloton of municipal wastes are incinerated and over 300 kiloton of fly ash are generated annually. About 30% of the fly ash generated from MWI contains PCDD/Fs higher than 1.0 ng I-TEQ/g. REMEDIA® D/F Catalytic Filter has been proved for the effectiveness in removing PCDD/Fs from large-scale municipal waste incinerator (MWI). [1] In this study, the pilot-scale catalytic filtration system was applied in a large-scale MWI in Taiwan for the evaluation of PCDD/F removal characteristics.

Materials and methods

The pilot-scale catalytic filtration system was applied in the MWI investigated. Part of the flue gas after basic additive injection and prior to AC injection was split (Figure 1) and introduced into the pilot-scale module which is schematically shown in Figure 2. The air/cloth ratio was controlled at 1 m/min. The flue gas introduced is reheated to the designated operating temperature which varies from 160°C to 210°C. The samples of flue gas and fly ash collected were spiked with known amounts of Method 23 internal standard and Method 1613 labeled standards following quantification standards, respectively, and then analyzed for seventeen 2,3,7,8-substituted PCDD/F congeners with high resolution gas chromatography (HRGC) (Thermo Trace GC) /high resolution mass spectrometer (HRMS) (Thermo DFS) using a fused silica capillary column DB-5 MS (60 m x 0.25 mm x 0.25 μm, J&W). In this study, all TEQ concentrations of PCDD/Fs are calculated with WHO_{2005}-TEF.

Results and discussion

Inlet PCDD/F concentrations of pilot-scale module were between 0.9 and 1.9 ng-TEQ_{WHO}/Nm^3 (average 1.5 ng-TEQ_{WHO}/Nm^3 based on 11% O_2). Therefore, greater than 95% of PCDD/F TEQ removal efficiency is needed to ensure that PCDD/F emitted meet the emission standard of large-scale MWI in Taiwan (0.1 ng-TEQ/Nm^3). Figure 3 shows PCDD/F TEQ removal efficiencies achieved with catalytic filter in pilot-scale module and activated carbon injection + bag filter (ACI+BF) in MWI investigated in this study. Removal efficiencies of gas-phase PCDD/Fs significantly increased with increasing operating temperature and 96.7% of total removal efficiency was achieved at 195°C. TEQ removal efficiency of gas-phase PCDD/Fs also increased as operating temperature was increased from 180°C to 195°C.

Figure 4 shows the removal efficiencies of seventeen 2,3,7,8-subtituted PCDD/F congeners. As the system was operated at 160 and 180°C, removal efficiencies of highly Cl-substituted congeners (7-8 Cl) were significantly lower than that of lowly Cl-substituted congeners (4-6 Cl). It may be attributed to the difference of chemical stability between highly and lowly Cl-substitited congeners. Chemical stability of PCDD/Fs increases with increasing chlorine number of PCDD/F congeners. However, the difference of removal efficiencies between highly and lowly Cl-substituted PCDD/Fs decreased as the operating temperature increased. In contrast, removal efficiencies of solid-phase PCDD/F congeners were quite constant since the major removal mechanism of solid-phase PCDD/Fs and particulate is via filtration.

PCDD/F removal efficiency achieved with ACI+BF in MWI was also evaluated in this study. Total PCDD/F TEQ removal efficiency was 97.1% at 180°C (Figure 3) and PCDD/F in stack was 0.03 ng-TEQ_{WHO}/g. However, PCDD/Fs may be significantly formed since the activated carbon injected can supply additional reaction area and carbon source. [2] Figure 5 shows PCDD/F concentrations in fly ash sampled from pilot-scale catalytic filtration system, semi-dry absorber and BF in MWI investigated in this study. Mass and TEQ PCDD/F concentrations in BF ash of MWI are 52.0 ng/g and 1.89 ng-TEQ_{WHO}/g, respectively, which are significantly higher than that of fly ash collected in semi-dry absorber of MWI (8.4 ng/g of mass concentration and 0.28 ng-TEQ_{WHO}/g of TEQ concentration). PCDD/F formation was significantly observed in BF ash of MWI after activated carbon was injected. In contrast to ACI+BF, PCDD/F concentrations in fly ash collected by the pilot-

scale catalytic filtration system are significantly lower than that of BF ash in MWI investigated in this study, even though operating temperature was controlled at 210°C at which PCDD/Fs might be significantly formed. It is interesting to note that PCDD/F concentration of fly ash sampled from pilot-scale module was slightly higher than that sampled from semi-dry absorber in MWI. It may be attributed to the fact that some gas-phase PCDD/Fs had been adsorbed by filter cake.

