The Impact of Combustion Controls

Safety Note

Do you know if your current system is up to date or accurately controlling the combustion process for your equipment? Learning more about combustion controls can help to sort through these questions as well as improve the operation of your fuel-fired systems.

Combustion controls regulate a fuel-fired system's air and fuel inputs to maintain the air/fuel ratio within the limits that are required for proper combustion. These ratios are maintained throughout its operating range, as specified by the burner manufacturer for the application, in accordance with demand. Any application such as an oven, furnace, boiler, kiln, dryer, heater or incinerator can realize added benefits through updates or modifications to its combustion control system. These advantages can include safer operation, improved reliability, increased efficiency, lower operating costs, decreased startup times, simplified maintenance and much more. When comparing the various control systems available, though, how do you know which system will prove most beneficial for your operations?

Air/Fuel Mixtures

Fuel and air must be delivered to the burner in just the right proportions to produce safe and reliable combustion with the desired amount of excess air. When a burner is operating at the desired air/fuel ratio, it is said to be tuned. This is typically the point where the equipment operates at near peak efficiency, with the best possible emissions for the given burner, and where all of the fuel is consumed. The flame will be stable and the volume of exhaust gases (and therefore emissions) will be minimized.

The exact flame characteristics will depend on the burner type, but a typical flame will be conical in shape and colored blue with pink or orange tips. If not tested and maintained, combustion controls can cause a system to drift off-ratio.

Off-ratio air/fuel mixtures may produce an unstable flame and can result in a variety of unsafe conditions. If the velocity of the air/fuel mixture exceeds the flame front velocity, blow off occurs. This condition is usually noisy and positions the heat from the flame in an undesirable location, which can result in overheating and damage to the refractory or other internal structures. If the velocity of the air/fuel mixture is less than the flame front velocity, flash back can occur. This condition results in flame impingement on the burner, which can quickly degrade the fuel nozzles or air registers.

Four Common Systems

The four most common firing rate control systems are:

1. Parallel Linkage Controlled Systems,
2. Independently Controlled Systems,
3. Cross Connected Systems
4. Fully Metered, Mass Flow Control Systems.

Parallel Linkage, Controlled System

Parallel linkage air and fuel controls utilize a single actuator to control both the combustion air and fuel supply to the burner (Figure 1).

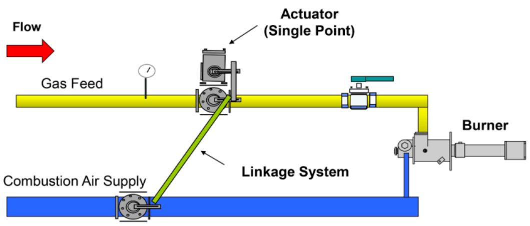

Fig. 1: Parallel Linkage Control System

Proceed with caution when using this control method. It presents the greatest risk of drifting off-ratio because there are two sets of mechanical linkages and only one control valve. Typically, the valves are characterized differently which means that for the same given percent open position, a different flow rate will be achieved. This may result in burners operating at different air/fuel ratios between the high fire and low fire positions. The parallel linkage control systems are most often applied to medium-sized packaged systems. A potential danger exists if the air/fuel pressures and flows change from the original setup due to lack of maintenance or failure of the mechanical linkages. Despite the disadvantages, this can be the simplest and lowest cost control option.

Independently Controlled System

As depicted in Figure 2, independently controlled air and fuel control valves use separate actuators: one for air and one for fuel.

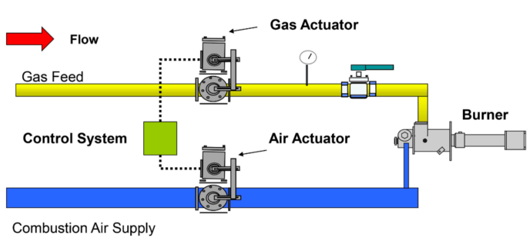

Fig. 2: Independent Controlled Air & Fuel Control System

The actuators may be of the linkage type or direct coupled. Valves are driven to positions determined by the control system programmed curves, feedback from process parameters, and/or air/fuel ratio parameters such as the percentage of oxygen in the exhaust stack. This style of control system is becoming prevalent on all types of equipment.

