

Project Description

Title: Hg Oxidation Compared for Three Different Commercial SCR Catalysts

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Selective Catalytic Reduction (SCR) for deNO_x has been shown to effectively oxidize mercury and thereby enhance mercury removal in wet scrubbers. Many years of research have gone into developing these catalysts for deNO_x, but relatively little is known about their mercury oxidation behavior. In this investigation, three different commercial catalysts were examined for their ability to oxidize mercury in simulated flue-gas. The trade off between the advantage of mercury oxidation and the negative impact of SO₃ generation was also compared for the three catalysts. The temperature range, area and space velocities, and bulk flue gas composition were consistent with conditions experienced at full-scale installations. The volume of each catalyst used was chosen so as to provide a consistent deNO_x value of >95% (with a one-to-one NH₃/NO ratio), for each catalyst. Quantitative information on the effect of HCl concentration, temperature, and the effect of ammonia injection on Hg and SO₂ oxidation are presented. This project was funded by USDOE National Energy Technology Laboratory's Innovations for Existing Plants Program.

All three commercial SCR catalysts compared in this investigation, provided by three different manufactures, performed similarly with regard to mercury oxidation and SO₂/SO₃ conversion. In addition, certain general mechanistic observations were made. The presence of ammonia and NO for one-to-one deNO_x may inhibit mercury oxidation at power plants with very low concentrations of HCl in the flue gas, such as might be the case for a plant burning a PRB coal with a particularly low concentration of chlorine. However, at higher concentrations of HCl in the gas, the combined presence of ammonia and NO had little effect on mercury oxidation across the catalyst.

A larger concern might be that regardless of HCl concentration, the absence of ammonia and NO allowed significantly more SO₂/SO₃ conversion. This is troublesome for two reasons. One, if plants run flue gas through their SCR in the off season to oxidize mercury and capture it in their scrubber, yet turn the ammonia off, because they don't need the deNO_x, then they may significantly increase their SO₃ formation. Secondly, most SCR reactors have multiple layers, the last of which typically do not interact with much ammonia, because most of the deNO_x takes place over the first few layers of catalyst, which means that even with ammonia injection, the lower catalyst layers will continue to generate SO₃ at a high rate.

The impact of temperature on mercury oxidation was found to be significant at low HCl concentrations. Mercury oxidation significantly decreased with increasing temperature up to at least 750 °F, with an HCl concentration of only 2 ppmv. However, at higher HCl concentrations, the temperature dependence flattened out. Thermodynamic equilibrium calculations suggest that this phenomenon may be entirely due to the thermodynamic potential for mercury oxide species to form at given temperatures and HCl concentrations. Beyond that, the data obtained in this work clearly indicate that increased mercury oxidation can be obtained across an SCR catalyst with increasing HCl concentrations, regardless of temperature, catalyst type, SO_2/SO_3 concentration, or the presence of ammonia, and without increasing SO_2 conversion.