Specifying, Achieving, and Measuring Mixing Quality for SCR Systems

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Summary

Achieving performance guarantees and long term SCR performance at guaranteed conditions on an SCR system for a utility boiler have significant potential cost impacts. The SCR designer must rely on the predicted and guaranteed catalyst performance; in turn the catalyst supplier bases his performance on the SCR designers specified conditions of NOx, ammonia, velocity and temperature at the inlet to the catalyst. Achieving intimate and uniform mixing of ammonia and NOx in utility scale SCR systems is widely recognized as both essential and challenging. Sometimes overlooked is the importance of correctly specifying the boundary conditions of the model study based on boiler configurations and operational procedures of the unit. Beyond the complexities of specifying the model study the difficulty of measuring and characterizing the mixing actually achieved in the field must be addressed.

Mixing of injected ammonia with the flue gas must be uniform, and this must be achieved within the limited space between the boiler economizer outlet and the catalyst inlet. One approach is to employ a large number of individually controlled yet fixed injection nozzles in a grid. Given that boiler outlet conditions vary based on mill firing configurations, coal quality, backpass damper positions, etc. such a static distribution system has difficulties meeting all conditions. An alternative is to use a small number of injection points together with static mixers. Properly designed for the variation of boiler conditions, such a system offers simplified construction, control, and maintenance. Once tuned, the system requires no further adjustment as unit load, boiler conditions, inlet NOx, and required NOx removal efficiency are changed.

While mixing of ammonia is the most obvious and critical requirement for high efficiency NOx removal, the catalyst inlet distributions of NOx, temperature, velocity, and dust be uniform for good performance of the SCR. Here, again, static gas mixers are employed to homogenize the inlet conditions across the ammonia injection and SCR inlet cross sections. Riley Power utilizes small scale models between 1:40 and 1:30 scale for flow and mixing design. Such small scale models provide a short design and testing cycle time allowing the exploration of the optimum system. The dust distribution of the system is tested in a final model of 1:12 to 1:18 scale. Detailed testing has proven the results from the small scale are scalable to the larger scale.

We present case studies for the design of gas mixing systems using physical flow models, and results from the operating plants.