Cross Connected Systems

Cross connected systems (Figure 3) are found on many types of ovens and furnaces. They work by feeding a small amount of combustion air to a gas regulator (commonly called a ratio regulator) as a reference pressure. The air is controlled by means of a motorized valve, again either linkage based or direct coupled. An increase in heat demand causes the air valve to open more, which leads to a pressure increase on the ratio regulator via an impulse line. A higher pressure increases the level that the poppet valve opens in the regulator, which increases the gas flow. The ratio regulator is set at the factor to deliver a gas pressure equal to the air pressure, but it can be adjusted to deliver either a higher or lower gas pressure by means of a biasing mechanism. The ratio regulator is used to set the low fire gas flow, and a limiting orifice valve downstream of the regulator is used to set the high fire gas flow. There are specific guidelines to follow when setting up a cross connected system. Follow the manufacturer's guidelines to ensure that you are adjusting the correct variable(s), whether it is the firing rate only, the air/fuel ratio only, or both.

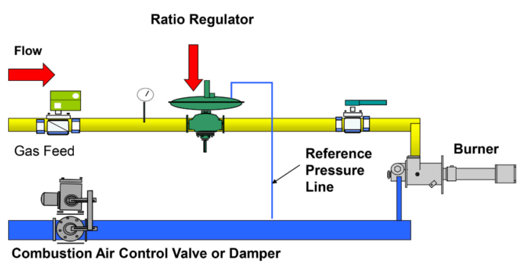

Fig. 3: Cross Connected Firing Rate Control System

Fully Metered, Mass Flow Control Systems

As shown in Figure 4, mass flow control systems automatically compensate for changes that affect combustion performance, such as air and fuel temperature and pressure, as well as combustion chamber pressure. In this case, both the air flow and the fuel flow are accurately measured. For each firing rate, there is one unique set point for fuel flow and only one corresponding set point for air flow.

ABOUT US

Honeywell Combustion Safety is a part of Honeywell Thermal Solutions, an industry leader in commercial and industrial combustion solutions. Honeywell Combustion Safety, formerly known as CEC Combustion Safety, has been in business since 1984. With engineers and staff members that sit on Code committees such as NFPA 56, NFPA 85, NFPA 86, and NFPA 87, our inside expertise is integrated within all of our practices, and our global reach ensures that customers around the world are kept safe. Honeywell offers testing and inspections, engineering & upgrades/retrofits, gas hazards management, training, and field services for all industrial facilities and different types of fuel fired equipment. By assisting organizations and their personnel with the safe maintenance and operation of their combustion equipment, Honeywell aims to save lives and prevent explosions while increasing efficiency and reliability of combustion equipment.

This is similar to the independently controlled system, except that the actual air and fuel volume flows are continuously monitored and corrections are made to compensate for temperature and pressure. This enables the ratio controller to convert the volume flows to mass flows. Generally, the air flow set point is generated as a characterized function of the fuel flow rate.

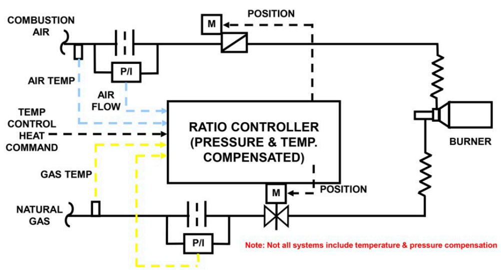

Fig 4: Mass Flow Control System

"Cross limiting" the air and fuel flow rates in this type of system prevents a fuel rich condition by ensuring that the air leads the fuel on a load increase and that the fuel leads the air on a load decrease. Also, this system will automatically shut down if the air/fuel ratio error becomes too large. In addition, full metering systems can be used to fire two or more fuels simultaneously.

This system is more flexible with regard to fuel type than others, but still requires a defined range of fuel heating values in order to generate the modeling curves in the control system. The system may also integrate feedback from oxygen sensors in the exhaust stack to enhance safety by ensuring that the equipment is not operating below the stoichiometric ratio. Performance testing is usually required for mass flow control systems to validate that the ratio of air to fuel is correct and stable throughout the operating range.

Regardless of what type of fuel-fired equipment is used at a facility, combustion controls are critical to maintaining a high-level of performance. Not only will the correct controls enhance a system's output, but they will provide added benefits such as safer operation, improved reliability, reduced emissions, decreased fuel costs, and maximized production. The most desirable system is one that is simple and flexible, but the process generally dictates which control system is best. Even after the system has been implemented, maintenance must be performed on a regular basis to ensure that equipment and controls operate properly.

For more information

Learn more about Honeywell Combustion Safety, contact info@combustionsafety.com, visit www.combustionsafety.com or contact your Honeywell Sales Engineer.

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