

Measure, analyse and control

The measurement and analysis of kiln, ESP and flue gases is a key factor in cement plant control. Equipment that is tasked with this operation needs to be reliable and accurate to obtain the best-possible performance.

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Gas analysis is a fundamental part of the measurement and control system of any cement plant, for both process and environment. Figure 1 shows the three major measuring tasks in such a facility:

- optimising the kiln operation by minimising the energy cost while maintaining clinker quality
- protective measurements for the electrostatic precipitator (ESP) and coal grinding system, including coal bin
- emissions monitoring in the cement flue gas.

Optimising production at Votorantim Cimentos

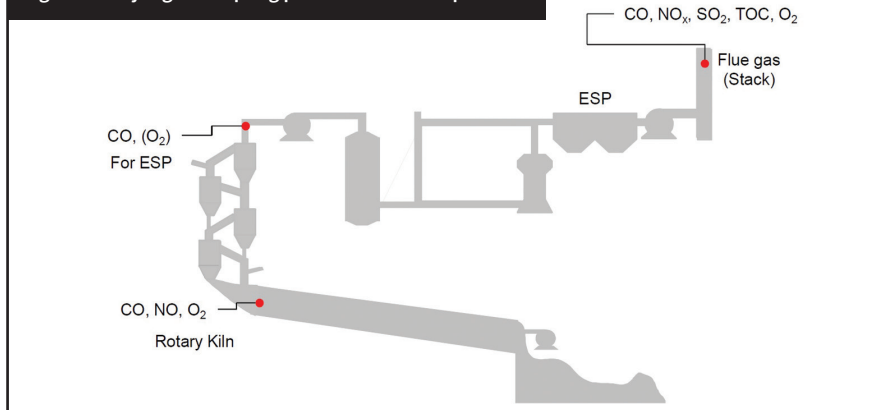
In the past few years, Votorantim Cimentos, Brazil's largest cement manufacturer, has invested significantly in improved process reliability and energy efficiency.

Local cement demand due to the boom in residential and commercial construction, along with the 2014 World Cup and the 2016 Olympic games in Rio de Janeiro, has accelerated the need for cement and construction materials. The modernisation of the Brazilian infrastructure such as ports, airports, roads, railway and power plants will continue to drive this forward.

To optimise cement production and improve market supply Votorantim has invested in 10 rotary kiln sampling systems and ABB's continuous gas analyser. The overall objective of gas analysis in a cement plant is to minimise production costs so that the plant is prepared for the challenges of the global market. Reliable gas analysis helps minimise fuel costs and increases quality. While quality improvements do not reduce production costs, they do raise profitability. Furthermore, unscheduled plant shutdowns are expensive: not only in terms of the costs for hours of work required for repair and maintenance, but more importantly, in terms of the loss of profit.

Gas analysis helps Votorantim to

Figure 1: major gas sampling points in a cement plant



acquire knowledge of the production process and optimise the cement manufacture.

Process measurements

To optimise kiln operation gas components have to be measured continuously, typically at the gas exit from the kiln. Oxygen (O₂) and carbon monoxide (CO) measurements are used to monitor complete combustion. However, realistic combustion is always a compromise between excess O₂ and incomplete combustion, represented by CO. The optimum value depends mainly on the fuel type used (coal, oil, gas or waste).

Furthermore, good clinker quality is the result of stable conditions in the kiln's sintering zone, which depends on temperature. A rapid and reliable indicator of temperature in the sintering zone is provided by nitrous oxide (NO) formed at about 1400 °C as changes in sintering zone temperature alter the NO concentration of the kiln gas (a mathematical correlation between NO and temperature exists). Therefore, quantitative measurement of temperature is not required.

Safety measurement

While burning fossil fuels in a kiln, a sudden increase of CO may occur. The primary cause for this is incorrect control

of the firing system. If the peak develops to a critical high CO level (exceeding the lower explosive limit) the ESP may act as a source of ignition and cause an explosion. It is important to be informed quickly about the incorrect burner adjustment or disturbances in the kiln.

Emissions measurement

Cement plants are by law subjected to emissions monitoring. Typical components to be measured in a plant's flue gas are CO, NO_x, SO₂, O₂ and total organic carbon (TOC).

Kiln gas sampling

Gas sampling at the kiln inlet is challenging due to several factors:

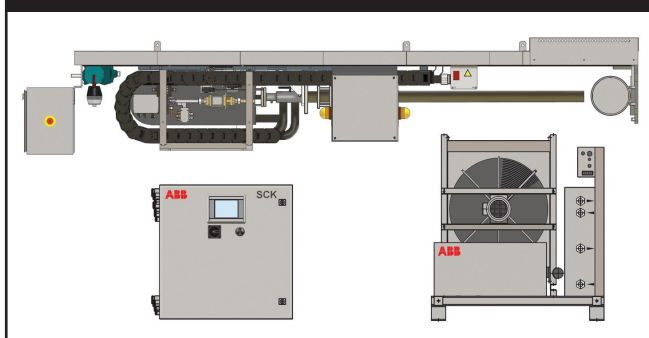
- high temperature (up to 1300 °C)
- high dust load (up to 500g/m³)
- danger of mechanical damage by falling lumps of coating on the sampling probe.

