PCDD/F REMOVAL IN WET SCRUBBING WATER BY THE COMBINATION OF POWDERED ACTIVATED CARBON AND CERAMIC FILTRATION

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Introduction

Japanese Environmental Agency published environmental standard of 1pg-TEQ/l in water from the view point of human health. According to this, the upper limit of PCDD/F in emitted waste water from incineration plants was also determined as 10pg-TEQ/l.

There are nearly one hundred municipal solid waste incinerators in Japan equipped with a wet scrubber for acid gas treatment. It was well known that wet scrubbing water contains not only salt and dust particles but also hazardous heavy metals such as mercury. PCDD/F is also contained in wet scrubbing water, but few papers reported its concentration[1]. In fact, sometimes PCDD/F concentration is very high and can be a cause of serious pollution. Therefore, it's necessary to treat wet scrubbing water to prevent PCDD/F emission via water.

Activated carbon is an excellent PCDD/F absorber and is applied to flue gas treatment in many incineration plants[2]. Its application to waste water is considered to be reasonable. If fine carbon particles which absorb PCDD/F are highly removed, extremely low emission might be possible. In this paper, the combination of powdered activated carbon (PAC) and ceramic filtration is evaluated as an effective PCDD/F removal system in waste water.

Materials and Methods

The schematic view of PCDD/F removal system is shown in Figure-1. Wet scrubbing water of 200l/h from a municipal solid waste incineration plant was introduced to the reaction reservoir in which PAC slurry was added at a concentration of 1000mg/l. The applied PAC was obtained from Norit Japan and was designed to remove PCDD/F effectively. After mixing, treated scrubbing water was sent to the ceramic filter and was separated into clean filtrate of 180l/h and concentrated waste water which contained PAC. The concentrated waste water was returned to the reaction reservoir again and mixed with wet scrubbing water. This mixture of 20l/h was sent from the reaction reservoir to waste water treatment process. This system was operated continuously for 2.5 weeks.

PCDD/F was measured in wet scrubbing water and filtrate after 2.5 weeks according to Japanese authorized method. PCDD/F in water was classified into "soluble" type and "particle" type. Soluble PCDD/F can be pass through a glass filter having a pore size of 0.6 micrometer, whereas particle PCDD/F is filtration residue. Heavy metals concentration were also measured at the same time.

Results and Discussion

Table-1 shows analytical results of evaluation test of the PCDD/F removal system. The total PCDD/F concentration in wet scrubbing water was 69.35pg-TEQ/l and therefore treatment was necessary to reduce concentration to 10pg-TEQ/l. The particle type occupied over 99% of PCDD/F. It seemed that most PCDD/F was contained in suspended solids such as dust particles.

After PAC treatment and ceramic filtration, soluble PCDD/F decreased from 0.35pg-TEQ/l to 0pg-TEQ/l. PAC could remove soluble PCDD/F perfectly. Particle PCDD/F was also reduced by 99.99%. Figure-2 shows homologue distribution pattern before and after treatment. Each homologues were removed very well. As pore size of ceramic filter was 0.05 micrometer, ceramic filtration is thought to be responsible for particle PCDD/F removal. In some case, temperature of wet scrubbing water was over 70C, it was important to apply temperature tolerable membrane.

Van de Kluet *et al*[2] showed that direct PAC application to wet scrubber reduced PCDD/F in flue gas from 0.34ng-TEQ/Nm^3 to 0.05ng-TEQ/Nm^3. This ADRT process was very effective for PCDD/F emission control of flue gas. However, it is likely that ADRT process produces waste scrubbing water which contains higher concentration of PCDD/F. As almost PCDD/F could exist as particle type by absorption to PAC, ceramic filtration was also thought to be useful technology for ADRT waste water treatment.

Heavy metals concentration was also measured. As shown in Table-2, Zn, Pb, Cd, Cr(VI) and As were not detected in wet scrubbing water. However, Hg concentration was 0.36mg/l and higher than waste water standard, 0.005mg/l. After filtration, it decreased below detection limit, 0.0005mg/l. As Reimerink *et al.*[3] reported that PAC absorbed both mercury and PCDD/F in flue gas, it was highly possible that mercury in wet scrubbing water was also absorbed by PAC. Therefore, filtrate was found not to contain any hazardous heavy metals.

From the above results, the combination of PAC and ceramic filtration was proved to be most effective technology for PCDD/F and mercury removal in water. As these hazardous materials in wet scrubbing water are finally concentrated in small amount of PAC which is drawn from the reaction reservoir, the treatment of this concentrated waste is still to be investigated.

