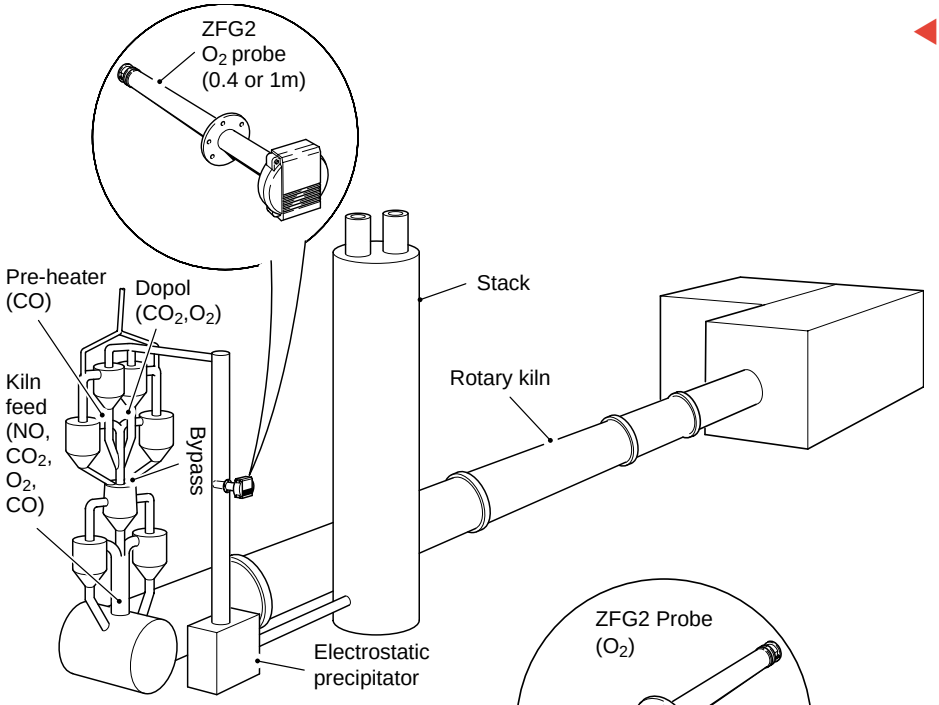
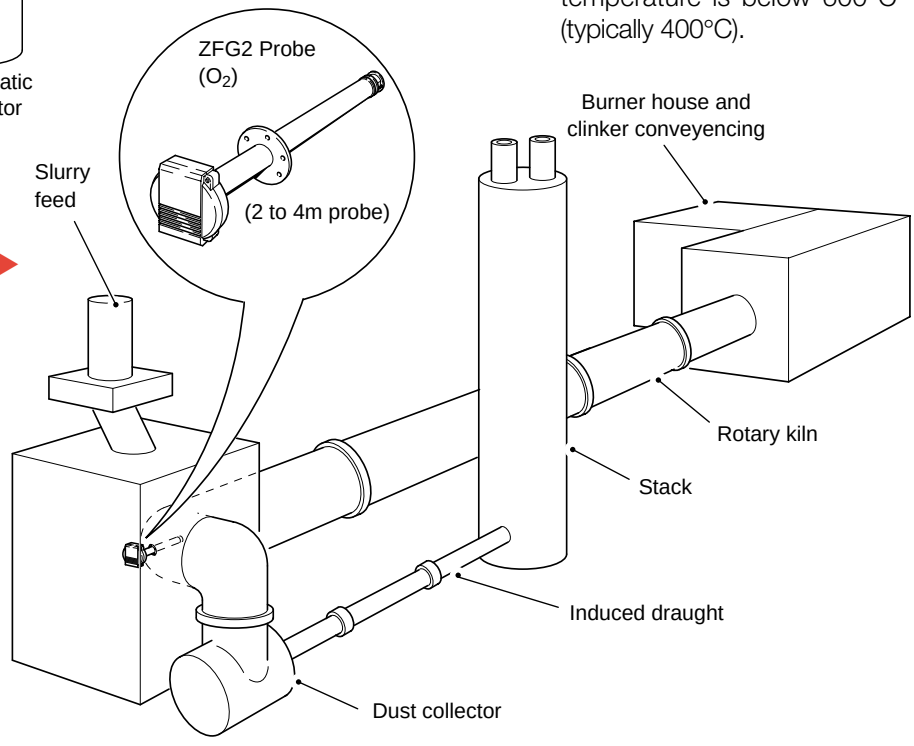
# Oxygen Monitoring of Kiln Waste Gases in the Cement Industry




The illustration on the left shows typical points of measurement for $0_2$ and other gases on a dry process cement plant. For combustion control purposes the ideal point of $0_2$ measurement is at the Kiln Feed. However, due to the high temperature and length of $0_2$ probe required, the measurement is not possible by means of an in situ Zirconia probe at that point. The Zirconia probe is therefore installed at the pre-heater outlet, prior to the electrostatic precipitator where the temperature is below 600°C (typically 400°C).




