Oxygen Measurement Improves Efficiency and Product Quality in Cement and Lime Kilns

The measurement of oxygen (O_2) inside a rotating kiln provides a good indication of combustion efficiency. This oxygen measurement can also provide an inferred indication of calcining rates and the production of thermal NO_x. Maintaining a consistent oxygen level can prevent variations in product quality.

New Design Addresses Application Difficulties

The zirconium oxide (ZrO_2)measurement technology has become the standard for measuring oxygen in any combustion processes. A measurement accuracy of +/- .05 % O_2 is achievable, and the sensing cells are very robust. However, some application difficulties hamper getting a suitable measurement of oxygen in a rotating kiln.

Particulate

The flue gas exiting from the kiln presents the best opportunity for measuring oxygen, but heavy particulate levels prevent the use of extractive methods without extensive filtering and sample conditioning systems, and the associated high maintenance required of such systems. In Situ O_2 probes place the sensing cell at the end of a long probe, and use passive filters with no educator, sample pump, or other method of inducing flow into the analyzer. The flue gases simply diffuse into the sensing cell on the end of the probe, and the diffusion element filters last for many months.

Tramp air

Getting an unbiased flue gas stream to measure is another challenge. While kilns will typically utilize “leaf seals” to minimize the amount of ambient air that gets drawn in between the rotating kiln and the stationary feed box, some upwards biasing of the flue gas O_2 levels is usually observed, depending on the quality and age of the seals. There are a couple of methods of minimizing this biasing of “tramp air”:

1. Testing with a portable analyzer and long sample probe to discern the “core” of the flue gas flow, ie. area inside the flue gas ductwork exiting the kiln where the oxygen least affected by the tramp air.
2. Utilize a long in situ probe, angled past the rotating seal. See figure 2.

Figure 1- Proper installation of an oxygen probe in a rotating cement kiln

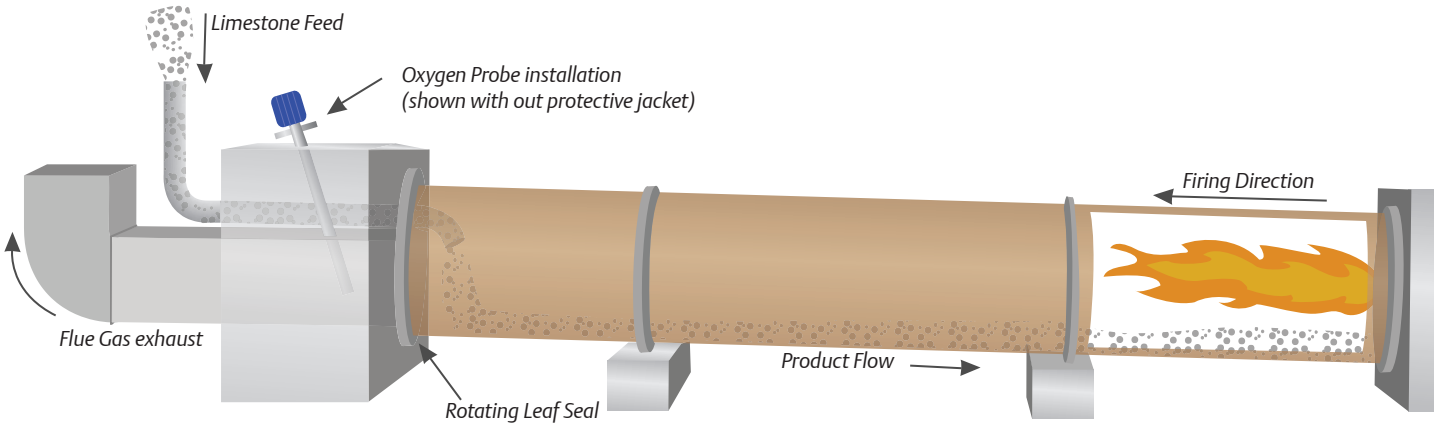

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Figure 2 - Rotating Kiln

Figure 3 - Long probe inserted down through feed box

Flue Gas Temperature

Lime kilns and longer cement kilns may operate below the 700 °C (1300 °F) maximum temperature of an in situ O_2 probe. Flue gases may reach over 1000 °C (1832 °F) in other kilns, however. In these instances a “Probe Mounting Jacket” can be used to simultaneously reduce the flue gas temperatures the probe sees, and also provides physical protection for the probe.

