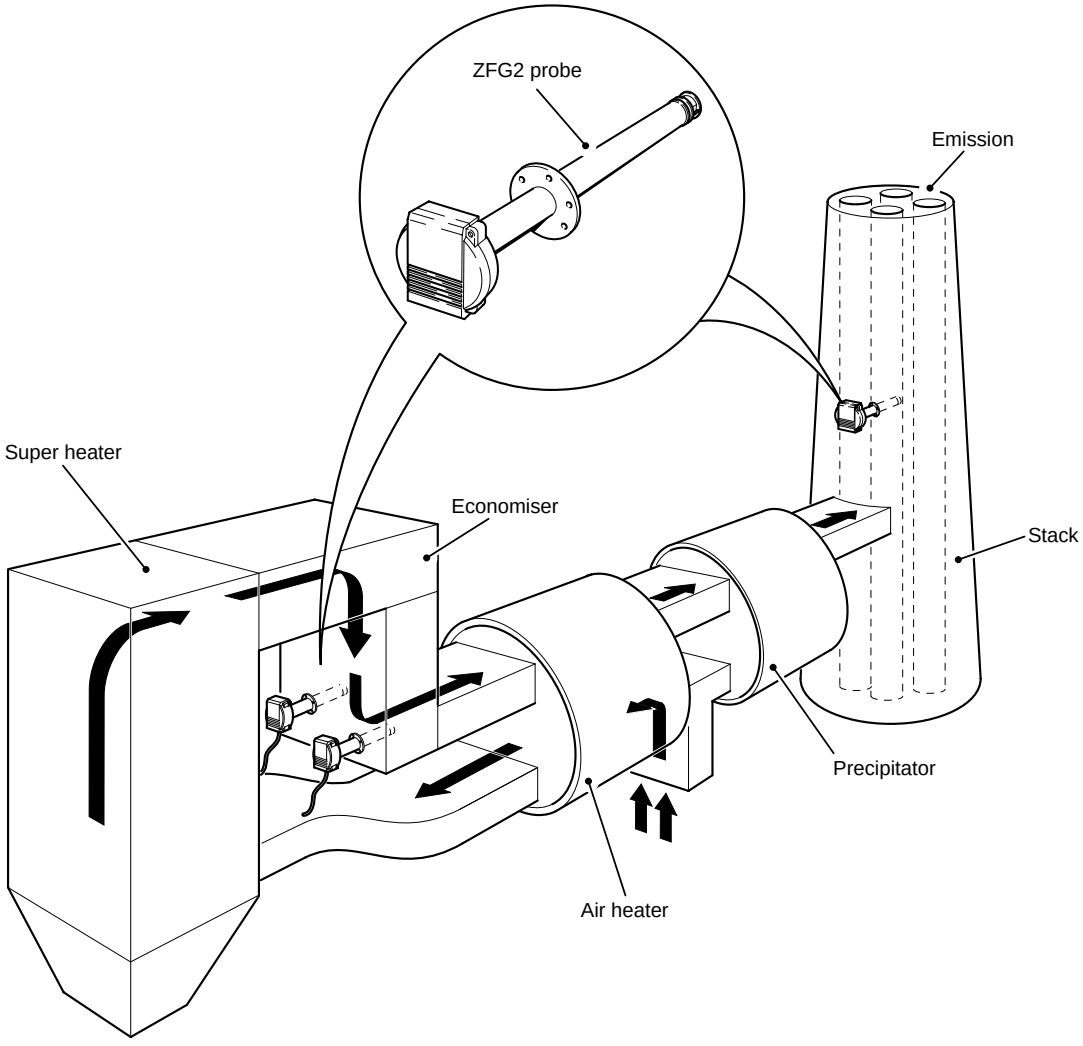
Application Guide
AG/AI–017_4

Oxygen Monitoring in Stack Gases in the Power Industry



The illustration above shows typical installation points on a coal fired plant. For combustion control (efficiency) purposes, single or multiple probe systems will be used according to the duct size per economizer outlet.

On large plant of 250MW or more, this may involve two or three economizer outlets. Additional probes may be mounted downstream monitoring air ingress to ensure efficient operation of fans and dampers.

Due to centrifugal forces, fly ash is concentrated towards the duct outer wall following bends in the duct. For this reason, probes should not be mounted at such locations, thus avoiding erosion due to the high velocity and high concentration of abrasive ash. Oil and gas fired plant do not present such problems.

Why use O_2 Monitoring in Stack Gases?

The customer needs:

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

Why use ABB Instrumentation?

- ABB offer greater security at a lower cost by having:
  - a worldwide network of companies and agents to ensure backup in most areas,
  - proven reliability – over 100 years of process instrumentation experience,
  - a range of cost-effective Zirconia oxygen analyzer systems with long-term reliability,
  - a choice of probe lengths and design options to meet the demands of various applications,
  - unique design features, ensuring low cost-of-ownership,
  - full installation, commissioning and routine servicing facilities available.
- Comprehensive range of field-proven products available.
- Transmitters and probes designed, manufactured and supported by the same company.

What ABB products are suitable?

- **ZFG2/ZMT Zirconia Probe System:**
  - the ZFG2 probe is truly in-situ, requiring no sampling,
  - low maintenance requirements – even under the most arduous conditions,
  - probes are available in various lengths – to suit all applications,
  - fully site-serviceable, requiring no special tools over the life of the probe,
  - long intervals between calibration,
  - the auto-calibration option reduces the need for routine attention,
  - our innovative sensor technology gives long sensor life and reduced long-term drift,
  - speed of response is maintained over long time periods on the dirtiest applications,
  - probe life ranges from 4 to 10 years on normal 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 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 sensor 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 partial pressure against which the sample is compared.

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 boiler design.

Air consists mainly of oxygen (20.95%) and nitrogen (78.08%). As Nitrogen contributes nothing to the combustion 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 firing rate of the boiler (boiler load) and is measured by the residual oxygen content in the flue 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 to maintain the requisite air fuel ratio.

Monitoring for air leakage will normally be differentially across the air heater and at other points downstream.

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 Power Utilities

Analytical Applications:

- Regeneration of the resin beds in both make-up Water Treatment and Condensate Polishing Plants using multi-electrode conductivity systems.
- pH monitoring with associated electrode systems.
- Sodium monitoring.
- Silica monitoring.

Industrial Applications:

- Recorders and recorder/controllers.

Flow Applications:

- MagMaster flowmeters.
- Pressure transmitters.

AG/AI–017 Issue 2

ABB Limited
Oldends Lane, Stonehouse
Gloucestershire
GL10 3TA
UK
Tel: +44 (0)1453 826661
Fax: +44 (0)1453 827856

ABB Inc.
125 E. County Line Road
Warminster
PA 18974
USA
Tel: +1 215 674 6000
Fax: +1 215 674 7183