

# Oxygen Flue Gas Analyzer BA 2000



In combustion applications such as process heaters, steam generation boilers or furnaces, the amount of air needed to reach optimum system efficiency can vary rapidly. The optimum heat rate for these units, which may lie within narrow limits, can be achieved with the BA2000.

Accurate O<sub>2</sub> measurement is also essential in the control of NO<sub>x</sub> and SO<sub>x</sub> emissions. Equipped with a fast responding sensor and attached directly to the fire box, this analyzer provides immediate information to allow adjustment of the combustion process in real-time.

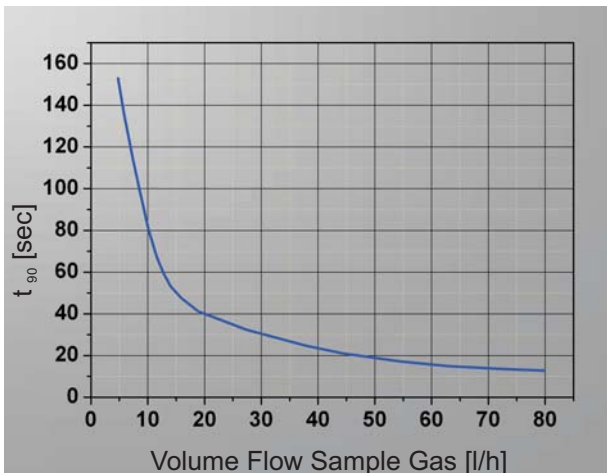
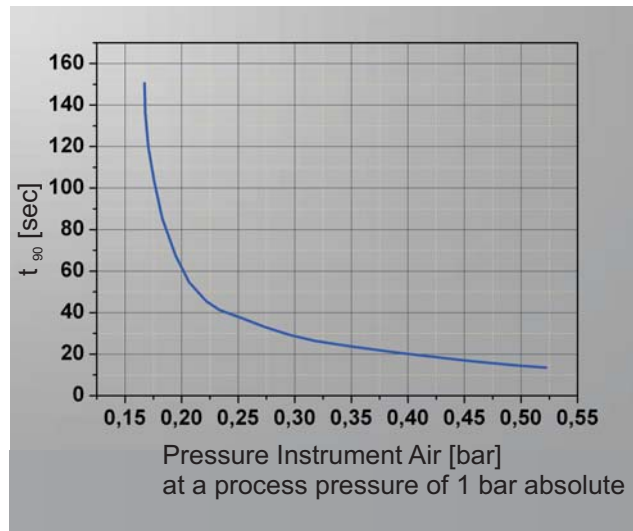
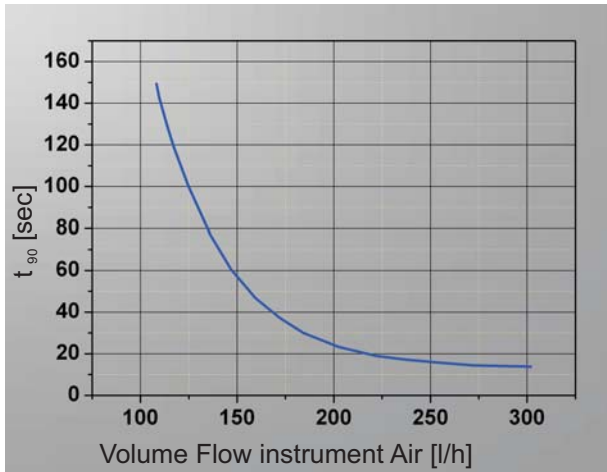
The BA 2000 is designed to ensure accurate and rapid measurement in most combustion processes. The unique fast loop design continuously provides a fresh sample gas stream to the zirconium oxide sensor. The sensor enclosure is heated to 180 °C to avoid condensation. The zirconium oxide sensor does not need any reference gas. 1-point-calibration of the sensor takes place with instrument air which is also used for the aspirator driving the sample gas. Optionally, a 2-point-calibration may be performed.

The measurement cell is protected against dust and particulates by a heated filter. The filter element can be easily replaced without tools by a 90° turn of the handle. Filter elements are available in ceramic, sintered or pleated stainless steel. The BA 2000 can be used with these filters for dust loads up approx. 2g/m<sup>3</sup>. When the dust load exceeds this limit, additional in-situ filters are available.

The BA 2000 provides all necessary information for safe operation. The controller has an integrated display with push-buttons for input, alarm outputs, calibration function and 4-20mA signal output.

