

## 집진필터에 포집된 활성탄에 의한 배가스 내 가스상 수은 제거효과

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### Gaseous Mercury Removal by Activated Carbon Collected on Filter Surface

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#### Introduction

Recently, gaseous mercury, which is a representative HAP (Hazardous Air Pollutant) among the air pollutants in combustion flue gas, has prompted widespread international concern. Gaseous mercury can be generally classified into elemental mercury ( $\text{Hg}^0$ ) and oxidized mercury ( $\text{Hg}^{+2}$ ) according to its oxidation form.

Approximately 50% of the gaseous mercury in flue gases from industries such as power plants and incinerators is elemental mercury [1]. Because elemental mercury does not easily dissolve in water, it cannot be removed by conventional WFGD (wet flue gas desulfurization) [2]. Activated carbon injection is the most well-proven and widely used method applied for mercury removal [3,4]. The activated carbon particles injected for removal of mercury are finally collected on the filter surface inside a particulate collector.

#### Experimental

Fig. 1 shows a schematic diagram of a bench-scale hybrid APCD (air pollution control device) for simultaneous PM/HAPs removal. In a hybrid APCD, activated carbon is injected into the inlet duct of the particulate collector to remove mercury first and then PM. The injected activated carbon is removed in the rear particulate collector.

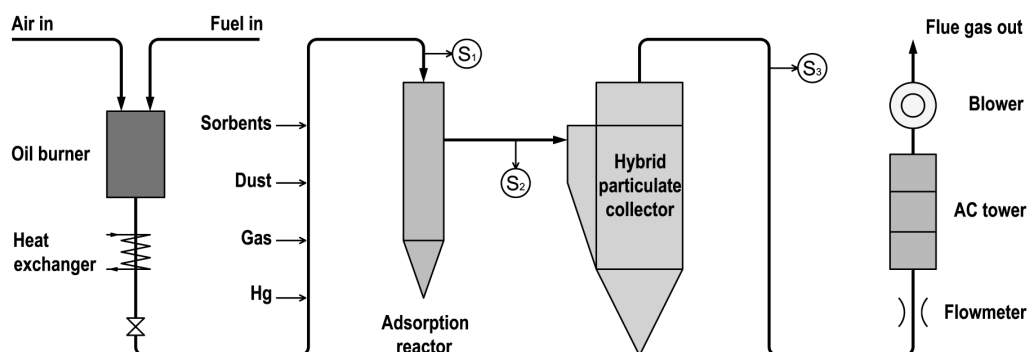


Fig. 1. Schematic diagram of bench-scale hybrid APCD.

An adsorption reactor, which consists of double hollow cylinders, and replaces the inlet duct, was situated in front of the particulate collector, to prolong the residence time of the activated carbon before it entered the particulate collector. An additional adsorption device (activated carbon tower) was placed in the rear of the particulate collector to prevent gaseous mercury from being discharged into the ambient air.

Gaseous mercury was spiked into a duct by evaporating liquid mercury at a certain temperature, with the controlled flow rate of nitrogen as a carrier gas.

The gaseous mercury was measured by a mercury vapor monitor (VM-3000, Mercury Instruments). Since the Ontario Hydro method can measure not only elemental mercury but also oxidized forms of mercury, it has been the most widely used mercury measuring method. However, this method takes so long to sample and analyze that rapid variations in mercury concentration are not recognized when they occur. Since the VM-3000 uses CVAAS (cold vapor atomic absorption spectroscopy) as its mercury measuring method, the monitor detects elemental mercury almost instantly and continuously. The term mercury is used below for convenience to represent elemental mercury.

Experiments were performed without any additional injection of particles except activated carbon, to exclude effects other than those caused by activated carbon on gaseous mercury adsorption. Table 1 shows the experimental conditions applied to the gaseous mercury adsorption experiments using activated carbon injection.

Table 1. Experimental conditions of the activated carbon injection experiment.

Gas	Light oil combustion flue gas
Inlet temperature	130 °C
Baseline O <sub>2</sub> level	5-7 %
Baseline NO level	60-70 ppm
Inlet mercury concentration (spiked)	30-50 mg/m <sup>3</sup>
C/Hg ratio	7000
Activated carbon	DARCO FGD <sup>TM</sup> (NORIT)
Filtration area	1.47 m <sup>2</sup> (3 filter bags)

## **Results and discussion**

Filter pressure drop refers to the pressure difference between the filter inlet and outlet. It is a measure of the amount of particulate matter accumulated on the filter surface. The filters in the particulate collector were cleaned by injecting compressed pulse-jet air at every assigned value in the measure of filter pressure drop.

Fig. 2 shows the change in mercury concentration at the collector outlet when the filter was cleaned by pulse-jet air. Filter pressure drop was reduced radically once the cleaning pulse-jet air was injected, whereas the mercury concentration in the collector outlet increased slightly as the collected activated carbon particles on the filter surface were detached by filter cleaning. This change in mercury concentration,  $\Delta C_{\text{Hg, filter}}$ , can be interpreted as the amount of mercury adsorbed by activated carbon particles that had collected on the filter surface.

