Advanced mercury oxidation under simulated power plant conditions

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Introduction

With the Mercury and Air Toxics Standards (MATS) rule coming into effect in the USA in 2015 all existing coal fired power plants will be required to limit their mercury emissions from the stack to less than 1.2 lbs. Hg/ Trillion BTUs [1]. In order to meet this requirement utility companies will either have to install advanced emission control technology, modify the plant's operations, or shutdown the power plant. There are already several different technologies available for Hg control each with their advantages and disadvantages [2], but a common approach is to use existing emission control technology for NOx and SOx removal to obtain a co benefit for Hg removal. This is done by using the Selective Catalytic Reduction (SCR) catalyst to oxidize Hg from elemental Hg^0 to oxidized Hg^{2+} which then can be more readily captured in the Flue Gas Desulphurization (FGD) unit.

In this report we will discuss ways to maximize the Hg oxidation potential of the SCR catalyst while not affecting the inherent NOx and SOx removal activity of the catalyst. This will be done using the results obtained from commercial SCR catalysts under simulated power plant conditions in a "micro-scale" rig, along with kinetic and experimental models based off these results.

Materials and Methods

This "micro-scale" rig (specifics explained in talk) was used to measure Hg oxidation simultaneously with NOx reduction and SOx oxidation measurements.

There are two main forms of commercial SCR catalysts used in power plant operations, extruded honeycomb or laminated plate, which typically contain vanadium as the active component. This "micro-scale" rig is capable of testing samples of both forms of catalysts under area velocities and linear velocities typically seen in coal fired power plants.

Results and Discussion

Using this "micro-scale" rig, flue gas components are continuously monitored and both the NOx conversion and Hg oxidation can be calculated for a given condition. These conditions have been shown to be critical to determining the level of Hg and NOx conversion. For example we have seen that for one condition (a low halogen bituminous condition) there is lower Hg oxidation than at the same condition but with higher halogen content, with relatively no effect on NOx conversion.

This highlights the effect of halogen concentration on Hg oxidation during SCR operations. This effect and other effects, such as area velocity, temperature, vanadium content, etc. were then modelled to determine the best operating conditions for Hg conversion. Some results from this model can be seen in Figure 1. Here the effects of area velocity and ammonia to NOx ratio (ANR) are shown for a single catalyst at a set temperature for two different HCl concentrations. From this figure we can see that the effects of ammonia (a large ANR) can be largely offset by increasing the HCl concentration or decreasing the area velocity. We can also see that at some conditions the presence of ammonia has little or no effect on the Hg conversion. In addition to modelling the Hg conversion response, the NOx conversion was also modelled when ammonia was present. This NOx conversion was then correlated to the Hg conversion and this correlation along with other effects studied in the model will be discussed in detail in order to achieve advanced Hg oxidation.

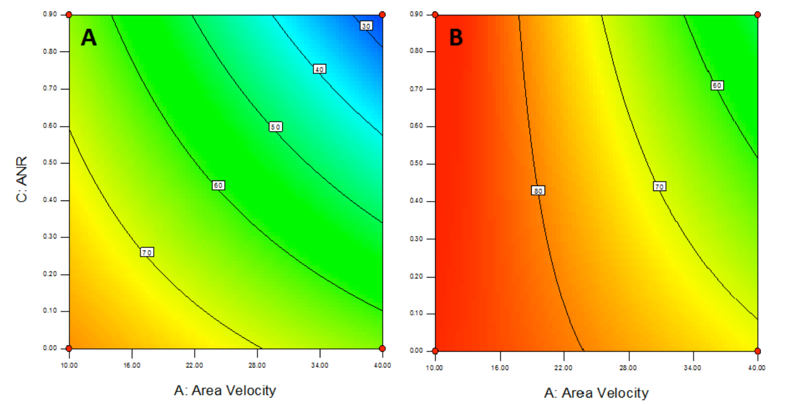

Figure 1. Contour plots showing the effects of area velocity and ammonia to NOx ratio (ANR) on Hg conversion for two different HCl concentrations, a) low HCl & b) high HCl.

Significance

Measuring Hg oxidation under simulated power plant conditions in the presence of ammonia allows for an accurate determination of a commercial SCR catalyst's Hg oxidation properties. Here we have demonstrated the ability to measure NOx, SOx, and Hg conversions simultaneously for a given condition and presented ways of optimizing NOx, SOx, and Hg activity using an experimental model. These novel results show how it is possible for a coal fired power plant to obtain high NOx, SOx, and Hg removal efficiencies using existing SCR catalysts.

References

1. U.S. EPA, Final Mercury and Air Toxics Standard Rule, *Federal Register 77*; (32) 9304-9512, 2012.
2. Wilcox, J.; Rupp, E.; Ying, S.; Lim, D.; Negreira, A.; Kirchofer, A.; Feng, F.; Lee, K. *InternationalJournal of Coal Geology* **2012**, 90-91, 4-20.
3. U.S. EPA, Method 8A, www.epa.gov/ttnemc01/ctm/ctm-013.pdf, 1996.