Acknowledgment
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References
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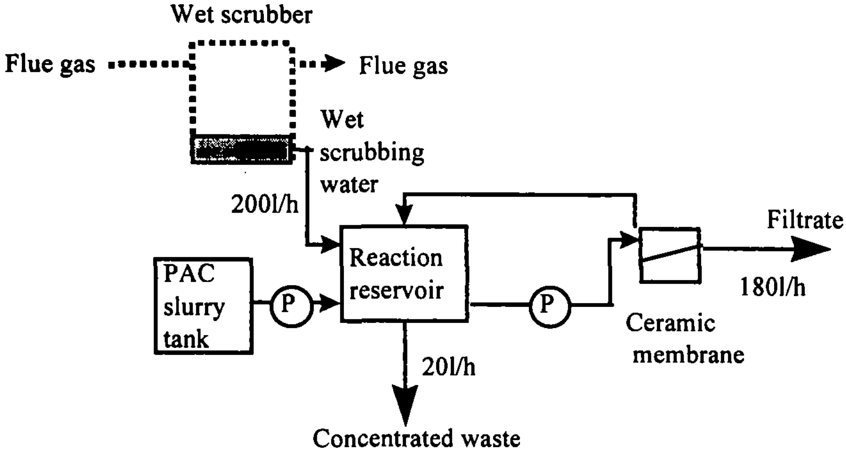
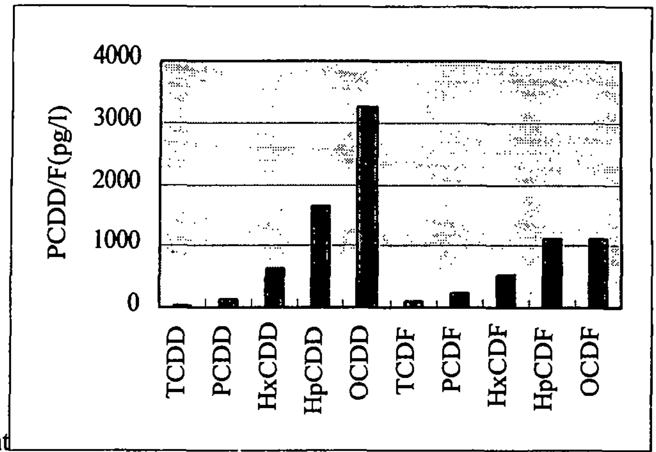


Figure-1. The schematic view of PCDD/F removal system

	Wet scrubbing water		After treatment	
	Particle type	Soluble type	Particle type	Soluble type
PCDD (pg/L)	5600	120	N.D.	N.D.
(pg-TEQ/L)	25	0.22	0	0
PCDF (pg/L)	3100	39	21	N.D.
(pg-TEQ/L)	44	0.13	0.0021	0
PCDD+PCDF (pg/L)	8700	159	21	N.D
pg-TEQ/L	69	0.35	0.0021	0

Table-1. PCDD/F removal by the combination of PAC and ceramic filtration

Before treatment



After treatment

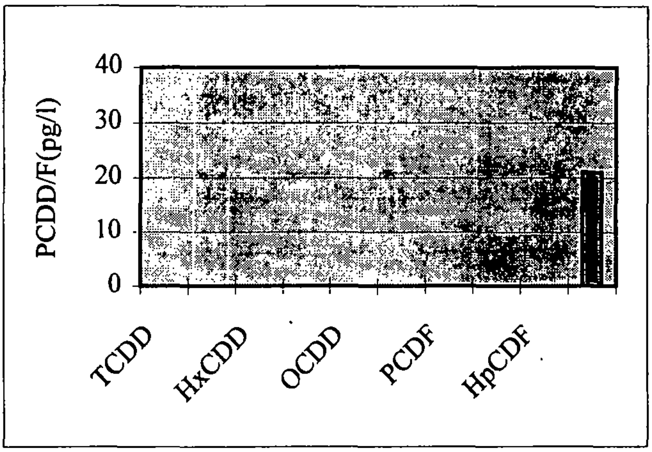


Figure-2.Homologue distribution pattern before and after treatment

Table-2. Behavior of heavy metals before and after treatment

	Regulation	Wet scrubbing water	After treatment
pH (--)	5.8-8.6	7.3	8.1
Zn (mg/L)	5	<1	<1
Pb (mg/L)	0.1	<0.05	<0.05
Cd (mg/L)	0.1	<0.01	<0.01
Cr^{6+} (mg/L)	0.5	<0.02	<0.02
Hg (mg/L)	0.005	0.36	<0.0005
As (mg/L)	0.1	<0.005	<0.005