WHY IS IT IMPORTANT TO MEASURE COMBUSTION AIRFLOW AND PULVERIZED FUEL FLOW?

AMC Power is a pioneer and leader in developing systems to accurately and reliably measure combustion airflow, with thousands of installations at virtually every utility in the United States. While the reasons for improving combustion airflow measurement vary from power plant to power plant, there are common applications at all power plants that would greatly benefit from improved airflow measurement. In addition to its many other benefits detailed below, use of our Pf-*FLO*™ pulverized coal flow measurement system has had the auxiliary effect of increased awareness of the need to more accurately measure combustion airflow. This report is a compilation of the experiences had by power plant managers who have installed our systems at their facilities, as well as information from published articles on combustion airflow. It will serve to explain the various plant enhancements that have been made by implementing AMC Power products.

AMC Power's VOLU-probe's unique, patented ability to measure flow in short duct runs makes it ideally suited to measuring all forms of combustion airflow. Figures 1 and 2 are boiler schematics that depict the typical points of airflow measurement. Figure 1 is a wall-fired boiler and Figure 2 is a tangentially fired (T-Fired) boiler. One can immediately note that the largest problem in measuring combustion airflow is the lack of straight duct runs.

Primary Airflow

The main function of primary air is to pneumatically convey the pulverized coal from the mill to the individual burners. Primary airflow is also important to the performance of low NO_x burners. Most low NO_x burner manufacturers stipulate that accurate primary airflow measurement must be available in order to meet NO_x performance guarantees. This requirement is placed on utilities because excess primary air will elevate flame temperature and therefore increase thermal NO_x created at a burner. Primary air also affects coal velocity and therefore the position of the flame relative to the burner tip. For most low NO_x burners both the flame temperature and position are critical to reducing NO_x. As such, accurate primary airflow measurement and control has become a critical component in the process of minimizing NO_x levels throughout the entire load range of the boiler operation. While decreasing primary air at lower loads is important to minimizing NO_x, one must be aware that a minimum transport velocity has to be maintained to avoid reaching the point where coal particles start falling to the bottom of the pipe in horizontal runs. This phenomenon, referred to as layout, can cause problems with burner performance, coal pipe fires and "slugging" (or surging) of coal into the burners.

The NO_x reduction benefit resulting from properly managed primary airflow is not just limited to plants equipped with low NO_x burners. Tight control of the primary air can help reduce flame temperature on *any* burner, place the flame where it needs to be for optimum combustion, and reduce water wall damage caused by flame impingement on the opposing furnace wall.

Location (A) is typical for a primary airflow station on a pressurized coal pulverizer (mill). In many cases, there is ample straight run after the hot and tempering air mix to measure at this location for the purpose of controlling the volume damper into the mill. Either VOLU-probes or a Combustion Air (CA) Station can be installed in the duct and used along with a Combustion Airflow Management System (CAMS) for generating a mass flow output.

Locations (B) and (C) are hot and tempering primary airflow respectively. In addition to having the correct primary air volume to transport the coal particles to the burners, primary air temperature control is also important for drying the coal in the mill. In order for all surface moisture of the coal to be evaporated, mill outlet temperature must be accurately measured and controlled by means of modulating the hot and tempering airflows. These flows can be measured individually using VOLU-probes or CA stations, and CAMS, with separate control of the hot and tempering air dampers, or they can be summed (by the CAMS) to give a total primary airflow signal, which can be used to control mass flow of the air to the mill with the mill PA volume damper.

Bulk Secondary Air

Bulk secondary air is the airflow feeding the windbox, which is then distributed to the individual burners. Most coal fired boilers have archaic flow measuring devices (if any at all) such as venturis or airfoils, for measuring bulk secondary air. Airflow traversing, normally utilizing Pitot tubes (standard or S-type), is required to in situ calibrate venturis and airfoils. Since most Pitot traverse methods require more straight run than is typically available, accurate secondary airflow measurement does not exist at most power plants. More importantly, these inaccurate flow measuring devices, by nature of their design, create significant amounts of permanent pressure drop. By removing and replacing them with AMC Power systems (usually VOLU-probes and CAMS), not only is measurement accuracy improved, but an increase in plant output is also realized through the decrease in energy consumption needed to overcome the pressure drop. In many plants that are FD fan limited the removal of foils and venturis and their replacement with AMC Power systems has allowed them to increase MW output. FD fan limitation usually occurs in the summer when less dense air prevents the fan from delivering the mass flow needed for maximum MW generation. It is in the summer months that the demand for and value of generated power is at its greatest, and therefore the economic justification of this modification is most apparent.

