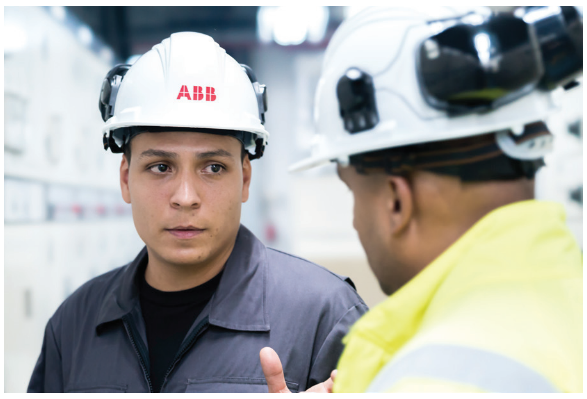
Cement plant

GAS ANALYSERS FOR BURNER CONTROL, FLUE GAS TREATMENT AND CEM IN CEMENT MAKING

Steel and cement are essential for construction of modern infrastructure. Roads, bridges, tunnels, tower blocks and waterworks - they all rely on these durable building materials. Concrete, which is made from cement, sand and aggregate is the world's most abundant man-made substance.



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Whilst cement is ubiquitous and can be produced at very low cost, cement-making is a highly developed process with sophisticated energy recovery systems and flue gas abatement. It is the perfect place to observe a diverse range of highly sophisticated gas analysers and sample probes for dust, pollutant gases, and greenhouse gas emissions monitoring.

Limestone to cement

The basic raw material for cement-making is limestone. Cement plants are generally located close to quarries to minimise the movement of large tonnages of rock. Clay and sand are also essential. The first stages in cement making are crushing of the rocks and blending of the various ingredients.

The next stages are pre-heating and calcination. During calcination, carbon dioxide is released as the limestone rock is converted to calcium oxide, which is a main constituent of cement.

Carbon dioxide (CO2) is the main greenhouse gas and there is an increasing focus to mitigate CO2 emissions across all sectors. Carbon capture will penetrate cement-making in coming decades to support the drive to decarbonise industry. As CCS systems are implemented, additional gas analysers will be required for process control.

The mixture of crushed rock, clay and sand then flows into a long rotary kiln. It is the hot heart of the process. Close to the burner, the kiln temperature can reach 1,450 °C. This high temperature is ideal for co-combustion of waste materials such as refused derived fuels (RDF) including tyres, mixed plastics, paper, and scrap wood. These are used as low-cost fuels. Many cement plants serve the dual purpose of being a waste incineration facility and are regulated as such in many jurisdictions.

Pulverized coal or petcoke are often used as the primary fuel in cement making. The chemical emissions footprint from the fuel mixture can therefore be highly complex. Mercury, oxides of sulphur, oxides of nitrogen and acid gases such as hydrogen chloride are possible. Furthermore, the heating of the rocks and clay in the calciner and kiln can release a diverse cocktail of gases. Stephen Gibbons, Global Market Manager, Continuous Gas Analysers at ABBs Measurement & Analytics Division confirms that "continuous emissions monitoring systems in the cement sector rely on some of our most sophisticated gas analysers. The ACF5000 FTIR is commonly used for regulated monitoring of the most complex emissions."

Controlling the heart of the process

Gas analysis for burner control in the cement kiln takes place at the entrance to the kiln in an extremely harsh environment. The temperature often exceeds 1000 °C. Lumps of clinker are rattling around. Gibbons says that "of all the gas analysis applications that I know, this is the most challenging in terms of sample withdrawal."

Copyright ABB - SCK probe in a cement kiln

ABB has a specially designed retractable probe assembly for cement kilns, the SCK. Gibbons confirms that "there is a choice of sample probes to fit on the SCK. The 60S model has two sample inlets and an air backflush system to avoid clogging in the dusty atmosphere. For extremely high fouling fuels, such as waste tyres, we recommend the H probe. It has a mechanical plunger to clean the gas pathway." Automated de-clogging systems simplify maintenance and ensure better uptime of the burner process control loop. That translates to better combustion efficiency and easier emissions control for the operator.

In comparison to the extremely challenging sampling conditions, the gas analysis requirement at the entrance to the kiln is simple. Oxygen measurement is the primary process control parameter and is used to adjust the air flow to optimise the combustion stoichiometry. "Our Magnos 27 paramagnetic analyser is the industry-standard for cement kiln oxygen measurement", adds Gibbons.

