APPLICATION BULLETIN
ICA-10

MEASURING INDIVIDUAL BURNER AIRFLOW

The Challenge

The objectives in the power industry today are twofold; to lower emissions, and increase plant performance. Precise measurement of combustion airflow and fuel rates positively contributes to achieving those objectives by providing the information needed to optimize stoichiometric ratios and facilitate more complete, stable combustion.

Traditional designs of tangentially fired, coal power plants lack any means to measure secondary airflow entering each fuel and aux air compartment. Efforts to meet NO_X attainment levels mandated by the Clean Air Act were frequently achieved by means of extensive and often non-repeatable tuning of burner settings solely targeted at meeting the NO_X and CO emissions guarantees at a single load condition. Just as there are variances in fuel distribution to each burner, multiple burners served by a common wind box ended up with substantial burner-to-burner imbalances in secondary airflow (SA).

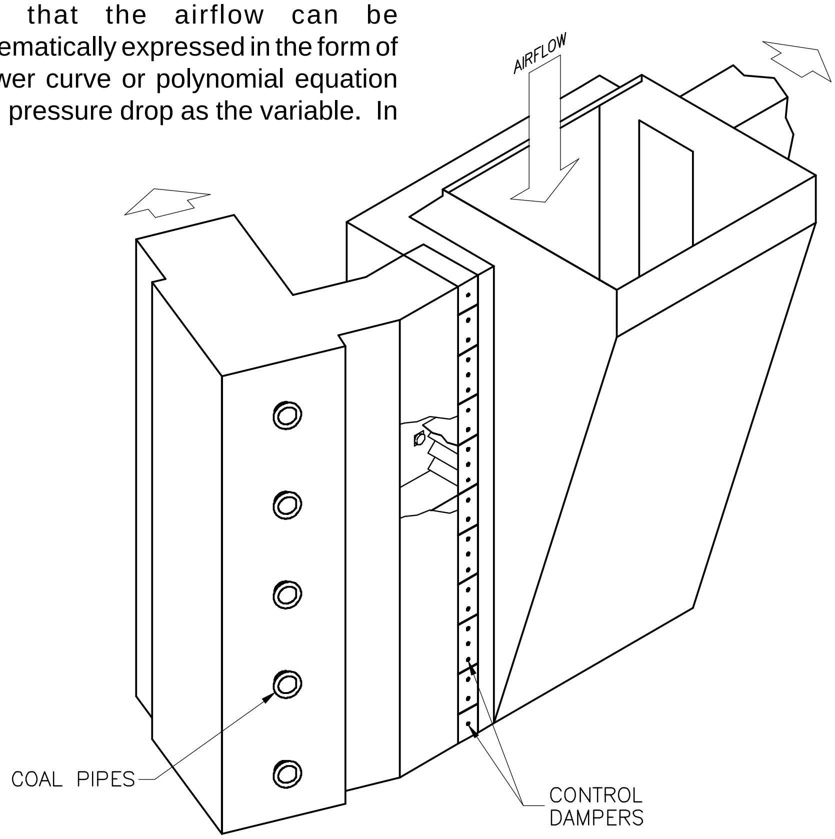
On tangentially fired boilers the modulating control damper at the entrance to each secondary air inlet has little if any straight duct run, not providing a location where even just a repeatable signal representative of actual airflow can be obtained. Since the secondary air inlets are not easily accessed for maintenance or repair, any airflow measuring instrumentation must be durable and repeatable, providing stable, accurate input signals to the DCS if a combustion optimization strategy using continuous adjustment of the secondary airflow is to be applied to each burner compartment.

The Solution

Air Monitor Power's Application Engineering department was called upon by a Southeast utility to design a system to measure airflow entering the individual fuel and aux air compartments of their tangentially fired 350MW plant, where new low NO_x burners were being installed as part of a total boiler upgrade.

The design solution was based upon the fact that airflow passing through a fixed resistance element (louver, perforated plate, orifice plate, etc.) produces a measurable, repeatable pressure drop, such that the airflow can be mathematically expressed in the form of a power curve or polynomial equation using pressure drop as the variable. In this tangentially fired application the dampers are modulated to control airflow, thereby making them variable resistance elements whose relationship to airflow becomes a mathematical function of two variables – the measured pressure drop across the damper and the damper position.

Each corner consisted of four burner elevations with three blade control dampers, five aux air compartments with two blade dampers, plus a top air and a bottom air compartment each with a single damper blade. A full scale mock-up of the wind box corner was constructed, complete with physical replications of the three different damper configurations, equipped with



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The Solution (con't)

the new actuators that were part of the boiler upgrade, and attached to Air Monitor Power's large scale test duct. Based upon customer provided current and future operating parameters, a 286 point test matrix consisting of three variables (windbox static pressure, damper position, damper size) was developed for characterizing each damper individually, followed by verification testing of multiple dampers being modulated simultaneously. The result was a developed series of multi-order polynomial equations correlating the pressure drop signal and damper position into air mass flow.

A key component of the project was designing the static pressure sensors required to measure the pressure drop across the control dampers. The sensors had to operate in the presence of fly ash particulate, be economically feasible to retrofit into the existing compartments, and not be adversely impacted by changing airflow patterns downstream of the modulating dampers. A custom ruggedized version of Air Monitor's SAP (Static Air Probe) was engineering to meet the application requirements.

The static pressure signals from the upstream and downstream SAPs were routed out of the wind box to the Combustion Airflow Management System (CAMS) enclosure. Within the CAMS enclosure the pressure signals, airflow temperature, and damper position input are converted by a CAMM/TFA using the multi-order damper characterization equations, into a fully density compensated lbs/hr mass flow output to the DCS.

The CAMM/TFA also manages the AUTO-purge™ system used to keep the SAP sensing ports and signal lines clear of accumulating fly ash. The purge cycle can be configured to operate on a programmable interval or initiated via a dry contact from the DCS. During the purge cycle the CAMM/TFA maintains a locked signal output to the DCS while providing a dry contact notification of purge cycle start and finish.

Result

An engineered solution consisting of customized SAP sensors, detailed damper characterizations and CAMS resulted in individual compartment SA measurement accurate to within ±5% of actual airflow over the full range of boiler operation.

The ability to accurately balance and/or bias individual corner airflow was a critical first step in optimizing boiler performance while simultaneously reducing undesirable emissions. Further reductions in NO_x levels were obtained when the continuous corner SA measurements were combined with nozzle tilt adjustments and DCS controlled modulation of the control dampers to dynamically maintain a burner and aux air strategy at varying fuel loads.

In addition to its essential contribution to optimization of PA / Feeder curves, incorporating Pf-FLO coal flow measurement for EACH burner allowed automatic adjustment of SA to reflect the actual fuel being delivered to each burner, thereby achieving the desired fuel / air ratio for each burner while safely lowering overall NO_x and reducing areas of high CO that otherwise produce undesirable slagging and water wall corrosion.