# CB/CP REMOVAL IN FLUE GAS OF MWI VIA PILOT-SCALE MODULE WITH CATALYTIC FILTER

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## Introduction

In Taiwan, 24 large-scale municipal waste incinerators (MWIs) are operating nowadays. "Activated carbon injection + bag filter" (ACI+BF) system is adopted in 23 large-scale MWIs as an effective technique for removing gas- and solid-phase PCDD/Fs from flue gas, but PCDD/Fs are transferred from gaseous to solid phase and concentrated in fly ash. Chlorophenols (CPs) and chlorobenzenes (CBs), the important precursors of PCDD/F formation, are also adsorbed by powder activated carbon and further removed by BF. However, compared with 17 toxic PCDD/F congeners, CBs and CPs are more difficult to remove due to higher vapor pressure compared to PCDD/Fs. On the other hand, hexachlorobenzene (HCB) and pentachlorobenzene (PeCB) had been listed into Part A (Elimination) of Stockholm Convention. Therefore, it is important to characterize CB/CP discharge, including emission and residuals. Catalytic filter has been proved for effective removal and destruction of solid- and gas-phase PCDD/Fs.[1] In this study, a pilot-scale catalytic filter module was applied in a large-scale MWI in Taiwan for the evaluation of CB/CP 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 (Fig. 1) and introduced into the pilot-scale module as schematically shown in Fig 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 180°C to 210°C. The sample treatment of flue gas and fly ash collected followed USEPA Method 3542 and the samples treated were analyzed by HRGC/LRMS (USEPA Method 8270).

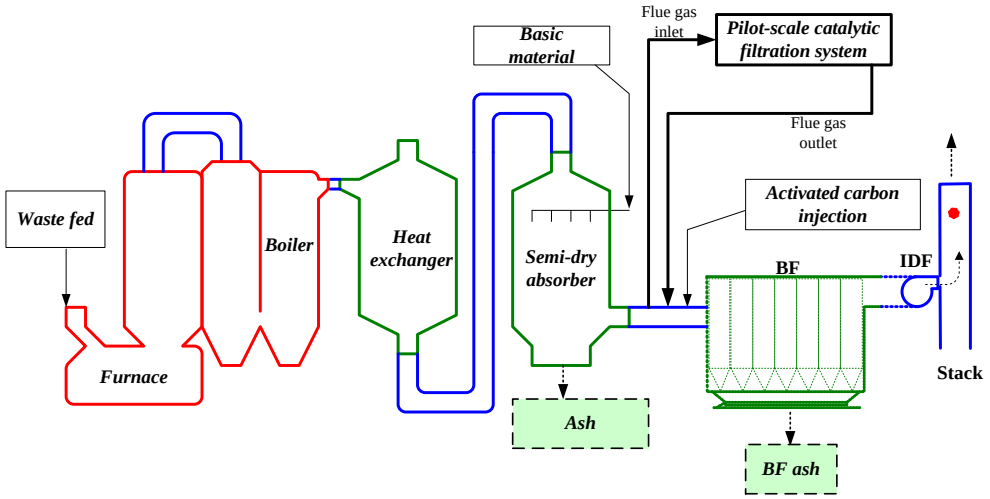


Fig 1. Flue gas flow in the MWI investigated and the location of the pilot-scale module