The illustration on the right shows typical points of measurement for $0_2$ and other gases on a wet process cement plant.

Due to the evaporation of water from the slurry the temperature of the waste gases is reduced to 300°C/400°C at the kiln feed point. It is therefore possible to use the ZFG2 probe at that point to measure the $0_2$ level in the kiln waste gases.

## Why use $O_2$ Monitoring in Kiln Gases?

**The customer needs:**

- To ensure efficient combustion of fuel.
- To minimize heat loss.
- To minimize power consumption by ancillary plant.
- To minimize emissions and enable accurate emissions monitoring.

## Why use ABB Instrumentation?

- ABB offer greater security at a lower cost by having:
  - proven reliability – over 100 years of process instrumentation experience and over 27 years applicational experience in Zirconia oxygen analysis,
  - full installation, commissioning and routine servicing facilities available, plus a worldwide network of companies and agents to ensure backup in most areas.
- Transmitters and probes designed, manufactured and supported by the same company.
- Comprehensive range of field-proven products available.

## What ABB products are suitable?

- **ZFG2/ZMT or ZFG2/ZDT Zirconia Probe Systems:**
  - the ZFG2 probe is truly in-situ, requiring no sampling,
  - probes lengths available, 1.0m, 1.5m and 2.0m – to suit all applications,
  - low maintenance requirements and unique design features, ensure low cost-of-ownership – even under the most arduous conditions,
  - fully site-serviceable, requiring no special tools over the life of the probe,
  - long intervals between calibration (the ZMT auto-calibration option reduces the need for routine attention),
  - innovative sensor technology gives long sensor life (from 4 to 10) years on normal applications and reduced long-term drift,
  - speed of response is maintained over long time periods on the dirtiest applications,
  - our probe design ensures system accuracy is maintained over the full working process temperature range without recalibration.

## Installation

- The IP rating of the probe ensures trouble-free operation on both indoor and outdoor installations.
- The ZMT/ZDT transmitter can be mounted adjacent to, or up to 100 metres from the probe.
- Auto-calibration option reduces need for routine attention.
- The ZFG2 probe can be mounted in any orientation.

## Process Description

### Basic Measurement/Analysis Theory

All Zirconia oxygen analyzers, whether extractive or in-situ type, utilize a ceramic (Zirconia) solid electrolyte sensor which is specific to oxygen.

When the solid electrolyte temperature is 600°C or higher and a difference in partial pressure of oxygen exists across the sensor, a flow of oxygen ions takes place from the higher to the lower partial pressure.

Air is used to give a reference oxygen partial pressure on one side of the sensor against which the sample is compared on the other side.

Accurate sensor temperature control and compensation for process temperature generated thermoelectric effects ensure accurate measurement under all normal process conditions.

On-line manual (semi-automatic) or automatic calibration is either single point or two-point by means of test gas injection.

### Combustion Control

For complete combustion of fuel an excess of air is required, the level of which is dependent on fuel type, burner design and kiln design.

Air consists mainly of Oxygen (20.95%) and Nitrogen (78.08%. As Nitrogen contributes nothing to the combustion process, but removes heat from the process, it is essential that the excess air is kept to a level which gives maximum efficiency.

This optimum level may vary considerably according to the kiln loading and is measured by oxygen content in the waste gases.

### Plant Efficiency

To ensure efficient combustion control is maintained under all normal operating conditions it is essential that all fans and dampers operate effectively and efficiently.

Failure to maintain these conditions and eliminate air leakage into the system will require higher fan loads.

### Emission Monitoring

For calculation of the total emissions ($SO_2$, $NO_x$, $CO_2$, etc.) over a given time period, the total gas volumes must be known. Gas volumes are normally calculated from the $O_2$ value measured on a dry basis (extractive system).

If the water vapour content of the stack gases is known, a dry value for $O_2$ can be calculated from the wet (in situ) value.

Alternatively, the probe must be used in an extractive ‘dry’ measurement system to give a true 'dry' $O_2$ measurement.

# Other ABB Monitoring Capabilities Suitable For Cement Plant

**Industrial Applications:**

- Recorders and recorder/controllers:

**Flow Applications:**

- MagMaster flowmeters.
- Pressure transmitters.

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