DESTRUCTION OF UP-POPS FROM SINTERING PLANTS BY CATALYTIC BAG FILTERS

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Introduction

Polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychorinated biphenyls (PCBs), hexachlorobenzene (HxCBz) and pentachlorobenzene (PeCBz) were listed as the unintentionally produced persistent organic pollutants (UP-POPs) by the Stockholm Convention. The iron ore sintering industry was considered as a significant industrial source of the unintentional formation and the release of PCDD/Fs[1,2]. Tian et al. investigated four sintering plants in China, the average emission factor of PCDD/Fs and dl-PCBs was 3.95μg WHO–TEQ ton/t., and the annual release of PCDD/Fs and dl-PCBs in 2007-2009 were estimated to be 2070 g WHO–TEQ, 2212 g WHO–TEQ, and 2307 g WHO–TEQ, respectively.[3]

Currently, a number of technologies, including catalytic destruction[4], catalytic removal and destruction by catalytic bag filters(CF) and activated carbon injection, have been developed for controlling UP POPs. For example, a CF system consists of an bag filters and a catalytic felt substrate, which can simultaneously remove solid-phase PCDD/Fs and destroy gas-phase PCDD/Fs from the flue gas during thermal processes[5]. The CF applies the V_2O_5-WO_3 based on TiO_2 catalysts. When the Gas-phase PCDD/Fs get through, they can mainly be converted into CO_2, H_2O, and HCl[6].

In this study, the pilot experiments were carried out to destruct PCDD/Fs, HxCBz, dl-PCBs and PeCBz using the CF system.

Materials and methods

Fig.1 shows the configuration and sampling point of pilot test equipment. The REs of pollutants in flue gas and filter dust are both calculated with the following formula:

$$\mathrm{RE}(\%) = \frac{(concentration)_{inlet} - (concentration)_{outlet}}{(concentration)_{inlet}}$$

Where $(concentration)_{inlet}$ and $(concentration)_{outlet}$ are the amount of inlet and outlet UP-POPs, respectively.

The flue gas samples were collected from the CF system module (Fig.1). Flue gas sampling was collected by an automatic isokinetic sampler (TECORA, Italy) using the method of HJ-77(China Ministry of Environmental Protection, 2008). To evaluate the REs of UP-POPs, two sampling points were set at the inlet and outlet of the catalytic filter chamber, respectively. In order to analyze PCDD/Fs, dl-PCBs, HxCBz and PeCBz , it was used the isotope dilution method under the method HJ-77.2.

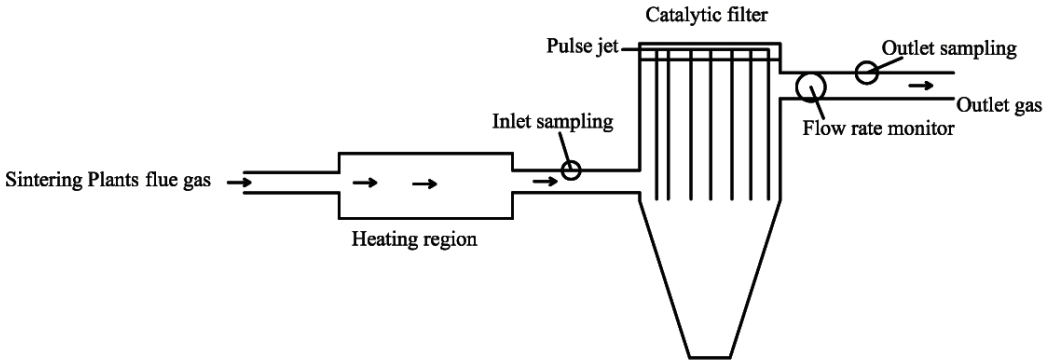


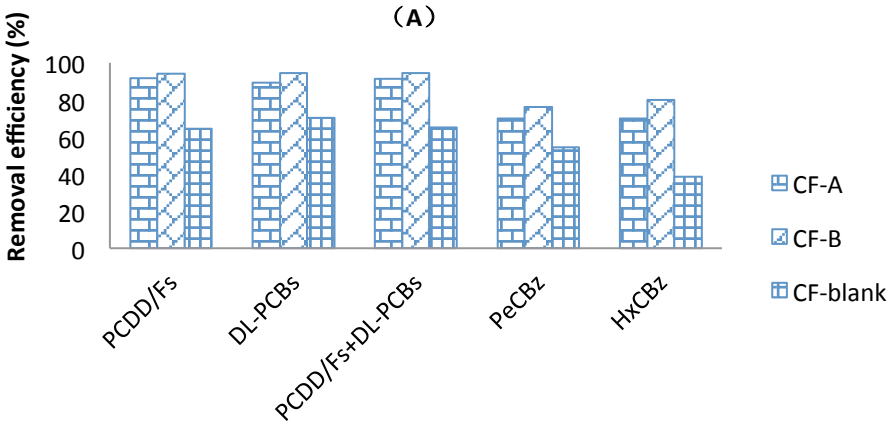
Fig.1 Schematics of the CF system module.

Results and discussion

According to references[7] report, it is known that the air/cloth (A/C) ratio (which defined as the gas flow rate (m^3/min) divided by the filtration area (m^2)) is about 1m/s which can have high removal efficiencies of UP-POPs. Under this condition of 200℃, it is firstly to understand the influence of the different catalytic filters. Three CFs (CF-blank, CF-A, CF-B) were selected for testing the RE of UP-POPs form sintering plants.

