REDUCING POLYCHLORINATED NAPHTHALENES (PCNS) EMISSION FROM MUNICIPAL WASTE INCINERATOR AND SECONDARY COPPER SMELTING PLANT

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Introduction

Although numerous studies have been conducted on the occurrence of PCNs in environment or emission sources, research on PCN removal achieved with existing air pollution control devices (APCDs) is limited. In Taiwan, the combinations of "semidry scrubber (SDS) + activated carbon injection (ACI) followed by baghouse (BH)" is commonly used in large-scale municipal waste incinerators (MWIs) and secondary copper smelting (SCS) plant to remove POPs such as PCDD/Fs from gas streams. In this study, emission characteristics and removals of 75 PCNs from an MWI and an SCS plant are investigated via intensive stack sampling/analysis.

Table 1: Operating conditions and characteristics of MWI and SCS investigated.

	MWI	SCS
APCDs	CY+SDS+ACI+BH	SDS+ACI+BH
Stack temperature (◦C)	138	112
Capacity (ton/day/unit)	450	8.1
Waste/feeding material	78 % MSW +22% industrial waste	copper sludge
Flue gas flow rate (Nm^3/ h/unit)	92,350	22,350
AC concentration (mg Nm^{-3})	60	50-90
PM concentration (mg Nm^{-3})	CY inlet: 6317 Stack:1.5	SDS inlet: 1045 BH inlet: 748 Stack: 0.9

N.A: nonapplicable

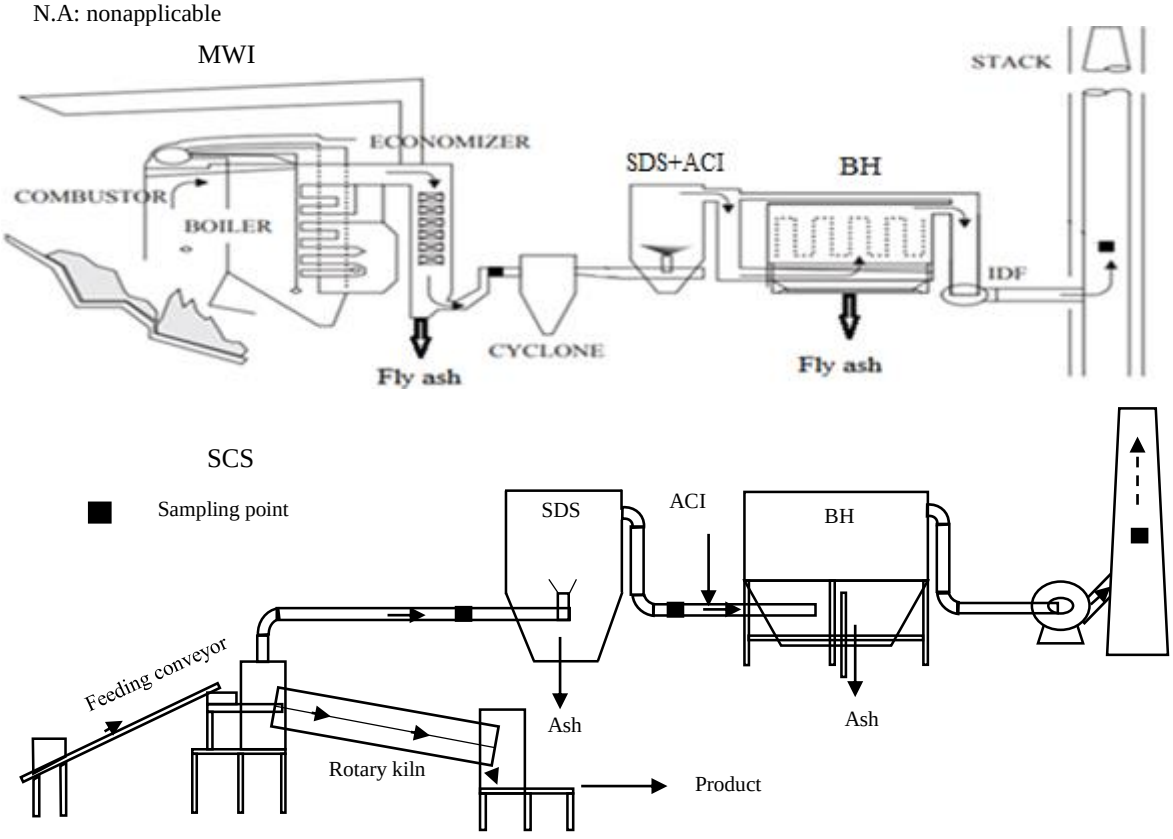

Fig 1: Flow diagrams and sampling points of the MWIs and SCS investigated.