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References:

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2. Chi KH, Chang SH, Chang MB. (2008); *Environ. Sci. Technol.* 42 (6): 2111-2117

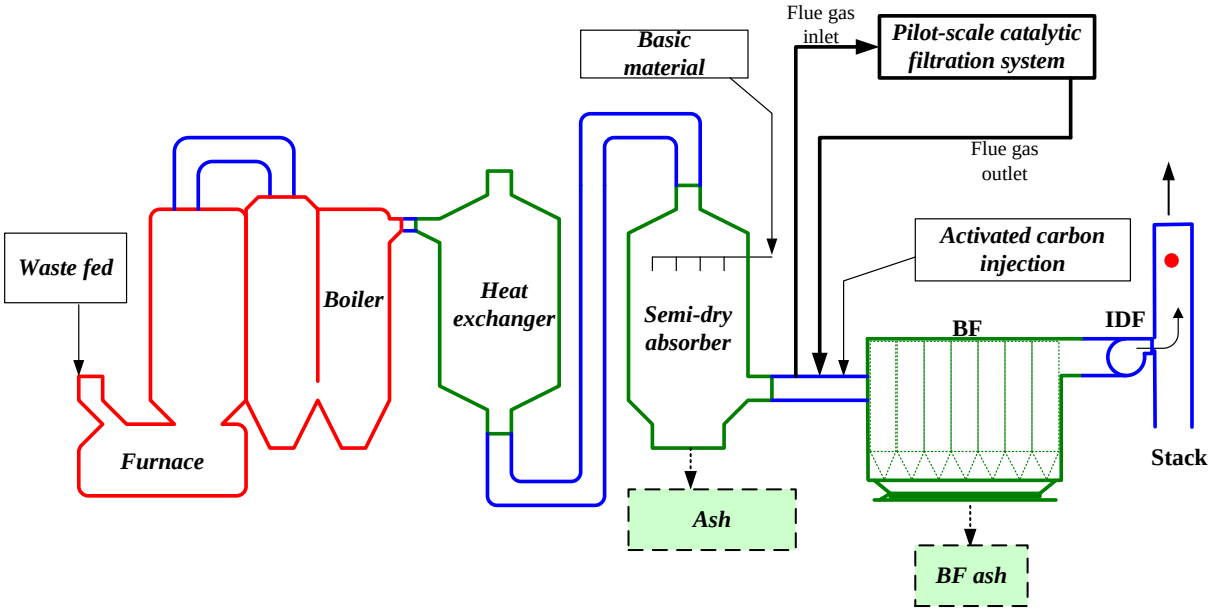

Figure 1. Flue gas flow in the MWI investigated and the location of the pilot-scale module

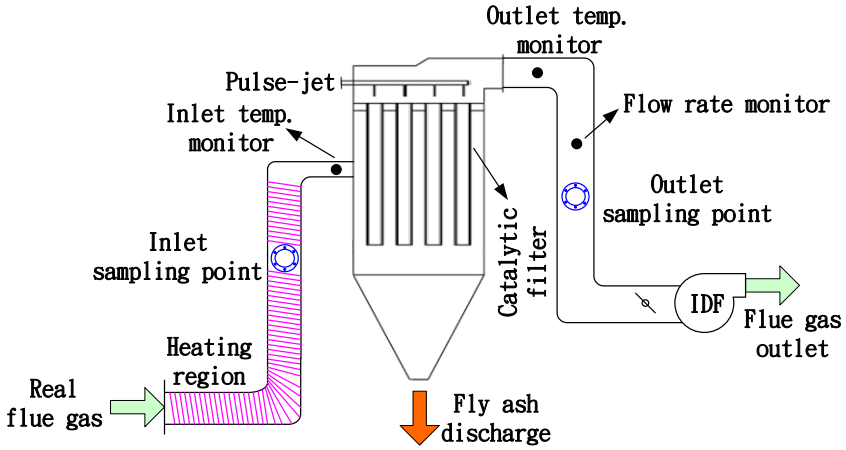

Figure 2. Schematic of pilot-scale catalytic filtration system

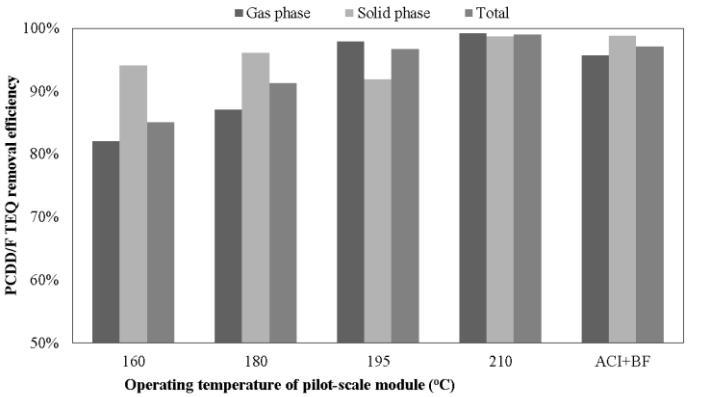

Figure 3. TEQ removal efficiencies achieved with the pilot-scale catalytic filtration system operated at different temperatures and ACI+BF in real pant