From the Fig.2, it shows the REs of UP-POPs in three different CFs at the same condition. It can be seen that the CF-blank can significantly reduce the solid-phase UP-POPs when flue gas discharged. The REs of solid-phase PCDD/Fs, DL-PCBs, PeCBz and HxCBz in (getting through) CF-blank are 72.58%, 75%, 96.15% and 93.33%, respectively. On the other hand, the REs of gas-phase PCDD/Fs, DL-PCBs in (getting through) the CF-blank are 64.31%, 70.27%, respectively. But for PeCBz and HxCBz,, the REs are only 54.45% and 38.58%, which are much lower than in solid-phase.

In this study, it is found that REs of UP-POPs from solid-phase or gas-phase in both the CF-A and CF-B compared are relatively high compared to the one in the CF-blank flue gas. Based on the results, the removal efficiencies of PCDD/Fs, dl-PCBs, PeCBz and HxCBz from sintering process via CF-A and CF-B were relevant higher than the CF-blank filter. Especially under the gaseous phase, the removal efficiency increased to 10-20%. Regarding to the CF-A with 100g m^{-2} and CF-B with 200g m^{-2} catalyst loading, the CF-B has more removal efficiency than CF-A.



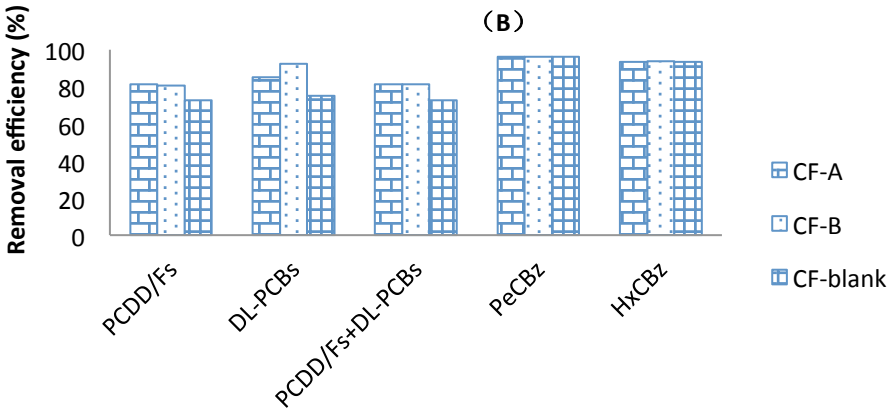
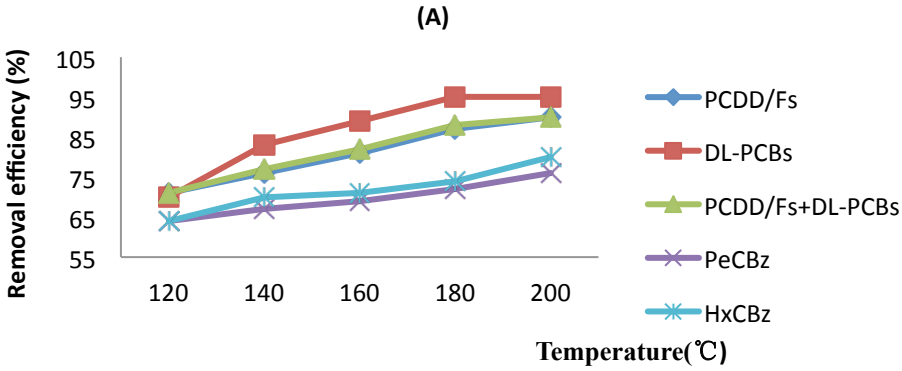


Fig.2 REs of UP-POPs from CF-A, CF-B and CF-blank (A): gas-phase; (B): solid-phase

According to other researches[7,8] , the order of the reaction and activation energy depends on vanadium oxide content and quality in the CF. Additionally, the order of the reaction also depends on the temperature. The research above has tested different CFs. In order to evaluate the temperature effect on the UP-POPs RE from CF-B, five temperatures (120,140,160,180, and 200 °C) are selected. Fig. 3 indicated that the REs of PCDD/Fs, DL-PCBs, PeCBz and HxCBz in the gas-phase and solid-phase from CF-B at five different temperatures. The REs of UP-POPs in the gas-phase increased with the temperature increasing, catalytic destruction of the UP-POPs raised significantly at a higher temperature. However, the temperature could not influence the improvement of the REs of UP-POPs in the solid-phase. Exceptionally, the DL-PCBs has a marked changes when the temperature is up to 180°C.The REs of solid-phase PeCBz and HxCBz from CF-B are all more than 95%.



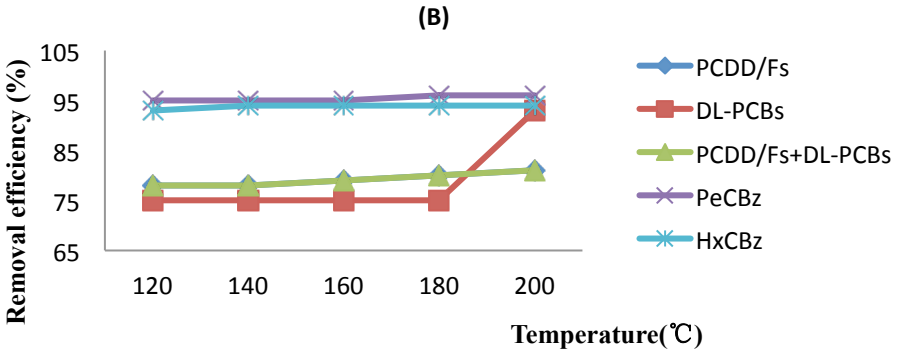


Fig.3 REs of UP-POPs achieved with the pilot-scale CF module: A: gas-phase; B: solid-phase

Acknowledgements

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