Materials and methods

The MWI and SCS plant investigated are located in northern Taiwan. The flow diagram and sampling points in MWI and SCS investigated are presented in Fig. 1. Relevant information regarding the operation of MWI and SCS investigated is listed in Table 1. MWI with 3 furnaces is equipped with cyclone (Cyc), SDS with ACI and BH as APCDs. Two set of samples were simultaneously collected before Cyc and stack. SCS is equipped with the combination of SDS + ACI + BH, flue gas samples were simultaneously collected twice at three sites including SDS inlet, ACI+BH inlet and stack to evaluate the removal efficiencies achieved with SDS and ACI+BH. The temperatures recorded at SDS inlet, ACI+BH inlet and stack were 372, 148 and 112^{o}C, respectively. In MWI, fly ashes from economizer and BH were collected, while fly ashes were collected from SDS and BH of SCS.

Procedures of pretreatment and analysis of PCNs were clearly presented in previous publication[1]. Briefly, samples were extracted by soxhlet-extractor with toluene and cleaned-up using multi silica gel column coupled with mini-carbon column. Samples were analyzed following isotope dilution method using HRGC/LRMS. TEF values used to calculate TEQ concentration are adopted from literature[2,3].

Results and discussion

Fig. 2 reveals the variation of PCN concentrations measured in MWI and SCS. For MWI, PCN concentration decreases from 409 ng/Nm^3 at Cyc inlet to 23.2 ng/Nm^3 in stack. For SCS, PCN concentration decreases significantly from SDS inlet (1604 ng/Nm^3) to BH inlet (311 ng/Nm^3), and the PCN concentration measured at stack is 32.6 ng/Nm^3, which is higher than that emitted from MWIs. Similar trend for TEQ concentration was found. The emission factor of PCNs from MWI is 124.6 µg/ton, while that of SCS is 2,157 µg/ton.ly

The homologue distribution and chlorination level of PCNs measured in flue gases collected from MWI and SCS, respectively, are presented in Fig. 3. Mono- and pentaCNs dominate in flue gas collected from Cyc inlet of MWI, while mono-, di- and triCNs are the main contributors to PCNs in other samples including stack of MWI and all samples collected from SCS. Fig. 3 also indicates that chlorination level decreases after APCDs, which is consistent with the higher removal efficiency of higher chlorinated homologue as presented in Fig. 4.

In MWI, particulate PCNs measured at Cyc inlet contributes 40% of total PCNs, while that measured at stack only contributes 5.0% of total PCNs. In SCS, PCN associated with particulate phase increases from 18% (SDS inlet) to 46% (BH inlet), which reveals increase of PCNs associated with particles due to significant reduction of temperature in SDS (from 372 to 148^{o}C). Significantly higher removal efficiency of gas-phase PCN (87%) compared with that of particulate-phase PCNs achieved with SDS (50%) is found. The performance of SDS is even better than that achieved with ACI+BH for gaseous PCNs (82.7%).

The overall removal efficiencies of PCNs achieved with Cyc+SDS+ACI+BH in MWI is 94.3%, while the removal efficiency of PCNs achieved with SDS+ACI+BH in SCS is 98.0%. Lower removal efficiency of gaseous PCNs achieved with ACI+BH compared with that of particulate PCN is found for both MWI and SCS. Removal efficiency of PCN achieved with existing APCDs increases with increasing chlorination level. For MWI, the overall removal efficiency of monoCN is the lowest (81%), followed by diCN (98%), triCN (99%) and other homologues with 100%. For SCS, the overall efficiency of PCNs increases from 96% for monoCN to 100% for heptaCN and octaCN.

