

In Development

A Portable Laboratory for Catalysts

EPRI Test Facilities Help Utilities Optimize Emissions Reductions at Coal Plants

By Chris Warren

Selective catalytic reduction reactors are among the most important tools for reducing nitrogen oxide (NOx) emissions from coal-fired power plants. Located between the boiler and air preheater, the reactors use a catalyst material—often a honeycomb-like ceramic substrate—that can eliminate more than 90% of the NOx from a plant’s flue gas stream. For optimal performance, ammonia is mixed with the flue gas before it reaches the reactors. The reactors offer an additional benefit: They oxidize mercury so that it can be captured in a coal plant’s wet scrubber.

The effectiveness of NOx and mercury removal depends on the formulation and condition of the catalysts, which can last several years before being replaced. Over time, the catalysts’ pores can get clogged with contaminants in the flue gas. Utilities typically monitor catalysts by periodically removing samples from the reactors and sending them to a lab for tests. Because it is prohibitively expensive to generate a coal-fired flue gas, labs burn natural gas in testing, and the resulting flue gas does not contain the fly ash present in a coal-fired facility.

“It doesn’t have the ash, and that is the question mark,” said EPRI Principal Project Manager Tom Martz. “The ash may or may not do some funny things when it comes to the behavior of the catalyst.”

Taking the Lab on the Road

To provide insights on a range of catalyst performance issues, EPRI developed two portable catalyst test facilities that can be set up at a coal power plant in just a few days. They pull a flue gas “slipstream” from the power plant, divert it for testing, and then return it to the plant.

“The portable facilities enable us to test catalyst samples in an operating coal flue gas environment, complete with fly ash,” said Martz. “Because the facilities are portable, we can evaluate catalysts at different plants with a variety of coals and operating conditions. We can provide site-specific information for plant catalyst managers.”

In their inaugural application in October 2015, EPRI used the facilities to compare the effectiveness of a standard new catalyst with a regenerated one.

“Regenerated catalysts are less expensive than new ones,” said Martz. “The utility wanted to know whether the regenerated catalyst was doing its job in terms of reducing NOx and oxidizing mercury. To vet the many replacement options and make informed purchase decisions, plant catalyst managers need independent catalyst performance data collected from operating power plants.”

For another utility, EPRI in 2016 conducted an on-site, side-by-side comparison of a more expensive advanced catalyst with a conventional one. “There’s no independent data on field performance to decide whether it’s worth paying a premium for the advanced catalyst,” said Martz. “The portable test facilities are perfect for answering this question.”

Because the price and comparatively low emissions of natural gas make it so competitive, many coal plants are being asked to cycle more often and operate at low loads. In late 2016, EPRI used the portable facilities to examine how this affects catalyst performance.

"Operating at a lower load may require selective catalytic reduction reactors to run at lower temperatures, but catalyst vendors set a minimum operating temperature to protect the catalyst," said Martz. "This can limit the load drop on large coal plants by as much as 100 megawatts, which is huge for utilities in terms of revenue and flexibility."

Vendors are concerned that ammonium bisulfate may form in the catalyst pores at lower temperatures, potentially impairing catalyst performance. But EPRI research has demonstrated that the temperature at which ammonium bisulfate forms can be lower than what vendors assert.

"Observations during EPRI's portable facility tests, combined with previous EPRI research, provide greater clarity regarding ammonium bisulfate formation," said Martz. "They show that the minimum operating temperatures may be safely lowered in many cases. We are now able to give practical guidance to plant managers for operating the reactors at lower loads."

"Our goal with the test facilities is to inform the industry so that plant managers have more flexibility," said Martz.

Key EPRI Technical Experts

Tom Martz