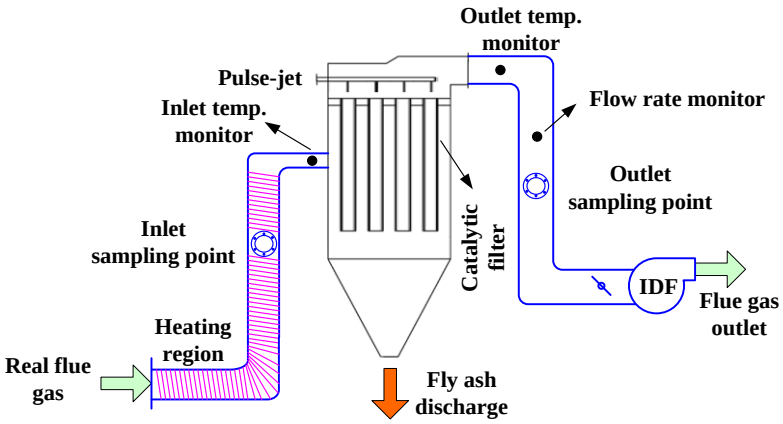


Fig 2. Schematic of pilot-scale catalytic filtration system

**Results and discussion**

In this study, removal efficiencies of contaminants are calculated based on the sum of solid- and gas-phase concentrations of specific congener. Concentrations of inlet CB/CP congeners in flue gas introduced from pipe of MWI are shown in Fig. 3. 3-6 Cl-substituted CBs and 3-5 Cl-substituted CPs in the flue gas are analyzed in this study. Highly Cl-substituted, especially pentachlorobenzene and HCB, are significantly higher than other CBs, and the highest concentration of CPs is 2,4,6-trichlorophenol. Fig. 4 shows the removal efficiencies of CB/CP congeners via catalytic filter. The removal efficiencies are enhanced with increasing operating temperature from 180°C to 210°C. It is attributed to the fact with catalytic activity is commonly enhanced at higher temperature. As 210°C, removal efficiencies of CBs and CPs are higher than 89% and 88%, respectively. ACI+BF system are adopted in the MWI investigated in this study and CBs/CPs in flue gas before and after ACI+BF system are also measured. The operating temperature of BF is about 165°C. Removal efficiencies of CBs and CPs are 70.4% - 86.5% and 72.1% - 91.6%, respectively. This result is similar to the removal efficiencies of CBs/CPs via catalytic filter at 180°C as shown in Fig. 4. Therefore, total removal efficiency of CBs/CPs obtained with catalytic filter operating at 180°C is higher than that via ACI+BF system operating at 165°C.

