Yokogawa presents zirconia oxygen analyzers for saving energy and environmental protection

Get a Long Service Life and Stable Operation with a Zirconia Sensor
Sensor Replacement is Easy

- A molecular bonding method completes installation of platinum electrodes, and its inherent connection prevents separation of platinum from the zirconia element
- A lead-less electrode design eliminates electrical disconnection
- Special coating protects the platinum and prevents the sensors from deteriorating or becoming damaged
- No special tool is required for cell replacement. Whenever required, the cell is easily removed by rotating the screws from the top of the probe

Down time (“from the time installation is started until it is completed”) is minimized to approximately ten minutes. After the cell is replaced, the analyzer requires a zero and span calibration only once.

The principle of the zirconia oxygen analyzer is as follows:

At high temperatures the zirconia element, as a solid electrolyte, is a conductor of oxygen ions. Platinum electrodes are attached to the interior and exterior of the zirconia. Heating the element allows diffusion of oxygen ions to the opposite sides of the zirconia creating an oxygen concentration cell. In other words, oxygen molecules gain electrons to form oxygen ions with higher partial oxygen concentrations. These ions travel through the zirconia element to the other electrode. At that point, electrons are released to form oxygen molecules (refer to the chemical formula). The Nernst expression can be applied to calculate the force by measuring the electromotive force $E$ generated between the two electrodes.

$E = \frac{RT}{nF} \ln \left( \frac{P_{\text{O}_2}}{P_{\text{Air}}} \right)$

For the ZR22 cell, temperature is 750°C and the corresponding reactive electromotive force $E$ is $50.74 \times \log_{10} \left( \frac{P_{\text{O}_2}}{P_{\text{Air}}} \right)$
ZF402G/ZR22G/ZR22S
Separate Type In Situ Zirconia Oxygen / High Temperature Humidity Analyzer

- Liquid-crystal touch panel display provides easy operation
- Interactive model displays instructions to follow, including those for: settings, oxygen concentration trends, and calibration operations
- Digital communications features are provided as standard – this enables the analyzer to be maintenance-remote
- Can measure either oxygen concentration or humidity with a single analyzer
- Highly reliable measurements with trend-data graphs
- The zirconia cell and heater assembly can be replaced in the field
- Explosionproof approval ATEX: EExd IIB + H, Group II, Category 2GD, T300°C
  FM/CSA: Class I, Division 1, Group B, C and D, Class II/III, Division 1, Group E, F and G, T2

ZF22G Detector

Achieving accurate O2 measurement in exhaust gas

With the measurement of oxygen in the exhaust gas, the flow of fuel can be controlled for optimum burner efficiency and minimum environmental effects.

ZF402G Separate Type Converter

Complete Operation Display

- Interactive operations along with operation display
- A variety of display modes – enabling you to select the operation mode freely
- Back-light LCD allows viewing even in the darkness
- Error codes and details of errors can be checked in the field without the need to refer to the appropriate instruction manual

Typical Converter Displays

- Example of basic display
- Example of trend display – displays data changes
- Example of setting data display – displays data changes

Self-testing suggests countermeasures for problems

If a problem occurs, the liquid-crystal display will provide an error code and the reason for the problem. This enables prompt and appropriate corrective action to be taken.

Error code Reason for error
E-1 Cell failure
E-2 Abnormal heater temperature
E-3 Defective A/D converter
E-4 Faulty EEPROM
ALARM1 Abnormal oxygen concentration
ALARM2 Abnormal moisture content
ALARM3 Abnormal mixing ratio
ALARM4 Abnormal zero calibration factor
ALARM5 Abnormal span calibration factor
ALARM6 Stabilization time over

One-touch interactive display operation
User-friendly design providing easy operation without having to use the instruction manual.

ZF22S Explosionproof version Detector

The relationship between air Rates and Heat Efficiency

With the measurement of oxygen in the exhaust gas, the flow of fuel can be controlled for optimum burner efficiency and minimum environmental effects.
The basic configuration consists of a probe and a converter. A flow unit and calibration cylinder may be added as required, depending on the application requirements. The optimal probe may be selected from a variety of probes. One type of converter is capable of handling all applications.

**Application and System Configuration**

**Detector**

- High temperature probe (0 to 1400°C)
- For sample gas temperature over 700°C
- Protects probe against dust
- General purpose probe + filter
- Protects probe from being eroded by fine particles
- General purpose probe + probe protector
- General purpose probe + probe supporter
- Various insertion lengths are available: 0.4, 0.7, 1.0, 1.5, 2.0, 2.5, and 3.0 meters

**Application**

- Boiler (fuel oil and gas)
- Boiler (coal/pulverized coal on fluidized bed)
- Heating furnace
- Annealing furnace
- Hot stoves
- Coke oven
- Sintering furnace
- Melting furnace
- Heating and annealing furnaces
- Lime kiln (rotary)
- Lime kiln (vertical)
- Cement kiln (cylindrical exit)
- Glass melting furnace (in furnace)
- Glass melting furnace (in stacks)
- Ceramic baking furnace
- Heating furnace
- Naphtha cracking furnace
- Heating furnace
- Black liquor recovery boiler
- Sludge kiln boiler
- Fining furnace
- Heat treatment furnace
- Window box
- Drying furnace
- Reacting furnace
- Steaming furnace
- Induction heater
- Sludge burning furnace
- Fermentation tank
- Indoor oxygen-deficiency monitoring

**Explosion proof probe**

- Various insertion lengths are available: 0.4, 0.7, 1.0, 1.5, 2.0, 2.5, and 3.0 meters

**Converter**

- 4 to 20 mA DC analog output, input/output isolated, Linear (or log) scale from 0 to 100% by volume of oxygen
- Programmable using 13 items, including four outputs, abnormal, maintenance, calibration, temperature high-alarm, Hi/Lo alarms etc.
- 4 to 20 mA DC analog input, process temperature input
- Programmable using five items, including two contact inputs, calibration-gas pressure decrease alarm, range switching, process alarm, slow-back start etc.