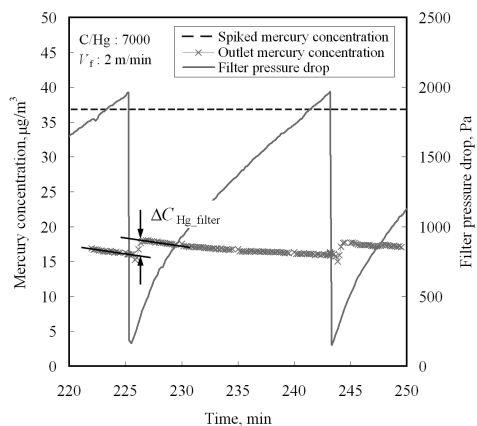


Fig. 2. The effect of filter cleaning on mercury concentration at the collector outlet.

4.7% (8.9% of the total mercury removal efficiency), and 5.6% (10.4% of the total mercury removal efficiency) when the filter cleaning onset pressure drop was set to 980.7 Pa, 1471.1 Pa, and 1961.4 Pa, respectively.

Alterations in mercury concentration at the outlet of the particulate collector during filter cleaning were minimal, despite the variations of filter cleaning onset pressure drop. The reason for this is probably that the contact time of the gaseous mercury with the activated carbon particles collected on the filter surface was too short for these to interact sufficiently.

Fig. 4 shows mercury removal efficiency proportionately at the collector inlet, the collector chamber, and the filter surface, at different filtration velocities. The onset condition of filter cleaning was set to 980.7 Pa in filter pressure drop for this test.

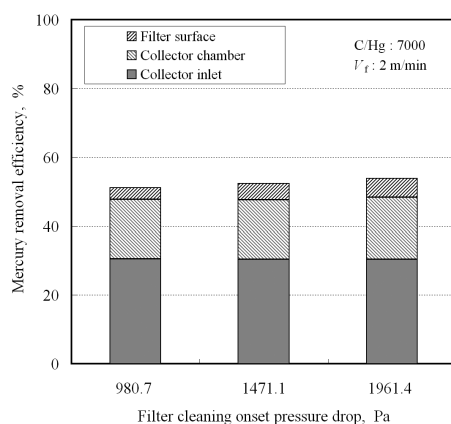


Fig. 3. Mercury removal efficiency in each part of the collector under varying filter cleaning onset conditions.

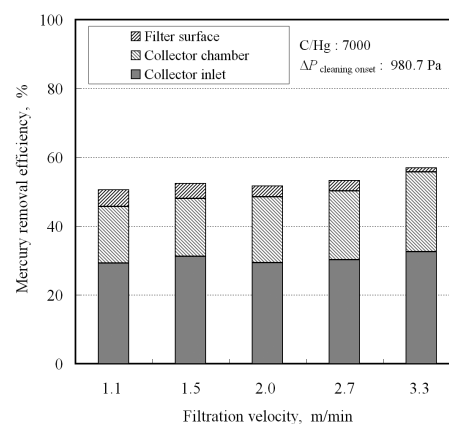


Fig. 4. Mercury removal efficiency in each part of the collector at varying filtration velocity.

As shown in this figure, mercury removal efficiency slightly increased as filtration velocity increased. This was probably caused by enhanced mixing and diffusion effects and by decreased gravitational particle loss due to the increased gas flow velocity, even when the arithmetic residence time of gas in the system was reduced. However, the amount of mercury adsorbed by the activated carbon particles collected on the filter surface decreased as filtration velocity increased. The mercury removal efficiency of the activated carbon particles collected on the filter surface was 4.8% (9.5% of the total mercury removal efficiency) at 1.1 m/min filtration velocity. If the filtration velocity increased to 3.3 m/min, the mercury removal efficiency by the activated carbon particles collected on the filter surface decreased to 1.2% (2.2% of the total mercury removal efficiency). This occurred because the contact time for interaction between the gaseous mercury and the activated carbon particles collected on the filter surface was reduced as the filtration velocity increased.

### **Conclusions**

The characteristics of gaseous mercury removal, using activated carbon injection in a bench-scale particulate collector with fabric filters, were experimentally assessed, and the contribution of activated carbon collected on the filter surface was also evaluated in terms of gaseous mercury removal efficiency.

From the results of the activated carbon injection experiments, it can be concluded that the mercury concentration in a particulate collector was reduced mainly by the activated carbon distributed inside the chamber rather than by that collected on the filter surface. The contribution of activated carbon collected on the filter surface to the removal of mercury was thus fairly minor.

The amount of mercury adsorbed by the activated carbon particles collected on the filter surface barely exceeded 10% of the total mercury removal efficiency achieved by the hybrid APCD. This is probably because the contact time for interaction between the gaseous mercury and the activated carbon particles collected on the filter surface is very short compared to that distributed inside the collector chamber.

### **References**

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