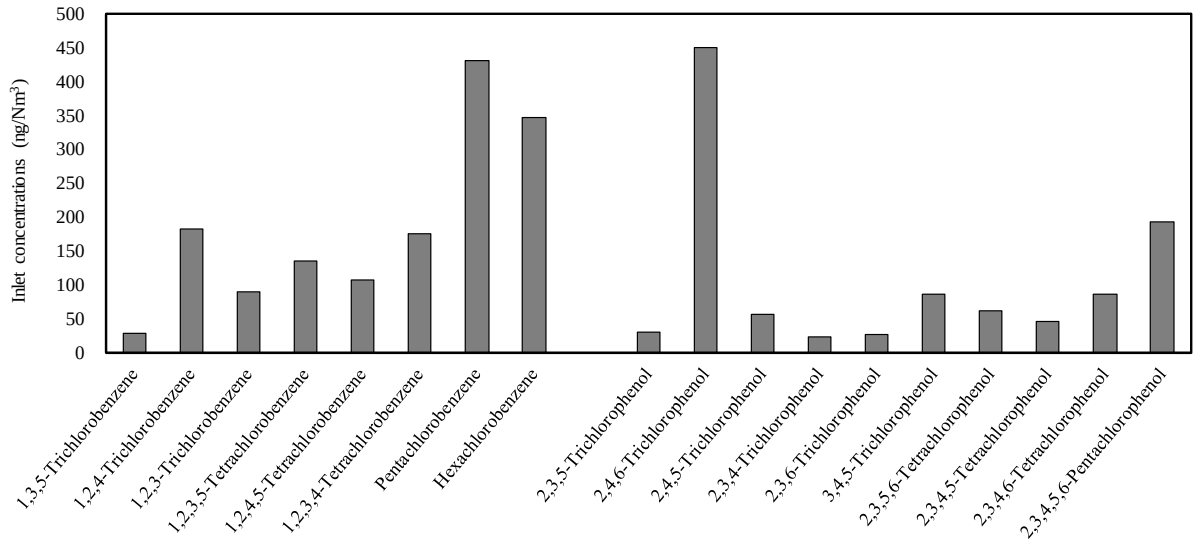


Fig. 3 Inlet CB/CP concentrations in flue gas of MWI investigated

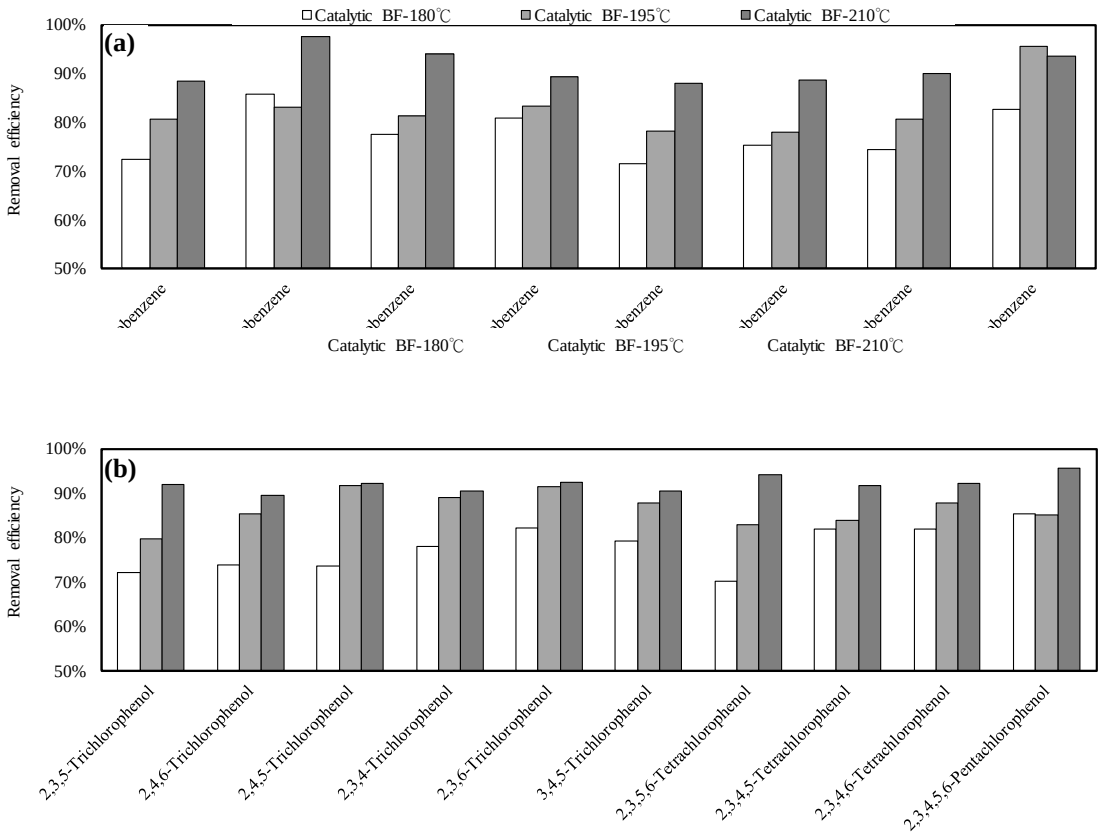


Fig. 4 Removal efficiencies of CB/CP congeners via catalytic filter: (a) CBs; (b) CPs

Fig. 5 shows the concentrations of CB/CP congeners in fly ash discharged from pilot-scale module and BF of the MWI investigated, respectively. Higher CB/CP content is observed in fly ash generated with ACI+BF system compared with that collected from pilot-scale module. It is attributed to the fact that CBs/CPs are significantly transferred from gas phase to solid phase and concentrated in BF ash achieved with high specific surface are of powder activated carbon. Interestingly, significant difference between removal efficiencies of lowly and highly chlorine-substituted congeners is found between catalytic filter and ACI+BF system. The mechanism of pollutant removal by ACI+BF technology is adsorption, therefore, high adsorption efficiency by activated carbon is easily achieved for the compounds of high boiling point and low vapor pressure. For catalyst, degradation of organic compounds is achieved with activated sites of catalyst. The boiling points of CB and CP congeners commonly increase with increasing chlorine-substituted level, so concentrations of 3-6 Cl-substituted CBs and 3-5 Cl-substituted CPs in fly ash collected from ACI+BF system are generally higher than that of 1-2 Cl-substituted CBs/CPs. For fly ash collected from pilot-scale module, there is no significant trend among different CB/CP congeners. Therefore, the test results with pilot-scale catalytic filtration system clearly indicate that catalytic filter can effectively decrease discharge of CBs/CPs.