- **Fast response**
- **Easy replacement of probe and filter**
- **Easy to handle**
- **Flue gas temperature up to 1600°C**
- **Durable ZrO<sub>2</sub> - cell**
- **Display showing O<sub>2</sub> concentration**
- **4-20 mA signal output**
- **Ambient temperature -20°C up to 70°C**
- **No reference gas needed**
- **No calibration gas needed**
- **Calibration by instrument air**
- **No gas conditioning needed**

## t<sub>90</sub>-Intervall against Volume Flow and Pressure



## Measuring Principal of O<sub>2</sub>- Measurement using ZrO<sub>2</sub>-Cells

Measurement of O<sub>2</sub> concentration in gases using zirconia dioxide cells is based on the NERNST equation.

$$(I) \quad U = \frac{RT}{4F} \ln \frac{p(O_2), \text{ air}}{p(O_2), \text{ sample gas}}$$

|                                |                                                                        |
|--------------------------------|------------------------------------------------------------------------|
| U                              | cell voltage in V                                                      |
| R                              | universal gas constant, R = 8,31447 J/(mol·K)                          |
| T                              | measurement temperature in K                                           |
| F                              | Faraday-constant, F = 96485,34 C/mol                                   |
| p(O <sub>2</sub> ), air        | Partial pressure of oxygen at the reference electrode in dry air in Pa |
| p(O <sub>2</sub> ), sample gas | Partial pressure of oxygen at the reference electrode in dry air in Pa |

The electrical conductivity of zirconia dioxide rises exponentially with increasing temperature and reaches high enough values above 600°C.

The oxygen concentration may be derived from the volume concentration instead of the partial pressure, presuming the total pressure of the gases are almost equal at the two electrodes. In this case, replacing the constants with their values, equation (I) transforms to equation (II):

$$(II) \quad \varphi(O_2) = 20,9 e^{(-46,42 \frac{U}{T})}$$

|                    |                                              |
|--------------------|----------------------------------------------|
| φ(O <sub>2</sub> ) | Oxygen concentration in sample gas in Vol.-% |
| U                  | Potential difference in mV                   |
| T                  | Measuring temperature in K                   |
| 20,9               | Oxygen concentration in dry air in Vol.-%    |

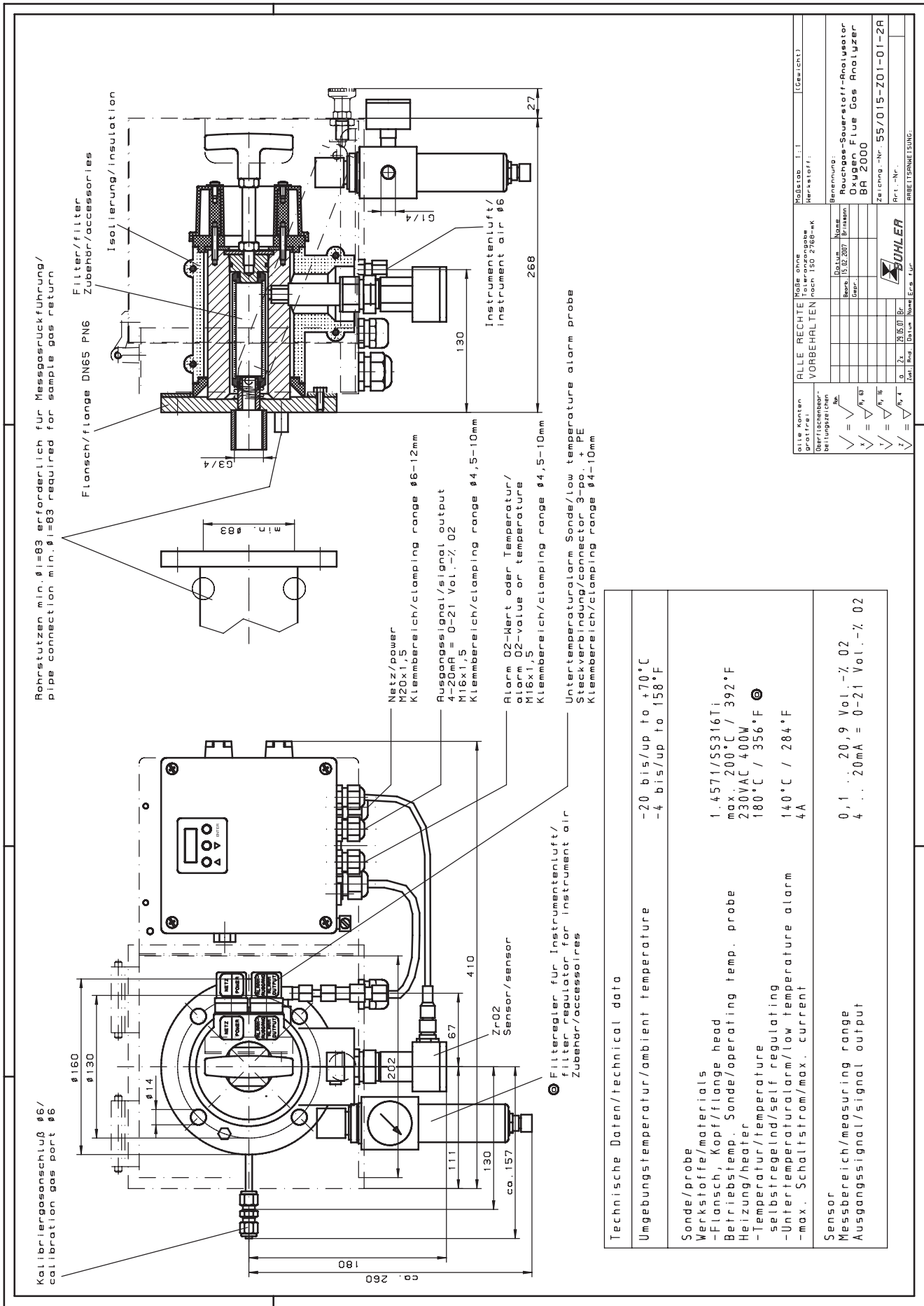
The BA 2000 uses a **potentiometric cell**. Reference electrode and sample gas electrode are separated by the gas-tight ZrO<sub>2</sub> tube in two volumes with different partial pressure of oxygen. At the electrodes, an e.m.f. (electromotive force) is produced which is proportional to the difference of the partial pressures of oxygen. The NERNST-equation is valid.

