

## Activity of commercial SCR catalyst for the oxidation of gaseous elemental mercury with respect to reaction conditions

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### Introduction

Atmospheric mercury is a global problem with many natural and anthropogenic emission sources. The coal-fired power plant is known to be the major anthropogenic source of mercury emissions [1]. Mercury exists in three forms in coal-fired flue gas: elemental ( $\text{Hg}^0$ ), oxidized ( $\text{Hg}^{2+}$ ), and particle-bound ( $\text{Hg(p)}$ ).  $\text{Hg}^{2+}$  and  $\text{Hg(p)}$  are relatively easy to remove from flue gas using typical air pollution control devices such as electrostatic precipitators (ESPs) and wet-FGD.  $\text{Hg}^0$ , however, is difficult to capture, since it is insoluble in water. Among the technologies being considered for mercury reduction in coal-fired power plant is thus the combination of a catalyst and a wet scrubber; the catalyst oxidizes  $\text{Hg}^0$  to  $\text{Hg}^{2+}$ , and the oxidized mercury is subsequently absorbed by the scrubber system [2]. Oxidation catalysts studied to date fall into one of three groups: SCR catalysts, carbon-based catalysts, and metals and metal oxides [3]. Selective Catalytic Reduction (SCR) has been a well-developed and commercialized technology for controlling emissions of NOx from power plant [4]. In addition to NOx control, however, SCR catalyst has been found to affect the mercury speciation by altering elemental Hg to  $\text{Hg}^{2+}$ . It is well known that increasing the emissions of  $\text{Hg}^{2+}$  allows for high Hg emission reduction because  $\text{Hg}^{2+}$  or  $\text{Hg}^{2+}$ -derived species such as  $\text{HgCl}_2$  can be removed in downstream equipment such as ESPs and wet-FGD systems. Therefore, the co-benefit of increased  $\text{Hg}^{2+}$  through the SCR catalyst is very important to the overall control of mercury emissions from coal-fired power plant.

In the present study, the performance of SCR catalyst for the oxidation of mercury with respect to reaction conditions was studied to understand the mechanism of mercury oxidation on SCR catalyst.

### Experimental

A commercial  $\text{V}_2\text{O}_5$ -based  $\text{TiO}_2$  SCR catalyst was employed for the simulated flue gas containing NO,  $\text{NH}_3$  which are typical components in SCR process. HCl with variable concentration up to 50 ppm was also present in the flue gas to examine the effect of HCl on mercury oxidation. Mercury concentration was continuously measured by cold-vapor atomic absorption spectrometer (VM-3000, Mercury Instruments Analytical Technologies). The concentration of oxidized mercury was measured by passing the reactant gases through the  $\text{SnCl}_2$  solution, which reduces all oxidized mercury species to elemental mercury.

### Results and Discussion

The activity of commercial SCR catalyst for mercury oxidation was examined for both reaction conditions of oxidation and SCR. As shown in Fig. 1, the oxidation of elemental mercury to oxidized mercury was negligible in the absence of HCl in reactant gases. The presence of HCl in the reactant gases greatly increased the activity of SCR catalyst for the

oxidation of elemental mercury to oxidized mercury under oxidation condition. The elemental mercury completely converted to oxidized mercury under oxidation condition with HCl. It indicates the presence of HCl in reactant gases is of crucial importance for mercury oxidation. However, the effect of HCl on the oxidation of elemental mercury was much less under SCR condition than oxidation condition. In addition, the activity of SCR catalyst for mercury oxidation decreased with the increase of  $\text{NH}_3/\text{NO}$  ratio under typical SCR reaction condition. This means that  $\text{NH}_3$  inhibits the HCl assisted oxidation of mercury under SCR condition. This seems to be attributed to  $\text{NH}_3$  prohibiting the adsorption HCl and/or Hg on the catalyst surface under SCR condition. The presence mercury slightly reduced the NO removal activity of commercial SCR catalyst, especially at lower temperature less than 300 °C, probably due to the competitive adsorption of  $\text{NH}_3$  and mercury.

### Significance

The present  $\text{V}_2\text{O}_5$ -based  $\text{TiO}_2$  commercial SCR catalyst is difficult to oxidize elemental mercury even in the presence of HCl under the typical SCR conditions. The understanding of the mechanism of mercury oxidation can give the direction to develop new concept of SCR catalyst for simultaneous removal of NOx and mercury.

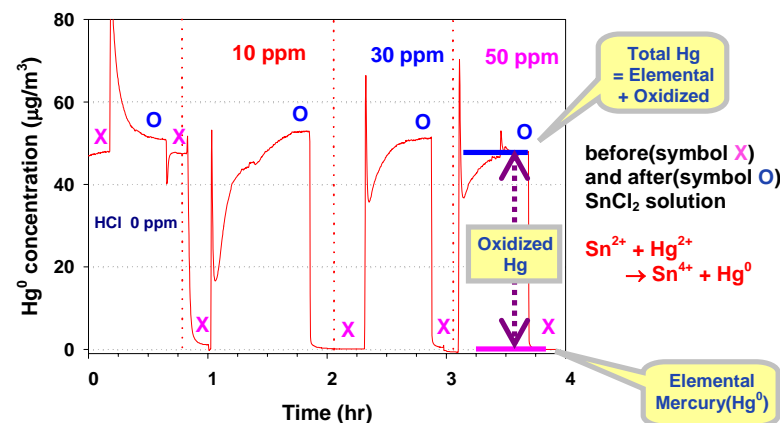


Figure 1. Typical concentration profile of elemental mercury under oxidation condition.

### References

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