OPERATING MANUAL

"Oxy-2" Oxygen Analyser

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➔ *Safety Information*

- This manual must be carefully and thoroughly read, observed and understood by all persons who decide on the use of this product, operate, service and maintain it and check its operational reliability.
- This user manual contains important information on hazard prevention in addition to instructions on the correct use of the product.
- Before using the product, users must decide whether it is suitable for its intended use in accordance with this manual.

➔ *Liability Information*

- ORBITEC shall assume no liability in cases where the product is not used for its intended purpose or used inappropriately. The selection and use of the product are the sole responsibility of persons acting on behalf of the company.
- Warranty claims and claims for any guarantees assumed by ORBITEC GmbH for this product shall become void if it is not used, maintained or serviced in accordance with the user manual.
- The aforesaid shall apply to the liability and warranty regulations of the General Terms and Conditions of Sale of ORBITEC GmbH; no changes shall apply.

➔ *Maintenance Information*

- This product should be regularly inspected and maintained by trained specialists. Records of inspections and maintenance should be retained. Only original ORBITEC GmbH spare parts should be used when carrying out any repair work. Repairs and maintenance work should only be carried out by ORBITEC GmbH. Modifications to instruments or components are not permitted and violate the approvals.
- ORBITEC GmbH shall only be liable for maintenance and repair work that it carries out.

Electrostatically endangered components
Please observe the handling instructions!
This instrument contains components that are electrostatically sensitive. Specialist personnel should open the instrument when carrying out any maintenance or repair work. Electrostatic discharging through unprotected contact with the components should be avoided. The warranty shall cease to apply in the case of severe damage to components caused by electrostatic discharging!

1. CONTENT

2. Instrument Description and Safety Information

The Oxy-2 was designed and constructed for use by trained personnel. It is used to measure the partial pressure of oxygen in gas atmospheres in conjunction with an oxygen sensor. Such sensors work at high temperatures. Precautions must therefore be taken to ensure that no ignitable gas mixtures reach either the sensor or the instrument. The gases being measured may escape or be infiltrated by air if the sensor ceramic is damaged. This should be avoided to protect any damage to the environment or other components.

The Oxy-2 can be used for the following measurements:

- Oxygen content in inert gases
- Oxygen content in forming gas with max. 10% hydrogen content

The measuring instrument is operated via the buttons on the front panel.

Safety Information

- - Please read and follow all instructions carefully.
- - Have the calibration checked on a regular basis (every year).
- - Check the function after an extreme mechanic load (drop, impact or similar).
- - Check the pump in everyday use (function and flow rate).
- - Only use the instrument for gases for which the sensor is installed.
- - Do not draw in any liquids and vapours as these severely damage the sensor.
- - Do not block the gas inlet.
- - Do not block the gas outlet.
- - Please note that the response time varies in relation to different gases.
- - The instrument should be installed and used in compliance with all applicable local and specific regulations, including the VDE and DVGW standards in particular.
- - Let a trained person evaluate the measured value.
- - Do not change or modify any instrument.

The measuring instrument is not suitable for the measurement of explosive gas mixtures, especially not for pure hydrogen. There is a risk of explosion!

3. Introduction

Measurement Principle

Oxygen measuring instruments are designed to process signals from an oxygen sensor made of stabilised zirconium dioxide. Zirconium dioxide is a ceramic, also termed a solid electrolyte, and is particularly suitable to be used at high temperatures as an oxygen ion conductor.
Such ion conductors possess the capacity to fill empty spaces in their crystal structure with oxygen ions within a temperature range that is dependent on the composition of the material. The oxygen ions attach themselves to a conductive contact surface that is normally made of platinum.
The concentration of oxygen in a gas being measured is therefore decisive for the degree of oxygen activity and thus the number of oxygen ions.
A sensor consists in principle of a solid electrolyte that is exposed to gas on both sides. One side of the electrolyte is in contact with a reference gas, air for example, the other with the gas being measured. The mechanical design of the sensor keeps the two gases apart so that any mixing of the gases is prevented.
Both heated and unheated sensors are used depending on the intended application. Unheated sensors are predominantly used in connection with ovens, heated sensors in applications where the gases being measured are under approx. 600 °C. (A minimum temperature of 500 - 650 °C is required by the measurement principle).
Heated sensors are held at a set temperature by a temperature controller built into the electronic processor. The temperature of heated and unheated sensors is measured by the electronics and is an essential component in the calculation of the oxygen content (oxygen partial pressure).

