

Pulse Firing Doubles Capacity and Cuts Fuel Costs

Why Pulse Fire?

Many industrial manufacturing leaders are learning that the “pulsing” of burners from high-fire to low-fire on furnaces and ovens is the quickest way to reduce costs, improve safety, and meet new emission-level targets. Upgraded systems are enhancing furnace production efficiencies production processes to gain the edge on competition and generate greater revenue/profits. Additional pulse firing benefits include:

- Reduced emissions
- Temperature uniformity
- Greater process control
- Enhanced output
- Extended equipment life
- Improved product quality
- Greater safety
- Fuel savings

Anatomy of Pulse Firing Systems

So, how does it work? Pulse firing is meant for multiple burner combustion systems. In pulse firing, the heat input is controlled on each individual burner by modulating the frequency of high- and low-firing ranges to result in very specific control, flexibility, and precision. The burners are fired at high fire for set periods of time, then cycled to low fire or turned off. This firing cycle is repeated throughout the course of the production period and is monitored by the process controller via the control algorithm within a Programmable Logic Controller (PLC) or pulse control module.

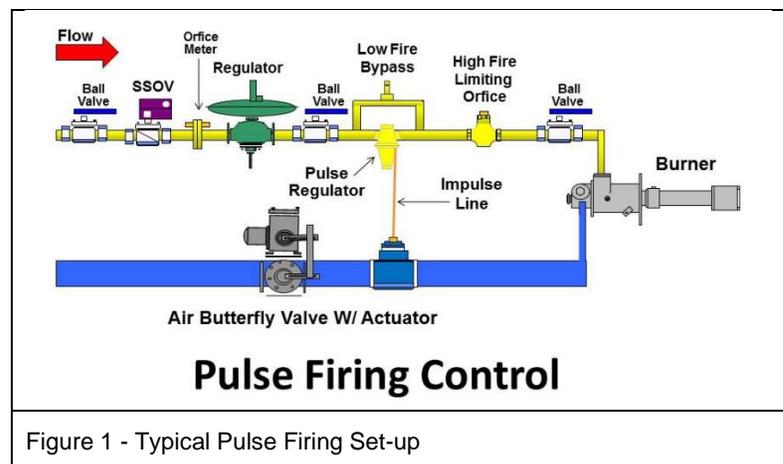


Figure 1 - Typical Pulse Firing Set-up

Rather than the typical linkage controls that modulate air valves, which are often found on combustion systems within the United States, pulse firing requires an air solenoid valve at each burner as well as a ratio regulator on each burner’s gas train for individual burner air/fuel

adjustments. The burners are very reliable and designed for very high duty cycles; 10,000+ cycles. Furnace chamber dimensions must be analyzed also. Sometimes additional burners are added and/or relocated to optimize turbulence and minimize cold spots. If the burner chamber is too large, the pulse firing method would be ineffective, as achieving temperatures, mixing, and uniformity may not be achieved.

Modifications to pulse-fired systems are completed electronically via the PLC or pulse control module. The computer control assures automated, safe, and simplistic start-up. Complicated piping design becomes a non-factor and commissioning time can also be reduced for pulse fired systems compared to traditional cross-connected combustion systems.

Pulse-fired systems are extremely efficient as they operate at high fire and on ratio. The high turbulent chamber mixing shortens temperature ramp up times and increases uniformity which creates ideal situations for higher product quality and production rates.

Equipment itself also sees extended useful life from intermittently operating at its peak firing rate. Specific burner types like Radiant Tube Burners encounter extended tube life from a more uniform tube temperature. Flat Flame Burners maintain their intended flame shape from the high velocity design of pulse-firing; reducing the possibility of flame impingement or rogue flames that damage refractory. Another attractive attribute of pulse firing systems is the innate reduction of burner emissions. When there is low excess air and more gas being consumed, NOx levels are low; helping to meet regulatory emission targets.

The flexibility of being able to tune and control each burner is, by far, the most substantial benefit of pulse firing. Typically, the burners are tuned to one rate, high fire, which allows for straightforward maintenance and troubleshooting, as well as sustained on-ratio air/fuel mixtures. Pulse-firing systems can see up to 30% in fuel savings since they're not constantly firing or adjusting from low to high fire, which can reduce the accuracy of the air/fuel ratios over the firing ranges. And when the pulse fired system is firing, fuel used is benefitting production rather than being wasted lingering in the combustion chamber and escaping through small leaks or cracks; or even worse, accumulating to produce a potentially dangerous situation.