Location (D) is typical for wall fired boilers. The preferred measurement location is downstream of the fan, preheater and primary air takeoff (as shown), but it can be made in other locations if necessitated by duct layouts. On an opposed wall-fired unit, secondary airflow measurement may also be important to balancing front and rear windboxes.

If the boiler has partitioned windboxes (Figure 3), balancing burner elevations also becomes important when attempting to reduce NO_x and LOI, as well as addressing slagging problems.

Locations (F) through (I) are typical on four-cornered T-Fired boilers. In addition to the possible FD fan limitation problems, many T-fired boilers have airflow balance problems that result in improper fireball positioning. Measuring and controlling secondary airflow to each corner can help position the fireball in the center of the furnace, thereby eliminating or reducing corrosion, LOI and/or NO_x problems associated with having rich and lean corners in the boiler rather than balanced combustion.

Individual Burner Airflow Measurement (IBAMÔ)

Though total secondary airflow can and should be accurately measured for boiler load control, the imbalances in secondary air delivered to the boiler via its multiple burners has created performance and emission problems for effectively every utility. Whether it be on open windbox boilers (Figure 1) , partitioned windbox boilers (Figure 3) or T-Fired boilers (Figure 2), burner-to-burner secondary air balancing has historically been difficult if not impossible to achieve. AMC Power's IBAMs are designed to be located in the secondary air register or barrel of each burner so that airflow to each burner can be measured (see Figure 4), and subsequently adjusted or controlled by means of each burner's secondary air shrouds. Because most burner configurations do not allow for sufficient straight duct run (even for AMC Power's technology), AMC Power has performed wind tunnel testing/calibration that has facilitated the design and commercial development of the IBAM probe for most low NO_x burner types. This allows for the implementation of instrumentation that can be used to balance burners at start-up using only IBAMs. For T-fired units, secondary airflow measurement to the burners can be accomplished by partitioning the corner windboxes and installing VOLU-probes at each burner elevation (Figure 5). When AMC Power's CAMS are used, burner balancing can be dynamically maintained online throughout the entire load range.

Overfire Air (OFA)

Overfire air is introduced in the upper part of the furnace above the burners. Plants that use OFA operate their burners sub-stoichiometrically, and then extend the combustion process into the upper part of the furnace where OFA is introduced. Typically, OFA is 20% of the total stoichiometric air. Because OFA is taken out of the windbox, it most likely affects (takes air from) some burners more than others, depending on the location of the OFA take-offs. Measurement and adjustment of individual burner airflows is therefore even more important when implementing an OFA system. OFA measurement is accomplished using VOLU-probes or CA stations along with CAMS.

Cyclone Burners

The most successful, widespread use of OFA with individual burner airflow measurement has been on cyclone boilers (Figure 5). Cyclone burners come equipped with an ineffective airflow measuring device that uses a perforated plate inlet screen to create a large pressure drop. These inlet screens are field calibrated using a Pitot traverse in the highly turbulent cyclone inlet, and as a result are not very accurate, prohibiting plants from being able to balance airflow between cyclone burners. In the normal course of operation these screens often get damaged, further reducing their ability to provide useable airflow measurement. Additionally, the permanent pressure drop (several inches of water) induced by the inlet screens is a significant and unnecessary waste of FD fan energy that can be put to better use. With the scheduled installation of selective catalytic reduction (SCR) systems into many cyclone boilers (and pulverized coal (PC) fired boilers), extra fan capacity will be required to overcome the hardware that will be installed in the ductwork. Removing flow obstructions such as the inlet screens (or venturis and foils on PC units) can help recover the extra fan capacity required. AMC Power developed a product specifically designed to measure airflow at the cyclone inlets (the VOLU-probe/VS-CI). This product has been tested for accuracy in a wind tunnel using a full-scale 10 ft. cyclone inlet. By using the VOLU-probe/VS-CI in the secondary air, VOLU-probes in the primary/tertiary air and CAMS, accurate airflow measurement can be performed, which allows for balancing or biasing of cyclones for optimum efficiency while reducing emissions.

