

## DIOXIN REMOVAL USING ACTIVATED COKE

Kyong-Tae Kim<sup>1</sup>, Dong-Jun Koh<sup>1</sup> and Jin-Hong Kim<sup>2</sup>

<sup>1</sup>Environment and Energy Research Center, Research Institute of Industrial Science and Technology (RIST), P.O.Box 135, Pohang 790-330, Korea

<sup>2</sup>Environment Team, POSCO, Koedong-dong, Pohang 790-600, Korea

### Introduction

The coke breeze by-produced from coking plants of iron making industry has been found to be used as a dioxin adsorbent when it is properly activated in an effective manner<sup>1</sup>. The activated coke has been tested on the dioxin removal efficiency at an industrial waste incinerator and a sintering furnace, with varying its injection amount. Together with the coke, a commercial activated carbon has been employed to compare with the removal efficiency of the coke. It has been noted that the activated coke shows similar removal efficiency to the activated carbon despite of its much less surface area

### Materials and Methods

#### *Preparation of the adsorbents*

The adsorbents used in this investigation were the activated coke prepared by our own laboratory and a commercial activated carbon purchased from a German company. The activation of the coke breeze was described elsewhere in detail<sup>1</sup>. The BET surface area and total pore volume of the two adsorbents are summarized in Table 1. The activated coke has very low surface area and pore volume of about 1/10 of the activated carbon.

The adsorbents used in the test were sieved under 200 mesh.

Table 1 Surface area and pore volume of the adsorbents

	Activated coke	Activated carbon
BET surface area( /g)	52	410
Pore volume( /g)	0.036	0.336

#### *Dioxin removal test*

The two adsorbents were employed in an industrial solid waste incinerator and a sintering furnace of iron making industry to compare their dioxin removal efficiencies. The incinerator and the sintering furnace are equipped with an electrostatic precipitator (ESP) operated at 170 ±

20 and 150  $\pm 10^\circ\text{C}$ , respectively.

During the injection tests, the adsorbents were injected into the flue gases at a position of 20m ahead of the ESP using an injection facility. In particular, for the injection tests at the sintering furnace with huge pipe of 7m in diameter, a series of an injection facility with sixteen nozzles was installed and employed for obtaining an uniform distribution of the injected adsorbent. The amount of injected adsorbent was varied from 0 to 250  $\text{mg}/\text{Nm}^3$ .

The flue gas samples were simultaneously taken at two points, that is, just before the injection and just after the ESP. The samplings and the analyses were carried out according to the Korean standard methods. The quantitative analysis was done using a high resolution GC/MS.

## Results and Discussion

### *Dioxin removal efficiency at the incinerator*

Table 2 summarizes some of the results obtained from the injection test carried out at the incinerator.

Table 2 Dioxin removal efficiency at an incinerator

Adsorbent	Injection rate ( $\text{mg}/\text{Nm}^3$ )	Dioxin conc. ( $\text{ng-TEQ}/\text{Nm}^3$ )		Removal eff.(%)
		inlet	Outlet	
Activated coke	150	6.95	1.42	79.5
	250	6.12	1.29	78.9
Activated carbon	250	3.62	0.84	76.8

During the test, the dioxin concentrations at the inlet varied between 3 to 7  $\text{ng-TEQ}/\text{Nm}^3$ . With the activated coke, the removal efficiency was about 79% irrespective of the injection rates over 150 $\text{mg}/\text{Nm}^3$ . With the commercial activated carbon, the efficiency was found to be similar to that of the activated coke at the same injection rate.

Fig. 1 and 2 show the changes in concentrations of congeners with the injections of the activated coke and carbon, respectively. There was no difference found in the congener profiles with the two adsorbents.

However, it is noticeable that the activated coke with much less surface area (52  $\text{m}^2/\text{g}$ ) showed the similar removal efficiency to the activated carbon with higher surface area (410  $\text{m}^2/\text{g}$ ).

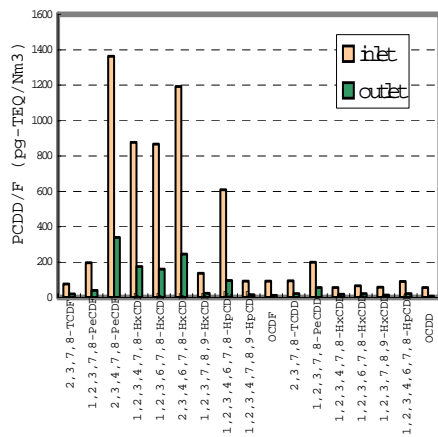


Fig. 1 Congener profiles with the injection of activated coke (250 mg/Nm<sup>3</sup>)

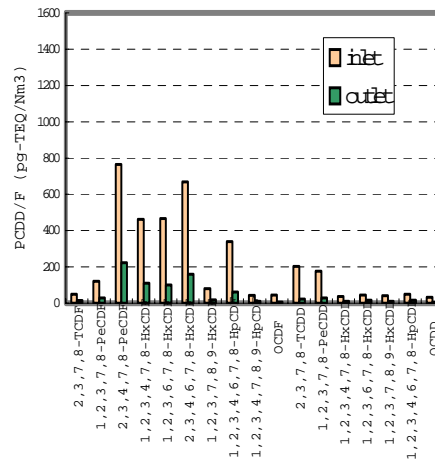


Fig. 2 Congener profiles with the injection of activated carbon(250 mg/N)

*Dioxin removal efficiency at the sintering furnace*

Fig.3 and 4 show the dioxin removal efficiency of the activated coke and the activated carbon, respectively. During the test, the inlet dioxin concentrations measured just before the injection point significantly varied from 0.5 to 3.0 ng-TEQ/ Nm<sup>3</sup>.

