

# 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.

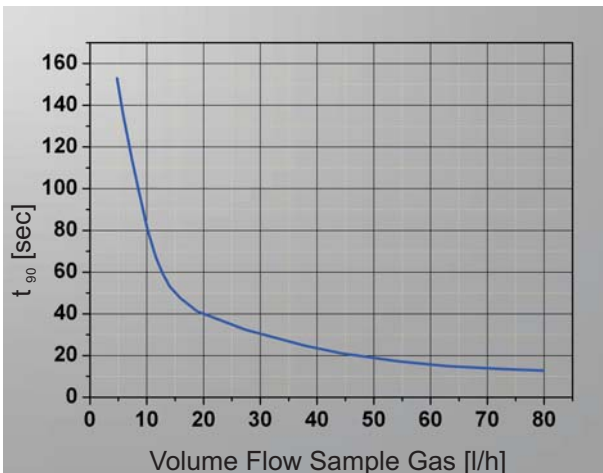
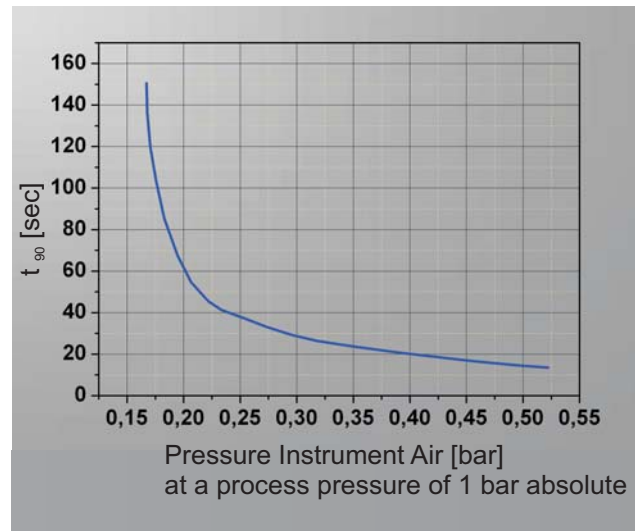
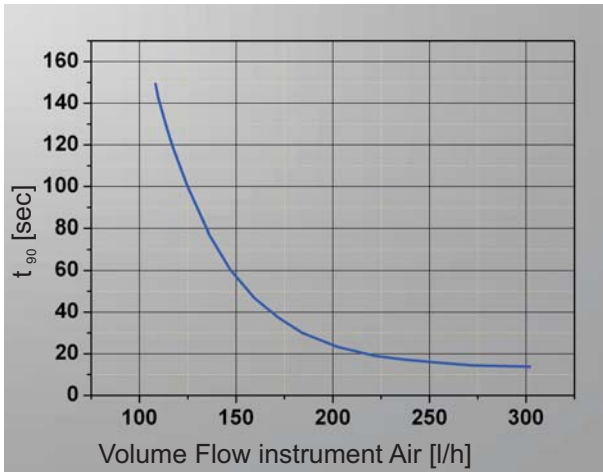
The BA 2000 is designed to ensure accurate and rapid measurement in most combustion processes. The unique fast loop design continuously provides a fresh sample gas stream to the zirconium oxide sensor. The sensor enclosure is heated to 350°F to avoid condensation. The zirconium oxide sensor does not 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. 1 gr/dscf. 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 2900 °F**
- **Durable ZrO<sub>2</sub> - cell**
- **Display showing O<sub>2</sub> concentration**
- **4-20 mA signal output**
- **Ambient temperature -4°F up to 150°F**
- **No reference gas needed**
- **No calibration gas needed**
- **Calibration by instrument air**
- **No gas conditioning needed**

## T<sub>90</sub>- Response time against Volume Flow and Pressure



## Measurement of O<sub>2</sub> 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 1110°F.

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 3.27 in (83 mm)
Sample tube length:	1.6 ... 4.9 ft
Mains supply:	115/230V 50/60Hz
Power consumption probe heating:	400W
Measurement 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) upper and lower limit of O <sub>2</sub> concentration (settable)
Alarm probe:	insufficient temperature
Ambient temperature:	-4 ... +158 °F
Process temperature:	up to 2910 °F, depending on the sample tube
Operating temperature probe:	max. 390 °F
Material probe:	1.4571
Aspirator connection:	6 mm tube fitting
Calibration gas connection:	6 mm tube fitting
Calibration gas 1-point calibration:	instrument air, 20.9 Vol.-% O <sub>2</sub>
Calibration gas 2-point-calibration:	instrument air, 20.9V ol.-% O <sub>2</sub> and 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 see data sheet DE461099 accessoires for sample gas probe GAS 222