Pulverized Fuel Flow Measurement

In addition to AMC Power's successes in the area of combustion airflow, the Pf-*FLO*™ pulverized coal flow measurement system is currently being applied at many utility power plants, giving them the ability to balance coal flow to their burners.

As previously stated, pulverized coal is pneumatically transported via the primary air from the mills to the burners, with one mill supplying pulverized coal to as many as eight individual burners. The majority of mills use splitter boxes, mechanical separators or orifice plates to distribute pulverized coal to the individual burners. Although the intention of these devices is to ensure an equal mass flow of coal is delivered to each burner, in practice the flow through each coal pipeline generally varies 20% or more. This unbalanced distribution of coal adversely affects the burner's air-to-fuel ratio, leading to decreased combustion efficiency, furnace slagging, and irregular heat release within the combustion chamber.

The Pf-*FLO*™ coal flow measurement system has been developed to determine the mass flow distribution and transport velocity of pulverized fuels in the pipelines from the mill to the individual burners. The Pf-*FLO*™ system enables the balancing of fuel mass flow delivered to the burners. In combination with continuous measurement of burner secondary airflow using AMC Power's IBAM, individual burner air-to-fuel ratios can be controlled to achieve optimum combustion performance at varying loads, while simultaneously reducing both NO_x and unburned carbon.

As you can see, AMC Power's equipment offers many performance enhancement and cost reduction solutions that address the two most important issues faced by the Power Industry today: NO_x reductions as mandated by the Clean Air Act, and efficiency improvements needed to remain competitive in a deregulated market.

