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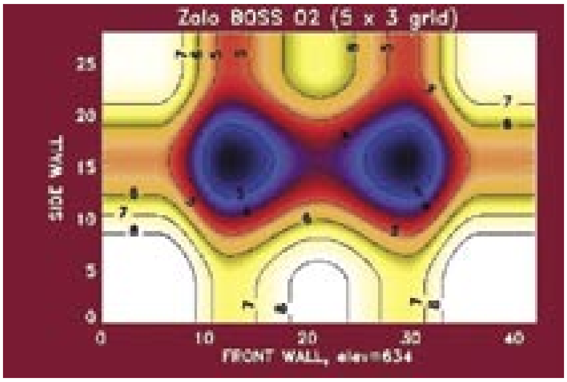
UPDATE

By Steve Blankinship, Associate Editor

Laser Spectroscopy Makes Total Combustion Mapping Possible

The most cost-effective way to increase efficiency and reduce emissions in a coal plant is to optimize combustion. One way to greatly enhance combustion is through highly accurate, real-time combustion efficiency measurements. Unfortunately, this approach has been sorely limited because measurements have had to be taken some distance from the boiler interior. Sensor technology has not allowed effective measurement inside the harsh conditions of the combustion zone. New laser technology has now brought precise measurement to the very heart of the combustion process.

Until recently, the only place combustion measurements could be taken was in the boiler's backpass near the economizer. It is now possible for a single instrument to completely map a combustion zone — showing temperature as well as the precise concentration, mixture and location (all in real time) of water (H_2O), oxygen (O_2), carbon monoxide (CO), carbon dioxide (CO_2) and anhydrous ammonia (NH_3). Also in advanced development is the ability to measure nitrous oxide (NO_2). Such measurement capability can generate an optimized burn that can lower fuel costs; lower and control excess air; reduce emissions, LOI, waterwall wastage and ammonia slip; improve sootblowing and reduce slagging; and even help identify tube leaks.



The ZoloBOSS system is capable of measuring along 16 separate paths throughout a boiler. Grid patterns are tomographically mapped to produce a 2-dimensional representation of constituent distribution. Illustration courtesy of Zolo Technologies.

The specific technology — Tunable Diode Laser Absorption Spectroscopy (TDLAS) — works on the principle of the molecular absorption of a given molecule. When scanning the wavelength of the laser over a molecular absorption line, the strength of the absorption is a direct measurement of the molecular concentration in the path of the beam. Nearly ten years ago, Stanford University demonstrated that multiple lasers (multiplexed spectroscopy) could be used as a powerful combustion diagnostic tool. Today, the dramatically lower cost of equipment needed to provide such readings under high temperatures and pressures inside a coal-fired boiler at kHz data rates makes it possible to measure a wide range of combustion conditions as they occur. Such a combustion optimization system is being marketed by Zolo Technologies, Inc. under the name ZoloBOSS (Zolo Boiler Optimization Spectroscopy Sensor).

The system conducts measurements without any physical contact inside the boiler and without any reliance on gas extraction. The sensors do not intrude into the boiler. Since the laser beams are sent from, and received into, optical fibers, all sensitive instrumentation is located in the control room, rather than on the boiler. Installation requires only a two-and-one-half inch access port. There are no sensor tips to wear out or replace, no reference gases are required and no probes are needed. Because the measurement process is based upon molecular absorption, the system does not require calibration and does not drift.

"Zolo has developed a way to sense molecules in a high temperature, turbulent environment, using multiple paths to produce multiple measurements in real time," says Robert Sutherland, vice president of sales and marketing for Zolo. He adds that with multiplexed spectroscopy, the system can also provide the ability to measure unburned hydrocarbons and process gases such as xylene, toluene, ethylene, methane and benzene. In addition to monitoring inside the boiler, the technology can be applied to SCRs, air heaters, process control and the plant's chemical monitoring.

Until very recently, components did not exist to build such a combustion optimization product unless it was controlled in a laboratory. The right kind of lasers did not exist nor did fiber optic switches. Coupling lasers into fibers was difficult and expensive. As a result, optical multiplexers were large and unstable. All of those problems have now been overcome thanks to the development of tunable lasers, fiber-optic switches and optical multiplexers developed with significant investment by Zolo for use in the telecommunications industry, and a collaboration by Zolo with Stanford University's High Temperature Gasdynamics Laboratory.

Ongoing testing of the ZoloBOSS system is currently underway at Xcel Energy's Valmont plant on a 220 MW Combustion Engineering tangently-fired boiler. Signal testing has been conducted at Salt River Project's Navajo plant (750 MW supercritical CE tangently-fired), and side-by-side O_2 measurement capability with ASME measurement probes has been successfully conducted with Foster-Wheeler on a TECO Energy unit. Tomographic mapping studies are being conducted with a large utility in the Midwest and additional measurements are being taken with the system at TVA's Gallatin Station.

During a low-load night-time test at TECO Energy, the system delivered O_2 measurements within 0.1% correlation to the ASME standard extractive test. Testing at TVA's Gallatin Station yielded successful measurement data for temperature, O_2, CO and H_2O during a recent project development run. TVA will be the launch customer for ZoloBOSS, installing a complete system on a CE twin furnace application. Delivery and start-up are expected to take place late this year or in early 2005. PE