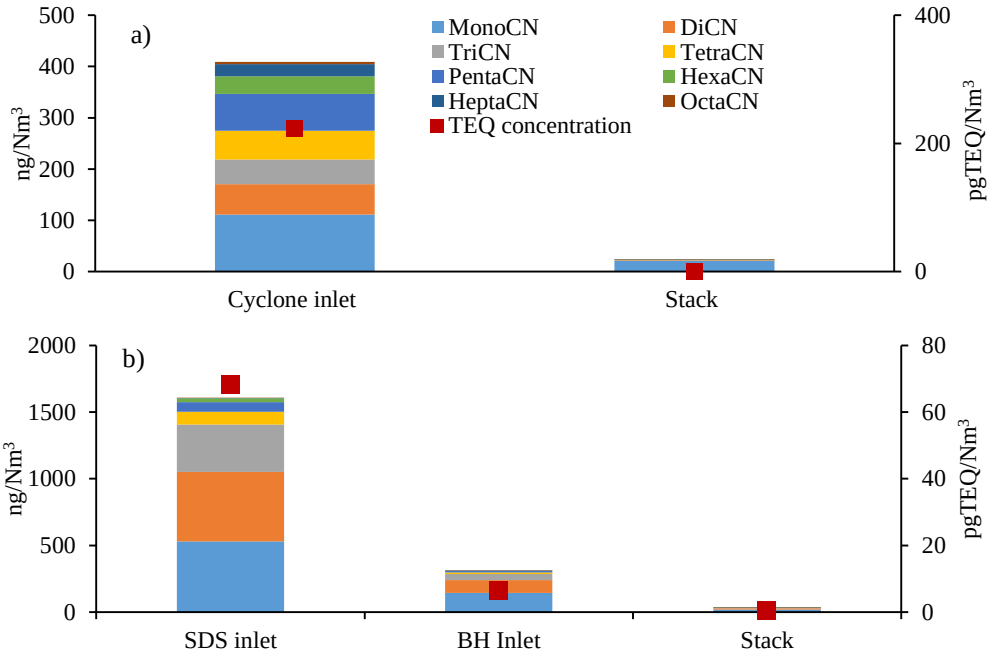

Fig. 2: Mass and TEQ concentrations of PCNs measured at MWI (a) and SCS (b)

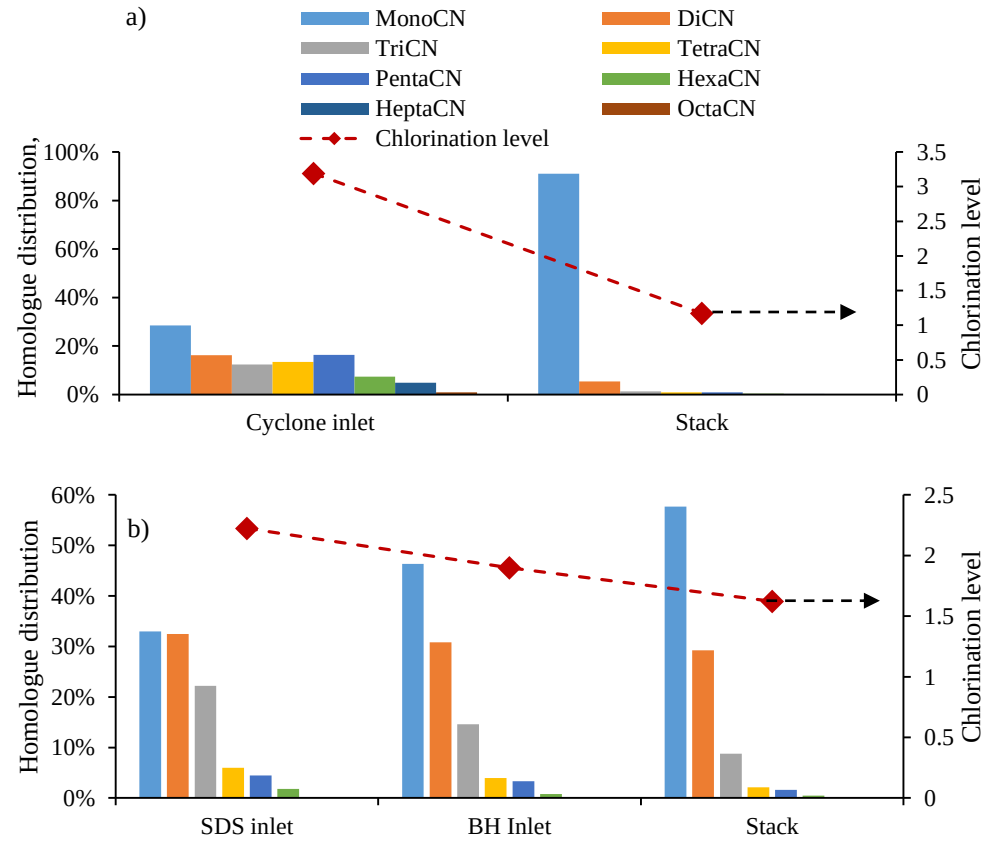

Fig. 3: Homologue distribution and chlorination level of PCNs measured at MWI (a) and SCS (b)