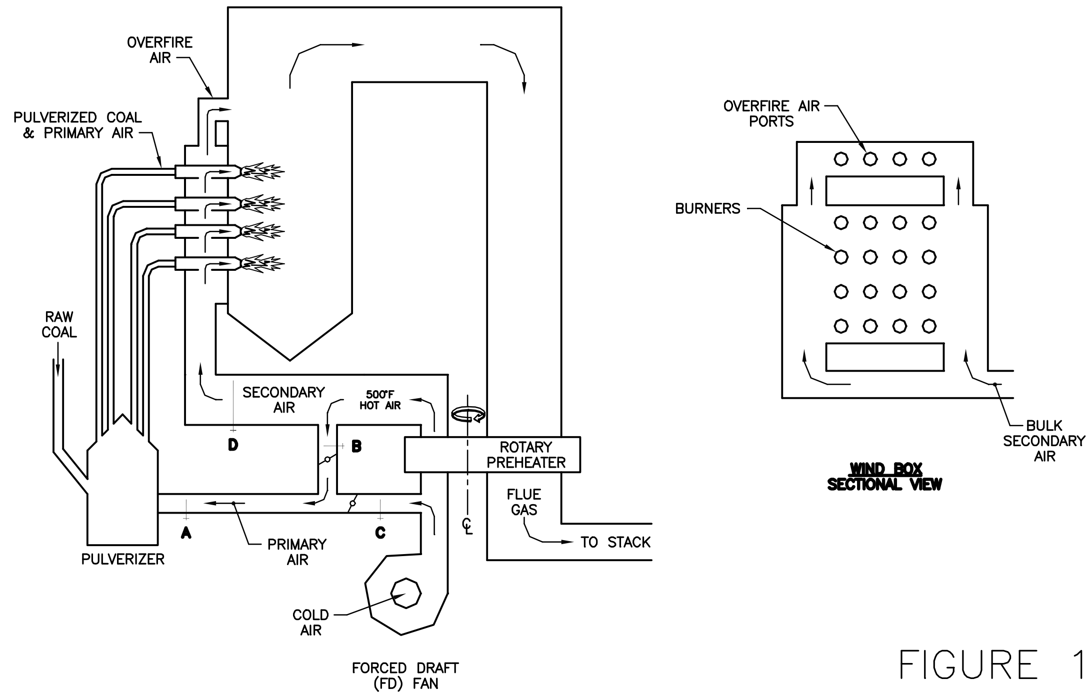

FIGURE 1

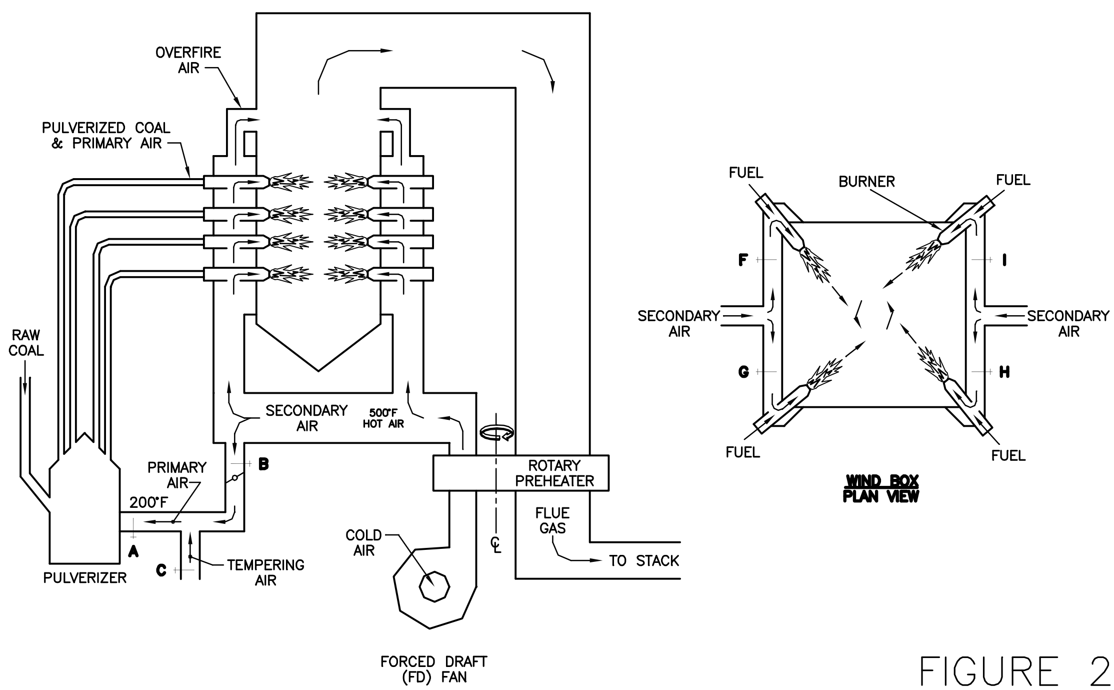

FIGURE 2

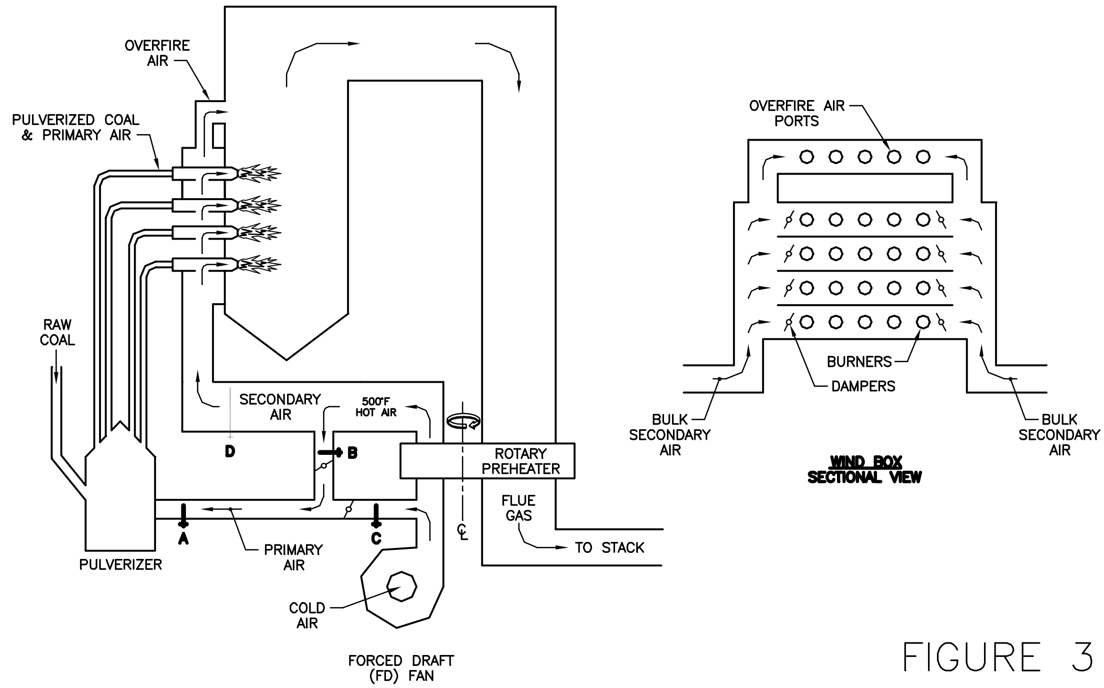