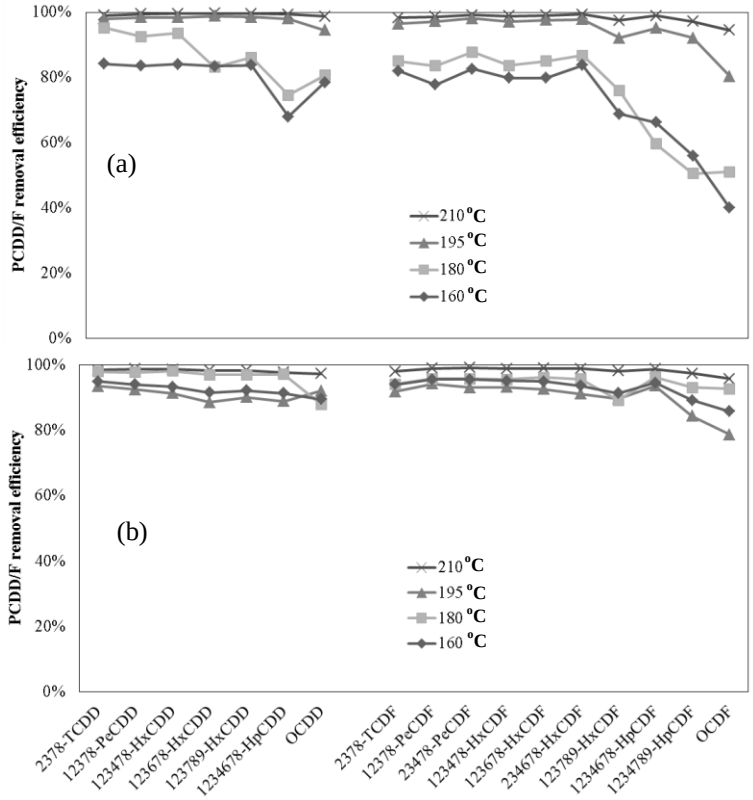

Figure 4. Removal efficiencies of seventeen 2,3,7,8-substituted PCDD/F congeners: (a) Gas-phase PCDD/F congeners; (b) Solid-phase PCDD/F congeners

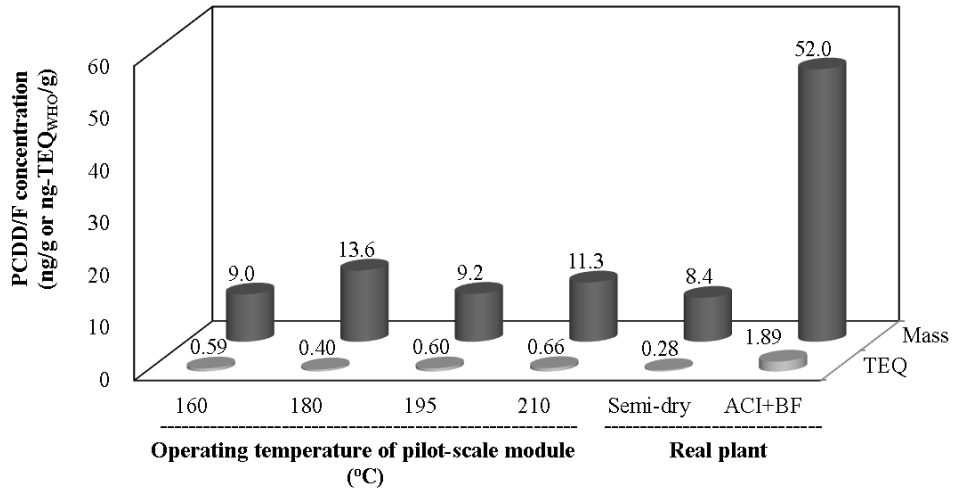

Figure 5. PCDD/F concentrations in fly ash collected from pilot-scale catalytic filter, semi-dry absorber and BF in MWI investigated, respectively.