The calculation uses the following formula:

$$EMK = \frac{R \cdot T}{4 \cdot F} \cdot \ln\left(\frac{P_1}{P_2}\right)$$

where:

R = 8.31J/mol K
T = Temperature in degrees Kelvin
F = 96493 As/mol
P_1 = Oxygen partial pressure on the reference side at 0.20946 bar
P_2 = Oxygen partial pressure on the side of the gas being measured
EMF = Electromotive force in volts

4. General Arrangement of the OXY-2

LED displays for:
- Inert gas
- Hydrogen content of 2%, 5% and 10%
- Control pump "Pump"
- Flow rate control "Flow"
- Ready to measure "Active"

Selector switch - gas type

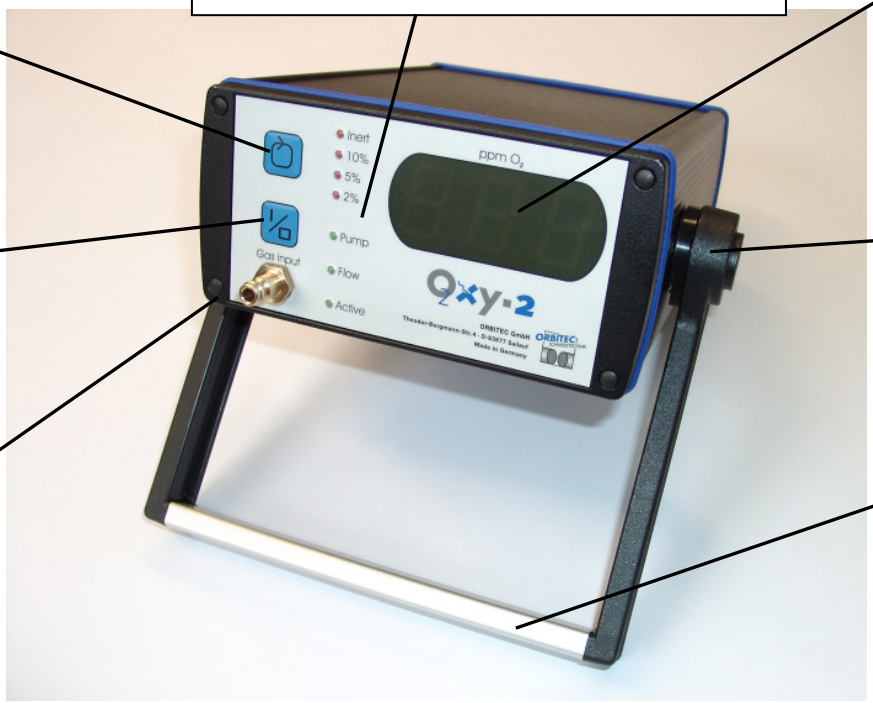
Pump On/Off

Gas inlet

LED display

Adjustment of carrying handle and support

Carrying handle and support



Power connection with power

Fuse

Fan

Data output for recorder (cube plug)

Gas outlet

Calibration screws (only to be calibrated by the manufacturer)

Main Measuring Instrument Components

The front of the instrument is divided into two parts:

1.Gas side (left):

The gas inlet with a nickel-plated bulkhead fitting.