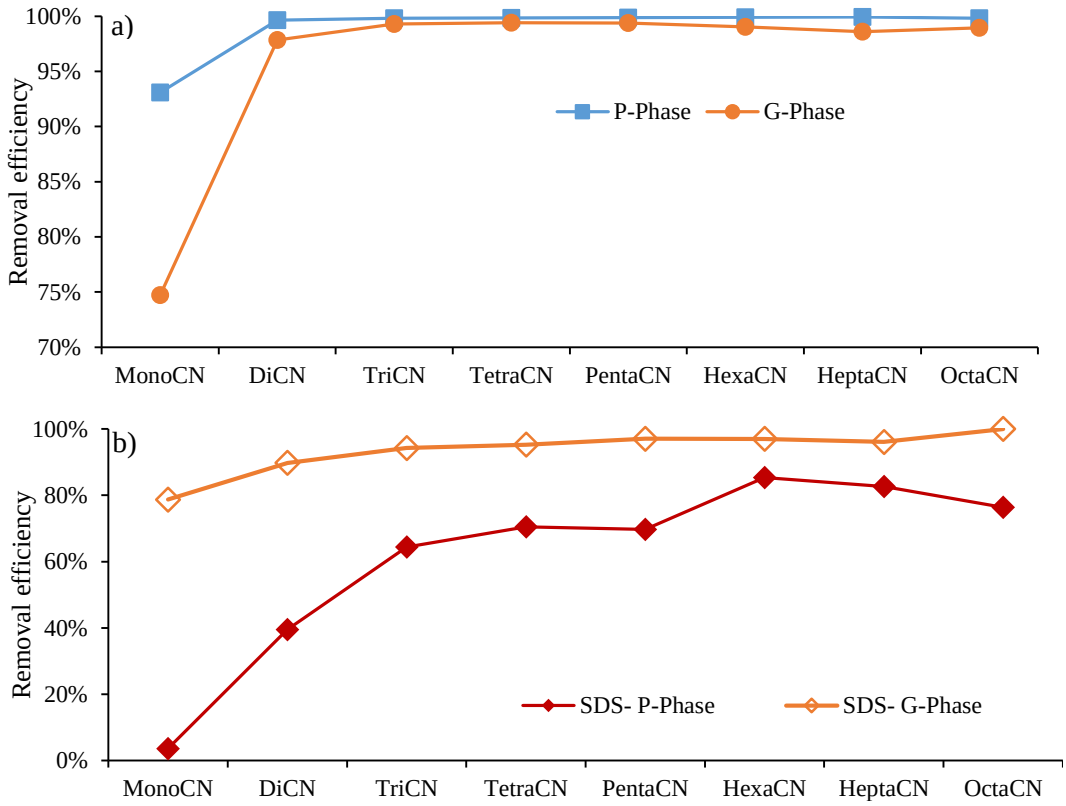

Fig. 4: Removal efficiencies of gas-phase and particulate-phase PCNs achieved with Cyc+SDS+ACI+BH quipped in MWI (a) and SDS equipped in SCS (b)

The PCN concentrations measured in fly ashes collected from BHs of MWI and SCS are 14.7 and 53.6 ng/g, respectively. Higher contribution of low chlorinated homologues is found in the fly ash collected from BH of SCS (90%) compared with that collected from MWI (52%), which is consistent with the distribution of PCNs in flue gases collected from two plants.

Conclusions

The results indicate higher emission level of PCNs from SCS compared with that of MWI. The combination of both SDS and ACI+BH is effective for PCNs removal. Temperature plays an important role in PCN removal in SDS and ACI+BH.

Acknowledgements

The authors gratefully acknowledge the financial supports provided by the Ministry of Science and Technology (MOST 105-221-E-008-006-MY3) and Taiwan EPA (1071G060) of ROC.

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