Benefits in Application

A Fortune 500 Metals Corporation recently upgraded to a two-zone, pulse-fired control on a car-bottom stress relieving furnace that was operating as a "Class 2" furnace, at temperatures up to 1050 °F. The previous system used a North American pulse system that was obsolete, requiring an increasing amount of maintenance, and couldn't achieve the desired lower temperature setpoints. Each zone on the system contained six Eclipse ThermJet 075 medium velocity burners, which were reused during the upgrade. The new on/off control system operates the burners only at their most efficient high-fire rate. Code compliant burner safety shutoff valves allow for individual burner shutdown. As heat demand increases or decreases, the control algorithm turns on or shuts off select burners; resulting in no optimum fuel usage for those select burners.

Originally, the furnace was pulse fired with optional impulse bleed control for high excess air operation. The pulse controller was an obsolete packaged unit that is no longer available, so it was removed. The existing Allen-Bradley PLC 5 was replaced with a GuardLogix Safety PLC,

which is National Fire Protection Association (NFPA) compliant and provides advanced, configurable safety logic, an human machine interface (HMI) touchscreen with many troubleshooting capabilities (control overview, equipment permissive screens, first out annunciator, etc.), modern pulse-firing controllers with rack mounted burner management system (BMS) units on the control panel door, and new gas valve train components.

The temperature control loop logic in the new PLC maintains up to three sets of proportional integral derivative (PID) constants, which vary the active PID settings and setpoint ramp rates depending on delta T from setpoint. This provides the ability to use more aggressive PID constants and ramp rates when further from the target setpoint, and less aggressive settings when closer to setpoint to prevent overshooting. The Control Loop Setup screen (Figure 2) allows the operator to modify PID settings and provides a pictorial view of the current switch points, as well as identifying which set of PID parameters is in use at the moment. The Control Loop Setup HMI screen and actual temperature trend are pictured in Figure 3.

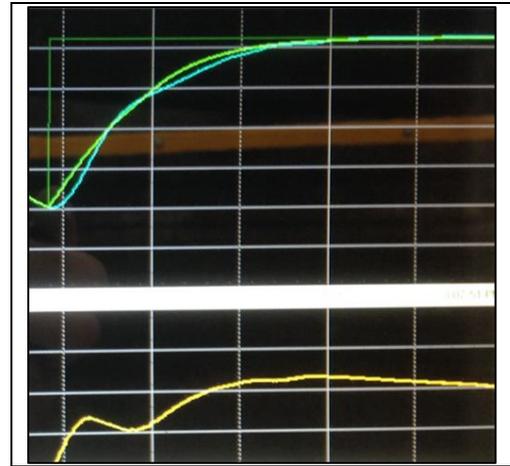


Figure 3 – Control Loop HMI Screen
 Temperature Trend (Dark Green = Target SP,
 Light Green = Working SP,
 Light Blue = Temp, and
 Yellow = PID Output)

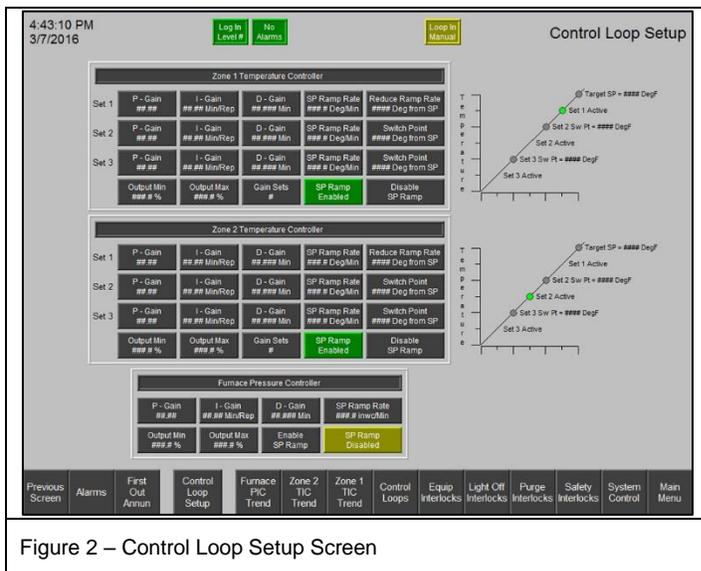


Figure 2 – Control Loop Setup Screen

The System Control Screen provides all control and status information that the operator requires during normal operation. For example, the HMI screens provide immediate feedback as to which burners are at high-fire, low-fire, or off. If an equipment or control problem arises, permissive screens are available that will inform the operator of all inputs that the PLC code is expecting for a certain function. These tools point maintenance personnel to the exact location of a given problem and reduces the time it takes for troubleshooting (Figures 4 & 5).