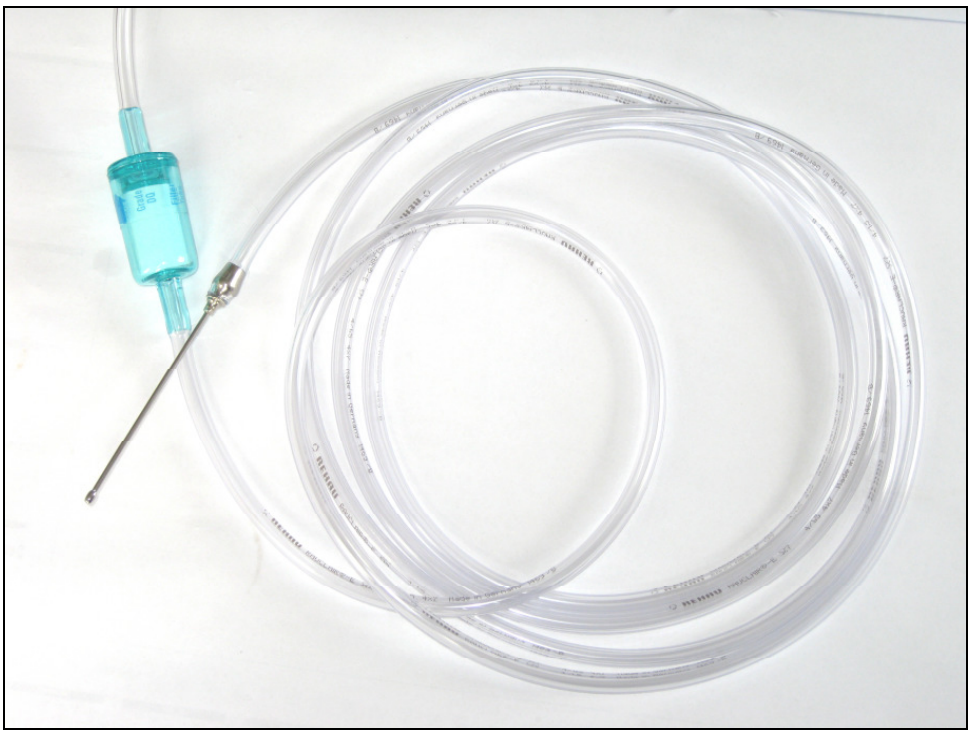
2.Display (right):

The display shows the measured values within the range of 0-999 ppm. Next to the display is a selector switch (push button), whose position is shown by LEDs, which ensures that the measured value displayed corresponds to the type of gas being measured.

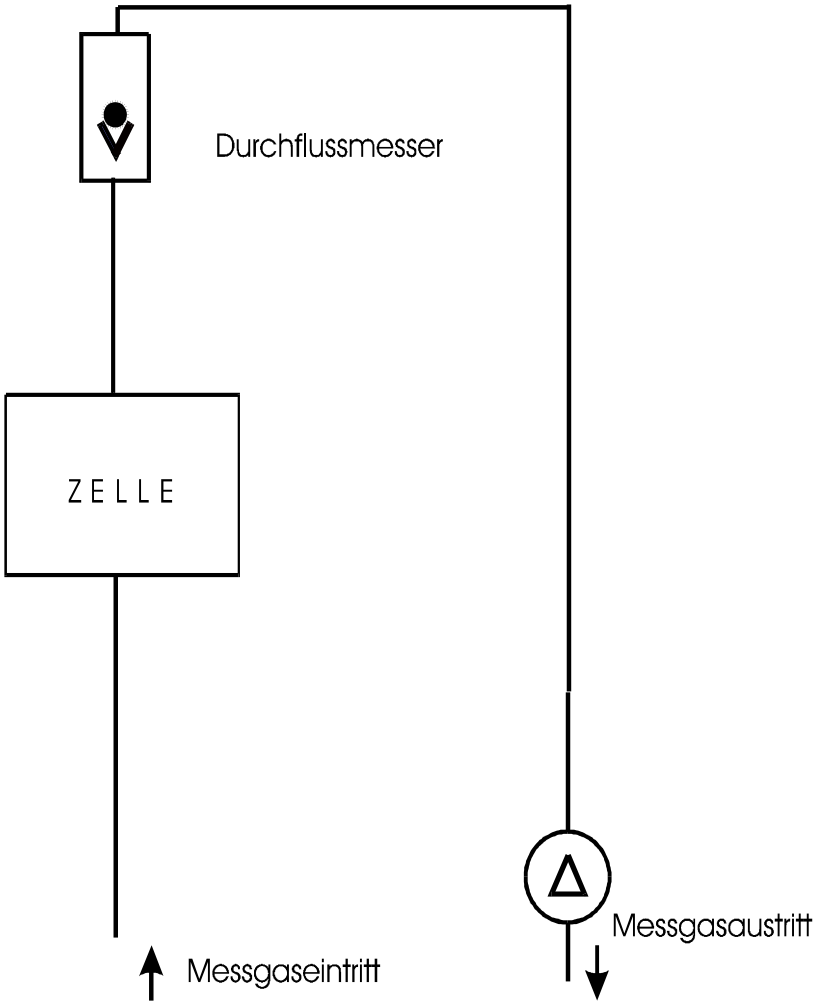
Sensor

The sensor is built into the instrument. The sensor comprises the measuring element made of platinised zirconium oxide, the heating element that is required to keep the element at a minimum of 700 °C as well as the heating controller.