To enable the sampling of gases exiting the kiln in such challenging environmental conditions, ABB has developed SCK, a kiln gas exit sampling system, which includes protective covers to allow for outdoor installation.

The SCK consists of three modules (see Figure 2):

- probe retractor with pneumatic motor and a chain-driven, water-cooled probe

Figure 2: SCK rotary kiln system – probe retractor, control and cooling units



- control unit with industrial controller and menu-driven touch panel operation
- cooling unit with speed-controlled heat exchanger and cooling water circulation pump.

The retractor with its pneumatic chain drive carries the gas sampling probe in a double-beam construction. While the probe can be completely retracted, an integrated pneumatically-driven kiln flap closes the sample opening (see Figure 3), thus preventing hot and toxic gases, that could be hazardous for operators and machinery, exiting the kiln. A complete top cover protects the moving parts from dust. Due to the design of the retractor, the tip of the probe is available for inspection and cleaning purposes at all times.

Two different water-cooled probes for the kiln application can be offered: Probe H (see Figure 4, right) is preferred where extremely hard encrustations are to be expected. The pneumatically-driven plunger, which is welded on the filter tip, mechanically breaks up the encrustations at the probe gas entry point without interruption of the measurement. Probe 60S (see Figure 4, left) is the choice for kilns where extremely hard encrustations are not expected. Different from other probes on the market, the tip of Probe 60S has a dedusting effect, which reduces the dust levels entering the sample.

The SCK controller unit includes an industrial controller and is operated by a menu-driven touch panel. The controller handles all probe manipulation like back purge and removing the probe, and monitors all critical states such as the temperature of the cooling water. The controller is completely menu driven for easy commissioning and configuration of cleaning cycles, limit values and periodical sampling according to the operator's needs, without any complicated PLC

programming. Program sequences can be displayed to easily follow the SCK's routines.

The operator has remote control of the SCK system via a Profibus connection, enabling retraction, insertion and back purging of the probe. Moreover, the control unit offers remote diagnosis through standard Ethernet connection. When no Ethernet is available, all relevant data can be downloaded via a USB stick.

Cooling of the sample probe is mandatory due to the prevailing conditions. The cooling system uses a closed water circuit for safe and environmentally-friendly cooling. Analogue sensors continuously monitor water flow, temperature and pressure. This gives the operator complete control of the system conditions.

The SCK can be used separately as a sampling system to individually designed gas analysis systems or combined with the ACX system based on Advance Optima.

Continuous gas analysis

The Advance Optima series of continuous gas analysers is a multi-analyser system,



Figure 5: Advance Optima series, AO2040 (wall mount) and AO2020 (rack installation)

Figure 3: sampling probe entering the kiln

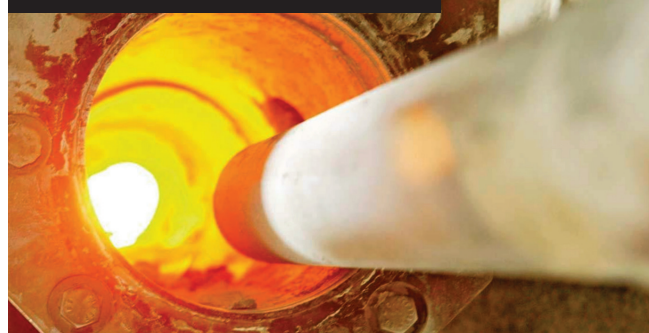
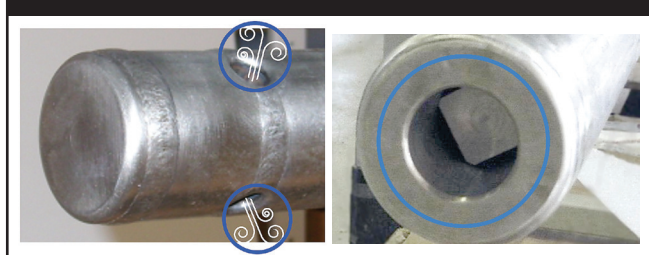


Figure 4: water-cooled probes for kiln gas sampling – Probe 60S (left) and Probe H (right)



combining different analyser modules for the highest flexibility. It features integrated self-control and monitoring of all process-relevant components and is driven by a simple, user-friendly human-machine interface (HMI). It can be used in almost any kind of industrial production and has proven its reliability in the toughest process environments, for example cement plants. Advance Optima offers a broad selection of diverse analyser technologies from infrared and ultraviolet photometers, paramagnetic oxygen analysers and flame ionisation detectors to laser technology.

With one central unit Advance Optima is able to measure up to six gas components simultaneously and operate up to four free combinable analyser modules. This saves space and cost, minimises installation work and simplifies analyser operation.

To provide reliable performance and easy operation, the gas analyser offers a comprehensive automatic calibration feature using certified internal calibration cells. As a result the use of test gas cylinders is not necessary for most applications. Advance Optima is able to monitor the correct functions of coolers and pumps from the sample handling system. An integrated programmable logical controller (PLC) allows function block programming like stream switching, back-purge and other useful features, for which ABB has achieved international certifications from independent test institutes. ■