

SCR Inlet NO_x Monitoring for Real-Time SCR Control

Aron Gaus, Ph.D. Presenter

Brand-Gaus, LLC 15603 Delahunty Lane, Pflugerville TX 78660

E-mail: agaus@brandgaus.com Telephone: (512) 989-0149; Fax: (512) 989-0745

Joel Brand, Ph.D. Co-author

Brand-Gaus, LLC 15603 Delahunty Lane, Pflugerville TX 78660

E-mail: jbrand@brandgaus.com Telephone: (719) 533-1129; Fax: (512) 989-0745

Summary

Brand-Gaus, LLC has field-tested a flange-mounted close-coupled NO_x and oxygen instrument for SCR process control. This first field trial was intended to test the feasibility of making NO_x measurements in this manner, to examine performance criteria necessary for process control, and to elucidate improvements necessary for a more commercial design. Data for NO and O₂ showed strong correlation with process variables and outlet CEMS readings, as well as good agreement with inlet readings of conventional extractive measurement at the inlet (it was a time-share system).

This design is an extension of the streamlined chemiluminescence NO_x and zirconium oxide oxygen detection technologies used in the conventional-extractive Brand-Gaus analyzers offered commercially for compliance CEMS. In this configuration, the optics, electronics, and pneumatics were packaged in a weatherproof enclosure mounted on a four-inch 150-pound flange. Sample was educed from the duct though an attached probe (a five-foot section of ½ inch stainless tubing) using a built-in heated eductor and returned to the stack through the same flange. The entire package weighed approximately 30 pounds and was contained in an enclosure of approximately one cubic foot volume.

The prototype was tested for approximately three months at a natural gas-fired combustion turbine with water injection in California, operating at nominally 40 PPM NO_x before the SCR and 8 PPM at the outlet. It was installed just downstream from the ammonia injection grid necessitating a hot-wet design that could handle the presence of ammonia and water at high levels, a rather demanding requirement. For this test, it was decided that NO only would be measured since the presence of ammonia would interfere with the standard NO₂ converter. All internal sample paths, including the eductor and the chemiluminescence reaction cell were maintained at approximately 180 C to prevent the deposition of ammonium salts or condensation of any other acid gases.

The results from the test were both encouraging and informative. Because only NO, and not true NO_x, was measured it was not possible to make a direct comparison of total NO_x. However, it was possible to compare NO readings by disabling the converter in the conventional extractive system. The total amount of NO₂ present appeared to be approximately 10% of the total NO_x and was relatively stable. Measurement of hot-wet oxygen, when compared to the dry-extractive system, allowed for determination of water content. The NO and O₂ readings tracked well with process conditions, and agreed well qualitatively with the extractive system when it sampled the inlet, but good quantitative agreement was possible only with correction for substantial water interference.

Water interference caused the close-coupled instrument to read approximately 17% lower than the dry extractive system, even after correcting to a common oxygen basis to account for the dilution effect. Subsequent laboratory testing has indicated that this may be reduced to approximately 5% by optimizing some of the operating parameters at the expense of ultimate sensitivity, but such a proposed configuration has not been field-tested yet.

Another significant issue was that the complications arising from operating the reaction cell at 180 C resulted in a measurement stability of approximately +/- 2 PPM, a significant degradation over the stability of the conventional extractive Brand-Gaus analyzers using the same technology which are typically stable to better than 0.1 PPM in this regime.

Given these two caveats however, the instrument otherwise performed well. While it was impossible to unambiguously measure response time to process changes, it responded to calibration gas and appeared to track process changes within a few seconds. The most encouraging result was the basic robustness of the instrumentation platform. After some initial

refinements to the thermal design of the enclosure, it ran continuously in hands-off mode and there were no significant contamination issues in making the measurement hot/wet. All installation, calibration, and testing tasks were performed by regular plant O&M staff, Brand-Gaus personnel never went on-site.

The results of this test indicated that this approach may be valuable for qualitative process control in its present configuration, but that improvements might be necessary for more quantitative measurements. One of the easiest ways to do this would be to move the installation point just upstream of the ammonia injection, in which case it would only be necessary to heat the reaction cell to approximately 50 C. This would allow for an optical design much closer to that used in our conventional analyzer, with concomitant gains in sensitivity. Most importantly, this could allow for modification of the operating parameters to realize the lower water interference values seen in laboratory tests. Moving the sampling point ahead of the ammonia injection would also allow for integration of a converter to measure true NO_x and not just NO, without concerns of ammonia interference.

Brand-Gaus is also pursuing another close-coupled design with the same sensor technologies that would virtually eliminate the issues of water interference and result in accuracy of approximately 0.1 PPM. It is expected that such a package would meet or exceed the performance of a low-NO_x compliance CEMS, with much faster response times and perhaps most importantly a drastically less cumbersome package.