**Acknowledgements**
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**References:**
1. Weber R, Plinke M, Xu Z, Wilken M. (2001) *Appl Catal B-Environ* 31:195-207

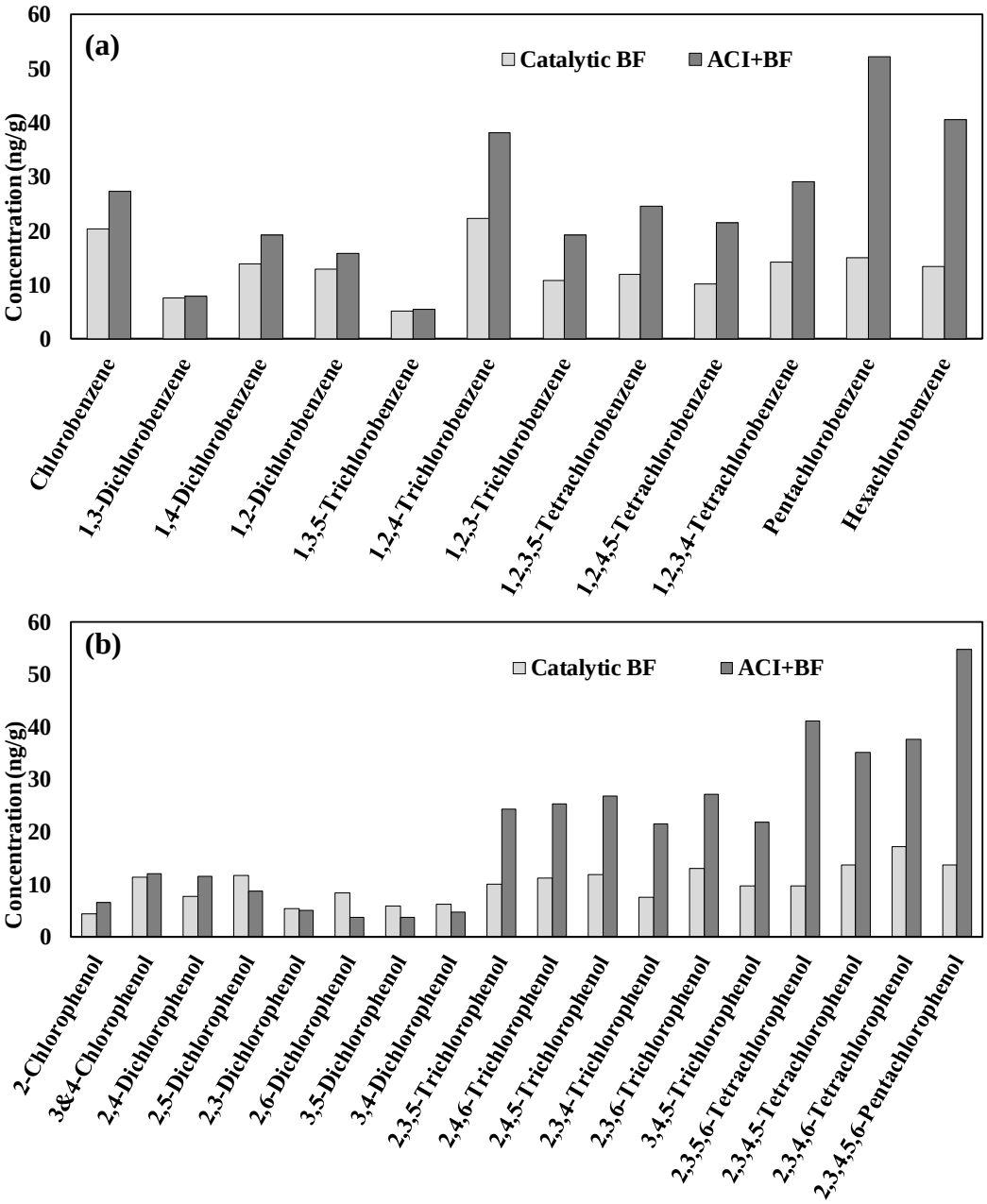


Fig. 5 CB/CP concentration in fly ash collected from: (a) Pilot-scale module with catalytic filter; (b) BF hopper in the MWI