## Technical Data

|                                      |                                                                                                                                |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Connection:                          | DN65 PN6 pipe connection inner diameter at least 83 mm                                                                         |
| Sample tube length:                  | 0,5 ... 1,5 m                                                                                                                  |
| Mains supply:                        | 115/230V 50/60Hz                                                                                                               |
| Power consumption probe heating:     | 400W                                                                                                                           |
| Measuring range:                     | 0.1 to 20.9 Vol.-% O <sub>2</sub>                                                                                              |
| Signal output:                       | 4 -20 mA = 0 - 21 Vol.-% O <sub>2</sub>                                                                                        |
| Accuracy:                            | relative error < 5%                                                                                                            |
| T <sub>90</sub> -time sensor:        | < 15 sec                                                                                                                       |
| Alarm sensor:                        | upper and lower limit of nominal value for heating (fixed)<br>upper and lower limit of O <sub>2</sub> concentration (settable) |
| Alarm probe:                         | insufficient temperature                                                                                                       |
| Ambient temperature:                 | -20 ... +70 °C                                                                                                                 |
| Process temperature:                 | up to 1600 °C, depending on the sample tube                                                                                    |
| Operating temperature probe:         | max. 200 °C                                                                                                                    |
| Material probe:                      | 1.4571                                                                                                                         |
| Aspirator connection:                | 6 mm tube fitting                                                                                                              |
| Calibration gas connection:          | 6 mm tube fitting                                                                                                              |
| Calibration gas 1-point calibration: | instrument air, 20.9Vol.-% O <sub>2</sub>                                                                                      |
| Calibration gas 2-point-calibration: | instrument air, 20.9Vol.-% O <sub>2</sub> and<br>calibration gas 0.1 ... 15 Vol.-% O <sub>2</sub>                              |

## Ordering Information

|             |                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------|
| 55200099    | BA 2000, 230V 50/60Hz                                                                                              |
| 55200199    | BA 2000, 115V 50/60Hz                                                                                              |
| 55200001    | Adapter flange DN65 PN6 to Servomex                                                                                |
| 55200002    | Adapter flange DN65 PN6 to Thermox                                                                                 |
| Accessories | Sample tubes, extensions and downstream filter<br>see data sheet DE461099 accessoires for sample gas probe GAS 222 |



| Technische Daten/technical data             |                                           |
|---------------------------------------------|-------------------------------------------|
| Umgebungstemperatur/ambient temperature     | -20 bis/up to +70°C<br>-4 bis/up to 158°F |
| Sonde/probe                                 | 1.4571/SS316Ti                            |
| Werkstoffe/materials                        | max. 200°C / 392°F                        |
| Betriebs-temp. Sonde/operating temp. probe  | 230VAC 400W                               |
| Heizung/heater                              | 180°C / 356°F                             |
| -Temperatur/temperature                     | 140°C / 284°F                             |
| -Selbstregelnd/self regulating              | 4A                                        |
| -Untertemperaturalarm/low temperature alarm |                                           |
| -max. Schaltstrom/max. current              |                                           |
| Sensor                                      |                                           |
| Messbereich/measuring range                 | 0,1 .. 20,9 Vol.-% O2                     |
| Ausgangssignal/signal output                | 4 .. 20mA = 0-21 Vol.-% O2                |

|                                           |                             |               |                                |
|-------------------------------------------|-----------------------------|---------------|--------------------------------|
| Alle Konten<br>gratieren<br>bei Lieferung | ALLE RECHTEN<br>VORBEHALTEN | Maßstab 1:1   | (Gewicht)                      |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | Hersteller:   |                                |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | Benennung:    | Rauchgas-Sauerstoff-Analysator |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | Bezeichnung:  | Oxygen Flue Gas Analyzer       |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | Zeichnung-Nr. | 55/015-Z01-01-2A               |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | Art.-Nr.      |                                |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | RAE 1500      |                                |
| ✓ = $\sqrt{\frac{h}{h_0}}$                |                             | RAE 1500      |                                |