Measuring tube with filter and measuring probe



Cable Routing Diagram



5. OPERATION

Switching on the Oxy-2 Measuring Instrument

Connect the Oxy-2 to the power plug and switch on the power switch. After the power supply is switched on, the sensor is heated to the measuring temperature within approx. 30 seconds. (Note: the sensor gives no useable measuring values during this period.) When the required temperature is reached, the "Active" LED lights up and shows that the instrument is ready for operation.

Should the gas measuring inlet be opened and the gas pump switched on, a value of 999 will be displayed on the instrument. The value shows that the measurement range of the instrument has been exceeded. (The "Flow" LED displays the correct gas flow when the gas pump is running provided that the gas inlet is not blocked.)

Note:
The measurement range will regularly be exceeded when the gas pump is switched on with the gas measuring inlet open. This means that 21% oxygen is present whereby the measurement range of the instrument is limited to 999 ppm oxygen.
(This condition can be maintained effectively and does lead to any damage and overload the sensor!)

The sensor can now be brought into contact with the gas to be measured. The gas pump must be switched on to draw the gas being measured through the instrument. The switch is located on the front panel of the instrument. A green LED will light up when the flow rate is OK.

When connecting the gas to be measured from a bottle, care must be taken to ensure that a high enough flow rate is selected so that the "Flow" LED switches on.

The maximum flow rate of the gas being measured should never exceed 100 l /h.
(For safety reasons, a suitable flowmeter should be inserted into the gas flow). It is therefore recommended that the bottle pressure is initially reduced to almost zero, then a line is connected to the measuring instrument and the bottle pressure is slowly increased whilst monitoring the flow rate on the flowmeter or the "Flow" LED.

Exceeding the maximum flow rate can severely damage the sensor.

Measuring Residual Oxygen

Once the instrument is switched on, it is ready for operation and can determine the oxygen in gases. As described above, the maximum flow rate must not be exceeded.

Bottled Gases

When measuring synthetic gases, such as nitrogen, argon, helium, etc., no other provisions for the preparation of gas are required other than pressure reduction and fine dosing.

Care must be taken to ensure the correct flow rate!
See the "Switching on the Oxy-2 Measuring Instrument" section

Process Gases

General

There is not a specific instruction, following which all process gases that occur with this technology will be correctly prepared and will not cause any damage to the measuring instrument. As a general principle, the gases being measured should be free from dust, condensate and products capable of condensing. Such components can block up the gas conduits in the sensor and damage it.

Hot Process Gases

When hot process gases are under investigation, these are drawn out of the process and fed to the sensor having been suitably prepared. The extraction tube can be made of metal or ceramic depending on the temperature. In most cases, it is not necessary to provide a specific cooling apparatus for the small quantities of gas required for the measurement. The gases being measured cool down naturally to around room temperature during their passage to the sensor. Care should be taken to ensure that the gas conduits have no leaks!

Special Process Gases

There are many processes whose gases contain components, which form solid or liquid condensates when the temperature falls below a certain value. These condensates can be deposited in the gas conduits of the sensor and either affect the measurement or damage the sensor. It is recommended that the existence of such components is ascertained before commencing the measurement and that steps are taken to remove them if they are present.

Important:

When condensate separators are being installed, especially for water, it is important that the collection container is at the lowest point in the gas conduit system. There is likely to be a delay in reaching the measurement due to the dead volume of condensate separators and filters.

Filter System: Construction

The gas preparation system should be matched to the specific requirements of the gas. A standard system could consist of the following:

1. Water separator upstream, possibly with an automatic condensate drain.

2. Coarse filter to remove particles above 50 µ. (only needed for very dusty conditions).
3. Fine filter to remove particles above 25 µ grain size. It is an advantage if this filter immediately cuts off the flow of gas being measured in the event of any liquid being deposited.

Switching off the Oxy-2 Measuring Instrument

The instrument is designed for continuous operation and can therefore be left in an active state at all times.
Should it be necessary to disconnect the instrument, this can be done by switching off the power switch or by pulling out the power plug.

Maintenance and Care

The Oxy-2 measuring instrument is fitted with an O^2 sensor that requires no maintenance.
The instrument should be calibrated each year at ORBITEC GmbH to avoid any measurement errors.

