APPLICATION DATA

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PAC 353™ COMBUSTION MANAGEMENT SOLUTIONS
FURNACE (DRAFT) PRESSURE CONTROL

BENEFITS

◊ Prevents leakage of hot combustion gases by ensuring that the furnace operates with negative pressure.
◊ Maintains a constant furnace condition to ensure safe, reliable operation of a boiler.

INTRODUCTION

This paper is one in a series that discusses Moore Products Co.'s Combustion Management Solutions. This installment discusses Furnace Pressure Control.

BACKGROUND

A basic boiler has a steamwater system and a fuel-air-flue gas system. In the fuel-air-flue gas system, the air and fuel are mixed and ignited in the furnace.

Air and fuel flow into the furnace and flue gas flows out. The force driving this flow is the differential pressure between the gases inside the furnace and those outside the furnace. Furnace pressure is commonly referred to as draft or draft pressure. The draft is maintained slightly negative to prevent the combustion products and ash from being discharged from the furnace into surrounding areas through inspection ports, doors, feeders, etc. For greatest efficiency, the controlled pressure should be as close as possible to atmosphere, thereby minimizing the ingestion of "tramp air" or excess air drawn through the openings in the furnace ductwork that cool combustion gases.

Furnaces are classified by the method for moving air and other gases through the system.

Natural Draft
A natural draft furnace uses the stack (chimney) effect. Gases inside the stack are less dense than those outside the chimney. The gases in the stack will rise, creating a vacuum (suction) which will draw the combustion air into the furnace and combustion gases or flue gas out of the furnace. Natural draft furnaces naturally operate below atmospheric pressure.

Induced Draft
An induced draft fan draws the gases through the furnace and the combustion air into the furnace. An induced draft fan makes high stacks unnecessary. Control is accomplished by regulating the fan speed or damper operation. An induced draft furnace is operated slightly below atmospheric pressure.

Forced Draft
A forced draft furnace uses a fan or blower to force combustion air through the system. Control is accomplished by regulating the fan speed or damper operation. This type of furnace is operated slightly above atmospheric pressure.

Balanced Draft

Furnaces equipped with both ID (Induced Draft) and FD (Forced Draft) fans are called balanced draft systems; see Figure 1. In balanced draft systems, the forced and induced draft fans are used together to move the combustion air and flue gases through the system. One fan is used to regulate the air flow through the unit while the other is used to regulate the furnace pressure. Balanced draft furnaces are typically operated slightly below atmospheric pressure, although they can be operated slightly above atmospheric pressure as well.

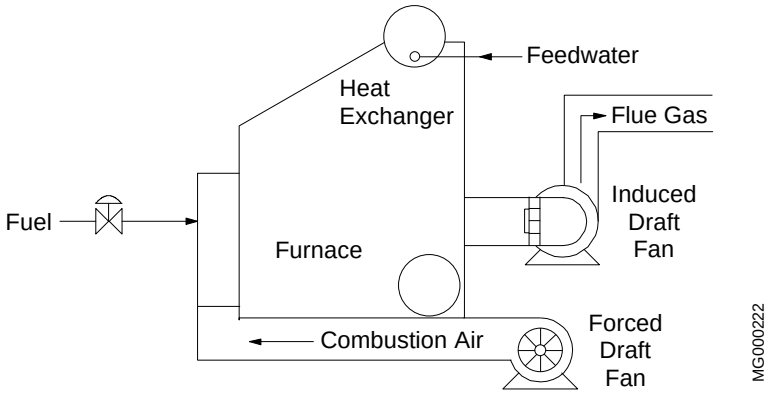

FIGURE 1 Typical Single Burner Boiler

MEASUREMENT

Furnace pressure control is typically implemented in balanced draft operations. Most often the furnace pressure is maintained just slightly below atmospheric pressure to prevent flue gas leakage to the surroundings. However, too low a pressure must also be avoided to minimize air leakage into the furnace reducing efficiency and, in the extreme case, to prevent furnace implosion.