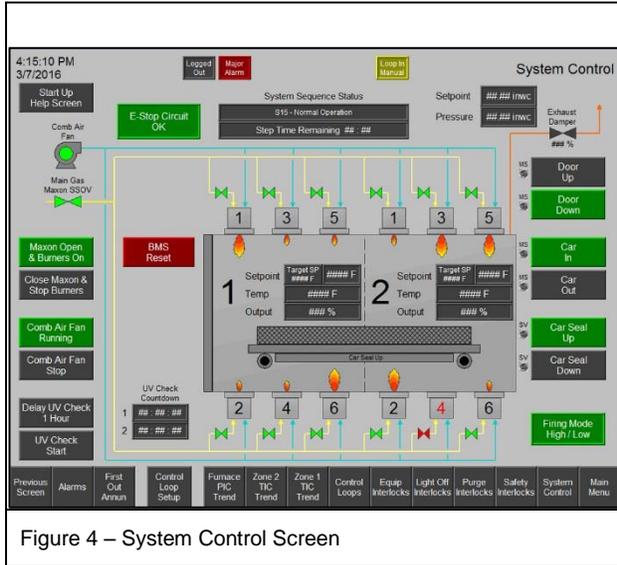


Figure 4 – System Control Screen

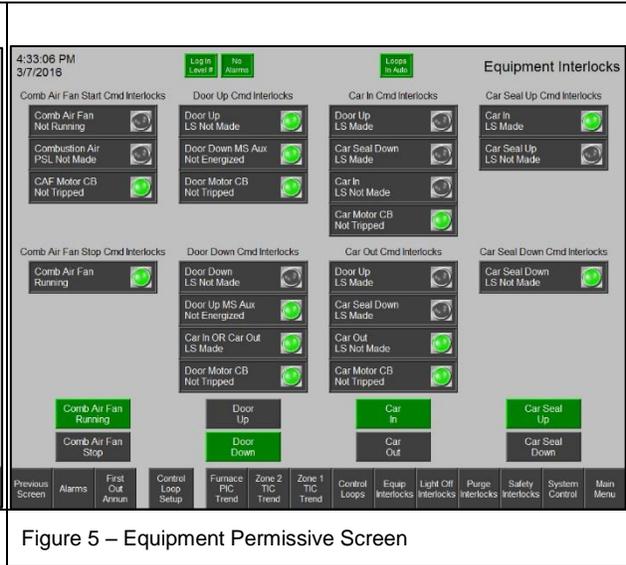


Figure 5 – Equipment Permissive Screen

The result was a furnace that is “operator friendly,” has “Class 1” (± 5 °F) uniformity with accurate pressure control, and excellent turndown via shorter pulse times and very low fire settings while high/low pulsing. With a flick of a switch, the system can be modified to pulse high/off if additional turndown is required. The project took a total of four weeks; three weeks for installation and one week for commissioning. The initial investment will be offset by reduced maintenance times, lower fuel usage (experienced an immediate decrease of 5%), improved temperature uniformity and compliance with NFPA 86 requirements.

Conclusions

Benefits of implementing better process control via upgraded combustion control systems are vast and impactful. Depending on the system's initial set up from air/fuel ratio accuracy, to equipment conditions and in-house maintenance abilities, savings on fuel and production efficiency can be well beyond the standard projections of 20% - 25%. When then comparing the enhanced product quality, the extended longevity of equipment's useful life, and the simplified burner maintenance and procedures, the transition to a pulse fired system, specifically, from current complex combustion designs can be the most beneficial change an organization can make to generate greater savings, and in turn, greater revenue. In today's ever changing world of tighter environmental and safety restrictions, having a head on your competition is vital, and internal process enhancements can enable a sustainable future if simple, efficient, and flexible.

Honeywell Combustion Safety, formerly CEC Combustion Safety, LLC, has been in business since 1984. With engineers and staff members that sit on Code committees such as ASME CSD-1, 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. Contact us at +1 216.749.2992 or visit www.combustionsafety.com for additional information.