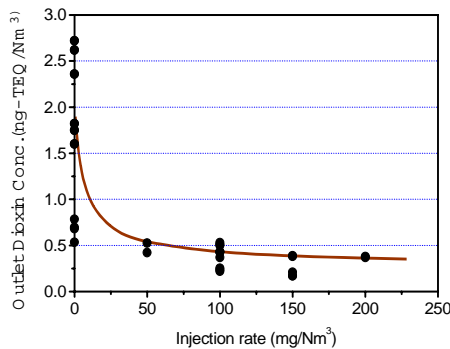


Fig. 3 Dioxin removal with the activated coke with varying injection rate

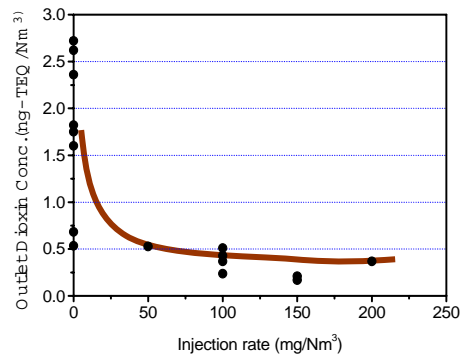


Fig. 4 Dioxin removal with the activated carbon with varying injection rate

The outlet concentrations measured after the ESP sharply decreased to 0.5 ng-TEQ/ Nm<sup>3</sup> until the injection rate reached 50mg/ Nm<sup>3</sup>, and then showed a gradual level-off at the injection rates above 50mg/ Nm<sup>3</sup>. Interestingly, by comparing the outlet concentrations in Fig.3 and 4, the two adsorbents show similar removal efficiency at the same injection rate despite of the big

difference in their surface areas. At this moment, a clear explanation on the removal performance could not be given because of our lack of kinetic knowledge on the removal process taking place during the injection of powdered adsorbent. However, it is conjectured that the adsorptive removal may be confined within some depth of the adsorbent particle due to short period of exposure time.

Fig. 5 and 6 show typical changes in congener profiles with the injections of the activated coke and the activated carbon, respectively.

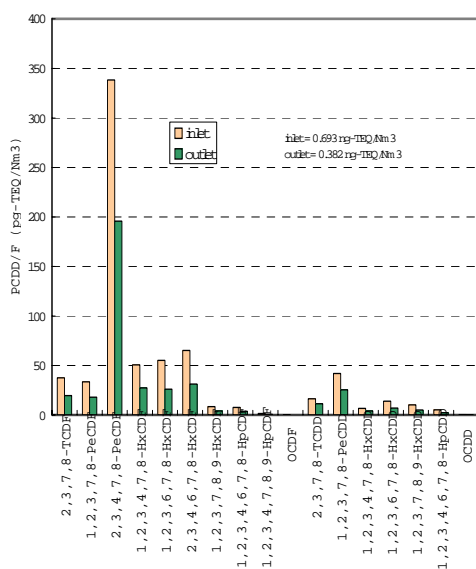


Fig. 5 Congener profiles with the injection of activated coke(150 mg/Nm<sup>3</sup>)

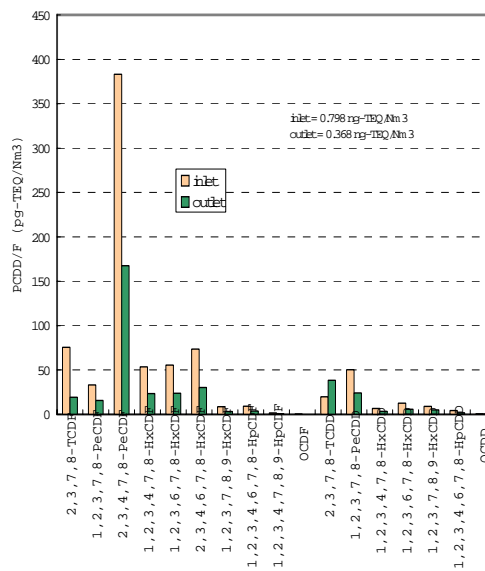


Fig 6 Congener profiles with the injection of activated carbon(200 mg/Nm<sup>3</sup>)

There was no difference found on their profiles between the two adsorbents. From the above results, it is concluded that the activated coke can be used as an effective adsorbent of dioxins even though it has low surface area.

**References**

1. Kim K.T, Koh D.J, and Kim J.H, Dioxin 2002, 2002,56,397.