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The Benefits of Adding Oxygen Trim to Single Point Positioning or Parallel Positioning Combustion Control Systems

Background

Single point positioning and parallel positioning combustion control systems cannot accommodate operation at peak efficiency unless they incorporate oxygen trim. Single point positioning control systems rely on a single actuator that is mechanically linked to the fuel valves and combustion air damper. Parallel positioning combustion control systems employ separate actuators for controlling the air and fuel flows. The air-fuel relationship for these types of systems is characterized by adjusting linkage angles between the actuators and the controlled elements (the FD fan damper and fuel valves) and by adjusting cams in the fuel control valves. These adjustments are made by the service engineer while using a portable combustion analyzer.

The air-fuel ratio for a given firing rate is often different on increasing and decreasing loads due to the backlash within the actuators and controlled devices as well as the hysteresis in the linkages. Fuel supply pressure changes, fuel BTU content changes, temperature changes and the cleanliness of the FD damper will also impact the fuel-air ratio throughout the year. Single Point Positioning and Parallel Positioning systems are set up with more-than-optimum airflow to accommodate this lack of repeatability. This is necessary to assure that there is always sufficient air to provide safe operation while also avoiding the very large efficiency detriment and smoke emissions associated with incomplete combustion. The down side for these types of control systems is that the additional combustion air provided to overcome their shortcomings results in additional heat loss up the stack and efficiency losses. These losses can only be eliminated by running the boiler closer to the optimum fuel-air ratio.

Discussion

Combustion efficiency can be improved for single point and parallel positioning systems through incorporation of an oxygen trim system. The oxygen trim system incorporates an oxygen analyzer and controller that adjusts the airflow for improved efficiency. The analyzer measures the actual stack O2 and provides an input into the trim controller. An “optimum oxygen vs. firing rate” curve is programmed into the controller based on testing performed by the service engineer. The controller uses this curve to compare the actual oxygen content to the desired optimum set point. The airflow is then biased by the controller until the optimum value is obtained. This system provides consistent efficient combustion throughout the operational range of the boiler.

Conclusion

Boilers with oxygen trim can typically be run at O2 levels that are 1% to 3% lower than systems without the trim. This reduced amount of excess air also results in stack temperatures that are lower. The typical effect of incorporating oxygen trim is an efficiency improvement of approximately 1-3% on reasonably well maintained boilers with single point positioning systems and parallel positioning systems that don't have O2 trim.

NOTE: Some commercial control system suppliers will advertise savings of over 10% to make their systems appear to be better than their competitors. Don't be fooled by overstated claims. Although it may be possible to get savings this large these overstated claims require an exceptionally poor baseline condition that probably could have reclaimed a major portion off the 10% with a simple tune up.

An oxygen trim system will typically pay for itself very quickly. As an example- A midsize package boiler continually producing 50,000 lb/hr of steam will consume over 500 million cubic foot of natural gas in a year. A 2% efficiency improvement for this example results in 10 million cubic feet per year natural gas savings. This same example for oil firing requires approximately 7 GPM of oil and the associated 2% savings would equate to almost 75,000 gallons of oil saved per year.