**Application 1**

Example of boiler instrumentation

**Application 2**

Petroleum refinery process fired heater

**Application 3**

Paper machine drying process

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**Probes for high temperature use**

- Process temperature of 0 to 1400°C

If the process temperature exceeds 700°C, use the probe for high-temperature application. For other special application requirements, appropriate probes and associated attachments are available.

**Probe**

Pipe: SIC (Silicon Carbide max. 1400°C) and SUS310S (Stainless steel max. 800°C) available. Insertion length 1.0m, 1.5m
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Sensor Replacement is Easy

- A molecular bonding method completes installation of platinum electrodes, and its inherent connection prevents separation of platinum from the zirconia element.
- A feedless electrode design eliminates electrical disconnection.
- Special coating protects the platinum and prevents the sensors from deteriorating or becoming damaged.

This special tool is required for cell replacement. Whenever required, the cell is easily removed by removing four screws from the top of the probe. Down time (“from the time installation is started until it is completed”) is minimized to approximately ten minutes. After the cell is replaced, the analyzer requires a zero and span calibration only once.

**Principle of Zirconia Oxygen Analyzer**

Electromotive force $E$ generated between the two electrodes.

Expression can be applied to calculate the force by measuring the electromotive force $E$ generated between the two electrodes.

Electrical signal $E$ = electromotive force $E$ = reactant electromotive force $E$

For the ZR22 cell, temperature dependence of the reactivity electromotive force $E = -\frac{50.74 \log (PA)}{mV}$

**SPECIFICATIONS**

**General purpose version**

- **Characteristics**
  - **Measuring range**: Oxygen concentration in combustion exhaust gas and mixed gases (excluding inflammable gases)
  - **Process gas pressure**: Oxygen partial pressure of zirconia element on the reference air side (%)
  - **Temperature**: Atmospheric air: 20.6(%); Instrument air: 21.0(%)
  - **Humidity**: Atmospheric air: 0.5% Maximum value of setting range/month
  - **Pressure**: Process gas pressure $O_2$: -5 to +250 kPa (Non-explosionproof)
  - **Temperature range**: Operating temperature: 0 to 1400°C; ZR402G: -20 to 55°C on the terminal box surface; ZR402G: -20 to 55°C
  - **Accuracy**: Air: ±0.3% of set point/month
  - **Response time**: 95% 20 to 200°C: 15 to 30 seconds
  - **Display**: Digital display
  - **Output**: 4 to 20 mA DC analog output
  - **Contact output**: (1) Abnormal, (2) High-high-alarm, (3) High-alarm, (4) Low-low alarm, (5) Low-alarm
  - **Size**: ø 123, L = 120.2 (Panel thickness)

**Explosionproof version**

- **Characteristics**
  - **Measuring range**: Oxygen concentration in combustion exhaust gas and mixed gases (excluding inflammable gases)
  - **Process gas pressure**: Oxygen partial pressure of zirconia element on the reference air side (%)
  - **Temperature**: Atmospheric air: 20.6(%); Instrument air: 21.0(%)
  - **Humidity**: Atmospheric air: Any setting in the range from 0 to 25 vol% H2O to 0 to 100 vol% H2O or 0 to 0.200 kg/kg
  - **Pressure**: Process gas pressure $O_2$: -5 to +5 kPa
  - **Temperature range**: Operating temperature: 0 to 1400°C
  - **Accuracy**: Air: ±0.3% of set point/month
  - **Response time**: 95% 20 to 200°C: 15 to 30 seconds
  - **Display**: Digital display
  - **Output**: 4 to 20 mA DC analog output
  - **Contact output**: (1) Abnormal, (2) High-high-alarm, (3) High-alarm, (4) Low-low alarm, (5) Low-alarm
  - **Size**: ø 123, L = 190.5 (Panel thickness)

**EXTERNAL DIMENSIONS**

- **Integrated Type General purpose Analyzer ZR202G**
  - **Flanges**: ANSI Class 150 4 RF SUS304
  - **Dimensions**: 258 x 68 x 281~294

- **Integrated Type Explosionproof Analyzer ZR202G**
  - **Flanges**: JIS 5K 65 FF SUS304
  - **Dimensions**: 258 x 68 x 281~294

- **Separate Type General purpose Detector ZR22G**
  - **Flanges**: DIN PN10 DN80 SUS304
  - **Dimensions**: 258 x 68 x 281~294

- **Separate Type Explosionproof Detector ZR22G**
  - **Flanges**: JPI Class 150 4 RF SUS304
  - **Dimensions**: 258 x 68 x 281~294

- **Separate Type General purpose Converter ZR402G**
  - **Flanges**: ANSI Class 150 2 RF SUS304
  - **Dimensions**: 258 x 68 x 281~294

- **Separate Type Explosionproof Converter ZR402G**
  - **Flanges**: ANSI Class 150 3 RF SUS304
  - **Dimensions**: 258 x 68 x 281~294

- **Integrated Type General purpose Converter ZR402G**
  - **Flanges**: ANSI Class 150 4 RF SUS304
  - **Dimensions**: 258 x 68 x 281~294

**Note:** The text in the image contains technical specifications and diagrams related to zirconia oxygen analyzers. The details include specifications for general purpose and explosionproof versions, as well as dimensions for various components such as flanges and converters. The text is primarily in Japanese, with English translations for certain parts to provide a clear understanding of the technical specifications.