Golf-ball sized lumps of clinker exit the kiln. After grinding in a ball mill, these become a fine powder that is mixed with gypsum to become cement. Cement particles are so fine that they can flow through a sieve that would retain water. Measurement of pulverized coal, crushed rock and cement dust are equally as important as monitoring of greenhouse gases and chemical pollutants in cement making.

Flue gas treatment

Cement-making is energy intensive. Alongside the calcination reaction, the energy requirements also result in CO2 emissions. Approximately 30% to 35% of the CO2 generated from cement production result from the heat required for the process. Clearly, energy-efficiency is of paramount importance for economic and environmentally sound operations.

One of the main ways that energy is conserved is the counter-current flow of hot flue gases leaving the kiln against the feedstock materials. The flue gases are treated using a range of processes. Some technologies are like the flue gas processing systems in the coal fired power generation sector or waste to energy plants. Others are customised to the needs of cement-making.

Dust removal is the first stage in the flue gas treatment. Bag filters are preferred over the electrostatic precipitation technique, which is common on waste to energy plants.

Coal, petcoke and old tyres are sometimes used as fuel. Also, sulphurous gases can be released from some types of clay or rocks that are fed to the process. This means that about 50% of cement plants operate flue gas desulphurisation. The preferred technology is dry sorbent injection using hydrated lime or sodium bicarbonate. Wet gas scrubbing, which is common on power plants, is avoided because the use of steam and water are not favoured in cement-making due to the high cost of wastewater treatment.

Air is used to supply oxygen to the burner, and this results in oxides of nitrogen (NOx) being formed during combustion. DeNOx equipment is now the default on most cement plants. The vast majority use selective non-catalytic reduction (SNCR). The

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Refuse derived fuel - tyres

alternative, selective catalytic reduction (SCR) is more costly and would be complex to implement in cement making. However, SCR may be required in the future to achieve lower NOx emissions levels as regulations tighten. But, at present, SNCR is adequate for regulatory compliance in most jurisdictions.

To operate the SNCR system, ammonia reacts with the oxides of nitrogen to form nitrogen gas and steam. Either aqueous or anhydrous ammonia may be added to the flue gas. Or an aqueous urea solution can be injected. Urea dissociates at high temperatures to form ammonia. One of the challenges in operating this process is to add the correct amount of ammonia or urea. Over-dosing means that ammonia 'slips' through the process as a pollutant emission to air. Too little means that the reaction is starved of ammonia and oxides of nitrogen are emitted to the atmosphere as pollutant gases.

Process control can be executed with measurement of the NOx concentration in the SNCR inlet with a fine-tuning trim controller to measure the ammonia concentration at the SNCR outlet. This is typically a target of several parts per million. Gibbons says that "a laser is the best device to measure trace ammonia slip concentrations at the SNCR exit. Our LS25 is optimised for these conditions and has proven to be highly reliable in the cement sector."

A further stage of flue gas polishing is conducted using activated carbon. VOCs and mercury are removed.

Copyright ABB, Cement making kiln

Automation and integration deliver value for money

Digital solutions, innovative services and automation are transforming gas analysis instrumentation. Cement producers stand to benefit from the changes. Reduced capex for gas analyser setups, simpler operations and lower long-term costs are the payoffs they can expect. Gibbons believes that "the synergy between digital solutions, great services and excellent hardware means we are working in the sweet spot and providing unrivalled value for money to our customers".

Maintenance can be avoided if it can be shown to be redundant. That saves time, cost and improves safety. Digitalised services, such as the ABB Ability™ Condition Monitoring solution, have enabled ABB's service teams to work with operators of gas analysis instrumentation to review the health of their analysers, on site or remotely, to anticipate failures before they occur.

Integrating gas analysers also means value for money. "Our product range has been designed to minimise the total project cost", confirms Gibbons. "Take the example of combustion optimisation. Our EasyLine range can combine several gas analysers with one controller."

Some ABB devices, such as the Uras26 Infrared gas analyser have two measurement channels which can be used for simultaneous carbon monoxide (CO) and CO2 measurement. That is an ideal solution for monitoring the catalytic conversion of CO to CO2 which is increasingly being used on cement plants to mitigate CO emissions.

Bailed refuse derived fuel, RDF

Author Contact Details

Stephen B. Harrison. sbh4 GmbH • Kranzlstraße 21, 82538 Geretsried, Germany • Tel: +49 (0)8171 24 64 954 • Email: sbh@sbh4.de • **Web: www.sbh4.de**

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