Improving Burner Control with Online Gas Chromatographs

Background

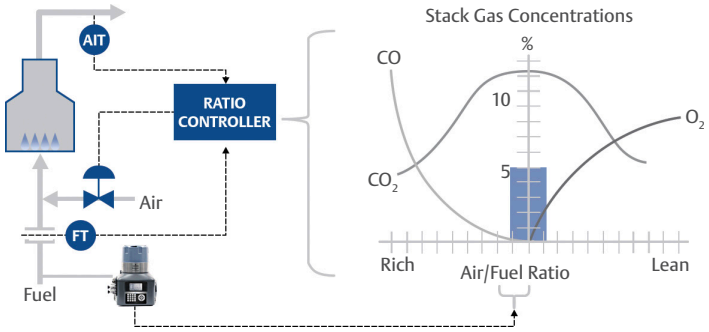
Burner control is critical for power and industrial plants as it affects emissions, energy costs, and process efficiencies. For natural gas burners, variations in gas composition can have direct impact on ability to maintain burner control and desired combustion characteristics, especially if the variations are rapid or transient. The magnitude of the impact can be severe with unstable combustion, ignitability problems, increased emissions, and burner noise. Historically, natural gas composition has been relatively stable. However, significant developments and diversification in the supply of natural gas (such as shale gas and liquefied natural gas imports) means that consistent gas quality can no longer be assumed.

Emerson offers low-cost, reliable analytical packages for natural gas combustion processes to help monitor and control for the changes in gas composition and gas quality. These packages improve burner control, improve efficiency, and reduce emissions. Our gas chromatographs (GCs) provide a reliable natural gas heating value (British Thermal Unit or Calorific Value) measurements, component composition, and physical properties to be used in feed-forward control strategies in a burner control system to help ensure optimal emissions, costs, and efficiencies. Unlike other analytical devices, the GC is capable of providing individual component concentrations, not just calculated indexes or inferred measurements. In addition, since the GC is the same analyzer used and approved by the natural gas transmission industry for custody transfer applications, it provides a trusted measurement that can be used to check and validate energy billing from suppliers. Furthermore, our Rosemount 370XA Gas Chromatograph addresses the perceptions that a GC has high maintenance and operating costs and requires experienced analytical engineers to operate.

Calculating Air/Fuel Ratio

The typical air/fuel ratio controller uses CO_2 and oxygen concentrations from the flue gas analyzers to control air/fuel ratio within the optimum combustion region. The emissions in the flue stack are monitored and fed back into the air/fuel ratio controller as a feedback loop. When the gas composition changes, the emissions will change outside of the optimal zone, and the air/fuel ratio will be adjusted accordingly. Using a gas chromatograph allows for a feed-forward control with its ability to provide information on gas compositional changes to the ratio controller before the combustion of the gas, and therefore before emissions are adversely affected.

This provides a method to adjust the air/fuel ratio before increased emissions or hydrocarbons are found in the flue stack.



Determining Gas Composition

Using a gas chromatograph to determine the gas composition provides insight into the fuel quality variations from the gas supplier. The gas composition is critical in some process industries as even small variations in compositions can cause significant process upsets if adjustments to the process are not made when the gas composition changes. Burner noise, flame stability, mixture ignitability, and emissions can be affected if the gas composition changes. Not only can changing gas composition cause process upsets and impact performance, it can cause burner instability issues like flashback, combustion dynamics, vibrations, and noise that can significantly damage equipment such as turbines. One major turbine manufacturer states “a permanent gas chromatograph shall be furnished in the plant’s main gas supply line” should there be variation in the composition of the gas.

The Rosemount 370XA Gas Chromatograph offers the industry standard C6+ measurement method for determining the gas composition and physical properties. This method determines the individual composition for each of the hydrocarbons from methane to normal-pentane, nitrogen, and carbon dioxide, and combines heavier hydrocarbons (hexane, heptane, octane, etc.) as a “C6+” component. From the composition, the energy content, specific gravity, Wobbe Index, and other physical properties are determined using calculations from international standards such as ISO 6976, GPA 2172, and AGA 8. The C6+ measurement is the standard that

governs custody transfer transactions, and therefore provides a direct method of ensuring the energy used matches the billing from the gas supplier.

In some applications, liquid hydrocarbons entering the burner can cause significant damage to the equipment, such as high performance gas turbines or adversely affect product quality, especially in glass manufacturing and rich gas measurement where the likelihood of liquid hydrocarbons increase. For these applications, the Rosemount 700XA C9+ Gas Chromatograph provides an extended analysis and hydrocarbon dew point monitoring, ensuring a method of protection against hydrocarbon liquids.

Wobbe Index for Burner Optimization

Two unique fuel gas compositions may have the same energy content but behave significantly differently in the burner. This is because different amounts of diluents (nitrogen and carbon dioxide) and different ratios of the hydrocarbons result in different densities and thus different velocities through the burner restrictors. The Wobbe Index is the ratio of the energy value to the specific gravity (Wobbe Index = Energy/√Specific Density) and provides an index related to how the fuel will act through a burner and delivers a better variable to control the air/fuel ratio.

$$WI = \frac{LHV}{\sqrt{SG}}$$

Changing Perceptions

To many, a gas chromatograph is a complex analyzer that is difficult and expensive to operate and maintain. However, the Rosemount 370XA Gas Chromatograph is designed with ease of use in mind to ensure that operators and maintenance personnel who may never have used a gas chromatograph before can quickly and easily start up, operate, and maintain the GC effectively. It comes with easy-to-use software assistants, contextual help, and built-in diagnostic functions to make operating the gas chromatograph easy and intuitive. The software assistants, such as the Start-up Assistant in the local operator interface, guide you through changing the calibration gas, optimizing valve timing, and replacing the analytical module of the GC. The help and diagnostics built-in functions provide fast support on common tasks and include a Diagnostic Tool that automatically gathers diagnostic data and creates an email to send to a technical expert for review.

The Cal-Gas Saver feature of the 370XA GC significantly reduces the operational costs of the GC by reducing the calibration gas usage to less than half that of other GCs. This not only offers direct savings on the calibration gas cylinder, it also means less time replacing gas cylinders and the option to use smaller calibration cylinders to reduce the installation footprint of the GC. In addition, the 370XA is capable of operating on either helium or hydrogen carrier gas, providing another means to reduce gas consumption.

To further simplify maintenance, the 370XA has the industry's only Maintainable Module™. This module includes the columns, thermal conductivity detector (TCD), analytical valves, and solenoids that can be quickly be removed and replaced to reduce downtime, but can also be maintained and repaired to reduce costs. The process of replacing a module can be done in the field in less than three hours, including warm-up time and purge, greatly reducing downtime and overall operating costs.

The Rosemount 370XA Gas Chromatograph provides a reliable, online measurement of natural gas composition to allow more efficient and precise control of the burners with a variable incoming gas supply. The focus on ease of use and the reduction of utility and maintenance costs in the design of the 370XA makes it an easier and cost-effective GC to install, operate, and maintain.

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