Figure 4 - View from inside of kiln, a long In Situ O_2 probe inside an abrasive shield, being supported by the limestone feed tube

Addressing upset conditions

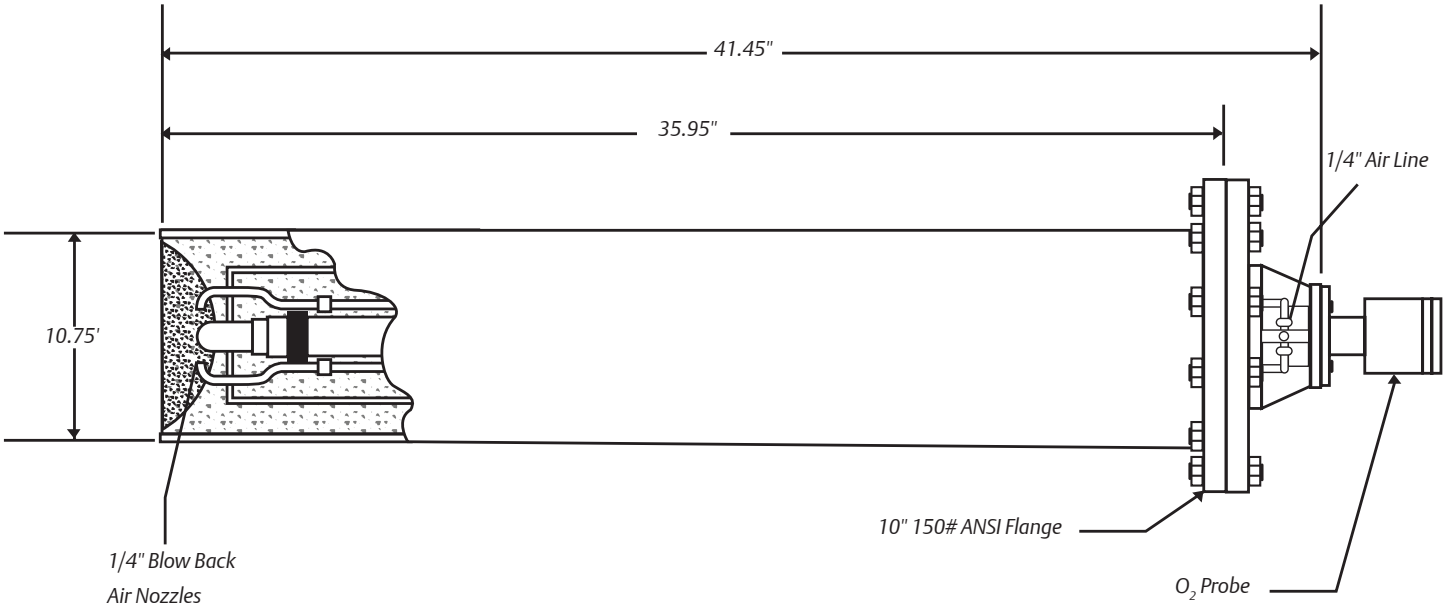
Kilns may burn multiple fuels and/or hazardous waste, and the BTU input at the burner may vary from time to time, causing temperature excursions above normal operation. Rosemount Analytical’s Xi electronics permits continued operation above normal heater set-point by turning off the probe heater, and calculating the O_2 level on the fly based upon the flue gas temperatures. Probe life is reduced by operation above 700 °C (1300 °F), but measuring through the upset can be important to operators.

Similarly, upset conditions sometimes cause flue gas O_2 levels to drop all the way to zero percent. A "stoichiometer" feature provides the ability to discern the level of a reducing event by establishing a lower O_2 range at deficient levels, such as -1 %. The operator can see the Oxygen levels dropping below zero, and make correction.

Gas Analysis Solutions

Emerson manufactures a broad line of Rosemount Analytical gas analyzers for use in combustion processes. Other analyzers measure CO, SO_2, NO_x, opacity and NH_3 and can be certified for use as Continuous Emissions Monitoring Systems (CEMS). Call Emerson Process Management at 440-914-1261 or toll free in the U.S. and Canada at 1-800-433-6076 for more information and solutions to your gas measuring problems.

Figure 5 - In Situ O_2 probe inside a protective "Probe Mounting Jacket". 1100 °C (2000 °F) maximum flue gas temperature



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