Normal ranges are compound with spans on the order of 1 inH_2O or less. This creates a challenge for most analog transmitters as such narrow spans generally amplify process noise created by pulsations from the varying rate of combustion as well as the ID and FD fans.

A smart draft transmitter is appropriate for this application. The selected instrument should have at least a span of 0.2 inH_2O and adjustable damping. This will allow use on a wide variety of furnaces.

CONTROL

Furnace (draft) pressure control is used to maintain a constant furnace pressure. This can be accomplished by a single-element feedback control loop. In this application, the air flow is controlled by the forced draft fan, while the furnace pressure is regulated by the induced draft fan. Controlling the air flow via the forced draft reduces the interaction between the air flow and the furnace pressure control loops.

When used, furnace pressure control is typically implemented in a feedforward fashion. As shown in Figure 2, the FD fan damper is generally manipulated by the air flow controller, and the ID fan damper is manipulated by the furnace pressure controller. When the air flow controller manipulates the flow, the furnace's internal pressure will be disturbed unless there is a corresponding change to the flow out of the furnace. An impulse feedforward connection couples the two dampers to minimize the furnace pressure disturbance on a change in air flow. As the impulse decays, external reset feedback to the furnace pressure controller drives the integral component to maintain the new steady state ID damper position. The furnace pressure controller trims the feedforward compensation as required to control the pressure at setpoint.

Control problems can result from the inherent noise of the combustion process and the relatively sluggish response of fans, dampers, or couplings in removing the large volume of hot gases. A positive pressure excursions may discharge flue gas and ash into the boiler house. The typical solution to this problem is to control at greater negative pressures to prevent upward excursions from reaching the positive pressure region. In some very large boilers, extreme negative excursions may implode furnace walls.

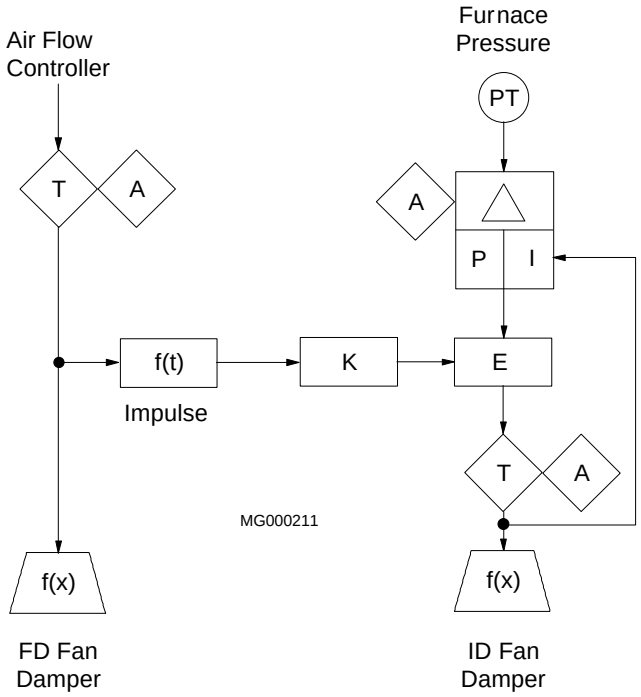

FIGURE 2 Furnace Pressure Control

In order to compensate for the dynamic problems encountered in furnace pressure control, advanced control strategies such as input filtering, damping, feedforward, lead, lag, and/or adaptive gain are often required. Typical analog control systems can require several panel or rack-mounted devices to implement these strategies. The versatile combustion management solution from Moore has the required functions built-in for a complete furnace pressure control system.

The following table lists typical instruments for a furnace pressure control system. This list is a guide. Consult your Moore representative for more information.

Instrumentation List

ITEM	MODEL
Draft Transmitter	340DABSAAB5N113
Controller	353A2FNNNNNNNA4

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