FIGURE 3

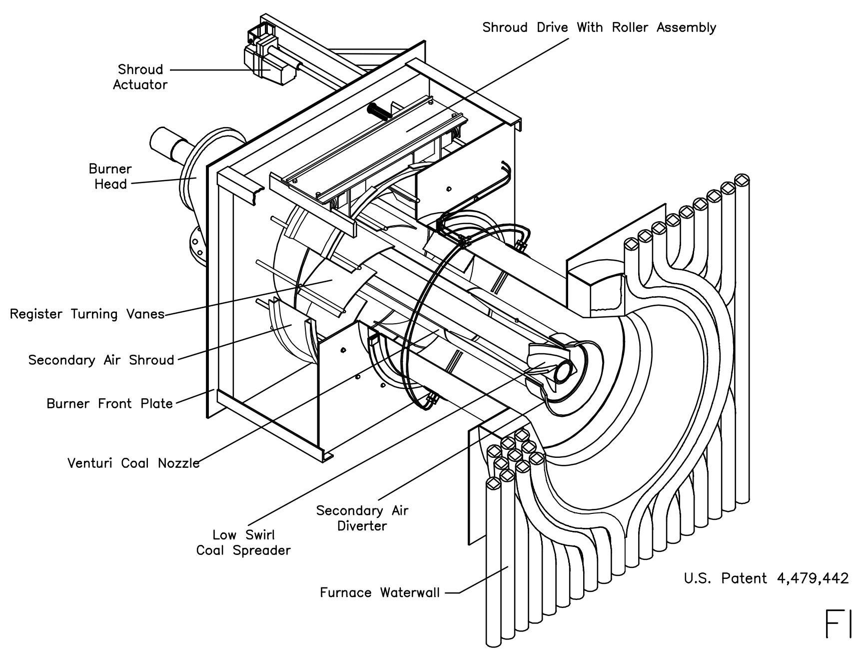

FIGURE 4

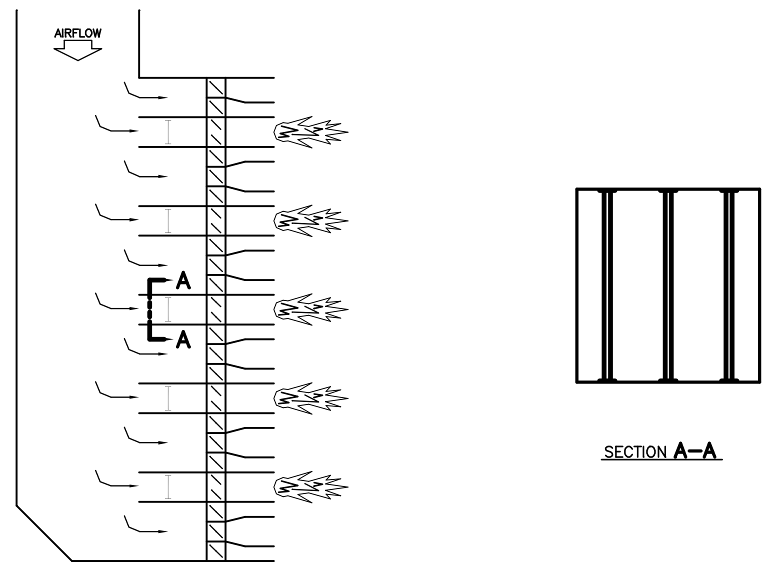

FIGURE 5