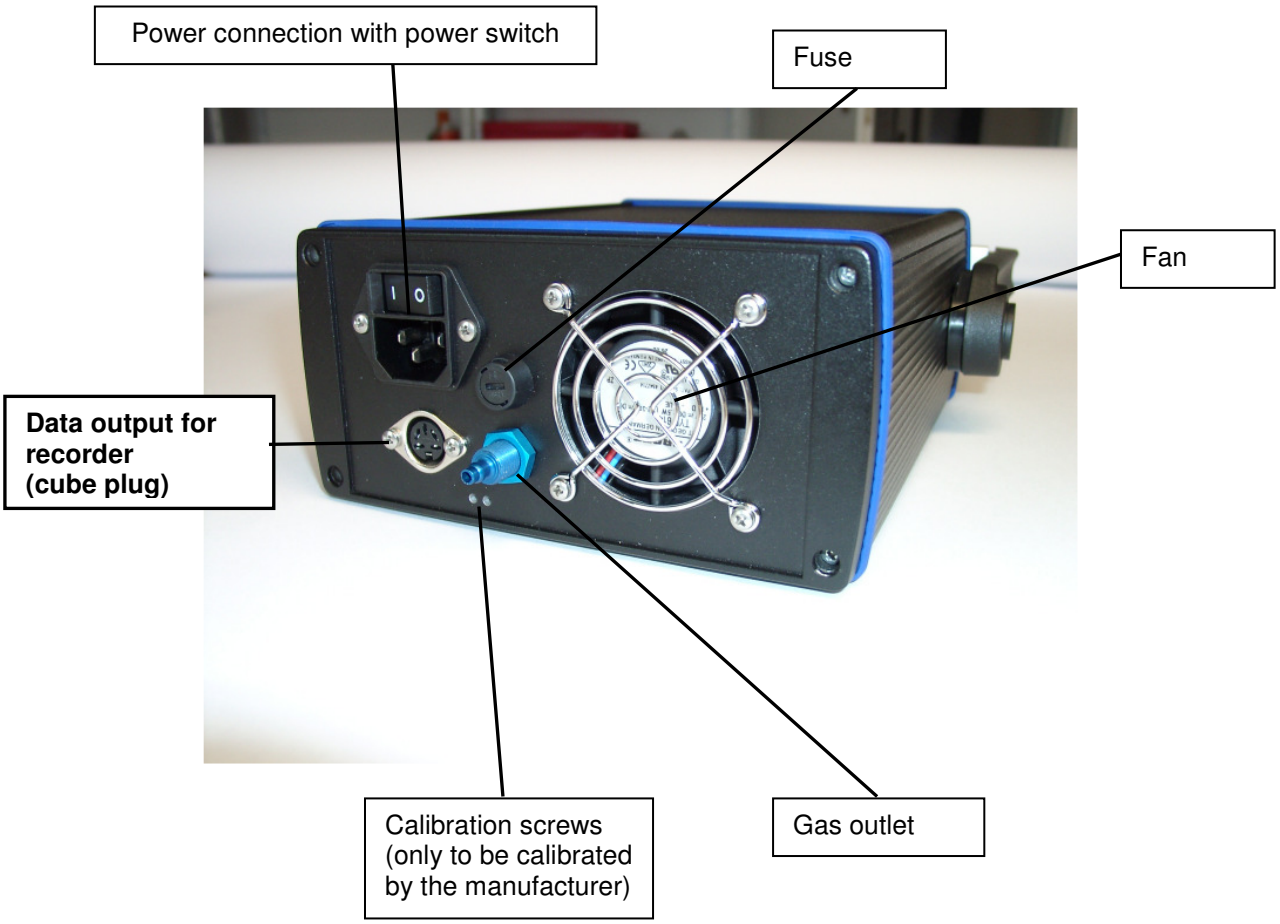
Always store the Oxy-2 in a dry place!

Do not use any sharp objects to clean it!
Clean the housing with a damp cloth!
Do not allow liquids to enter the inside of the housing!

6. Interfaces

Recorder Output (Analogue)

The recorder output supplies a 0-4 V signal synchronous to the measurement display 0-800 ppm. (The range 800-999 ppm is inhibited). The signal is intended for data backup. The output is not potential-free, i.e. the minus is linked to the housing.
The socket to connect the recorder signal is located on the back of the instrument.



7. Technical Data

Measurement range	0-999 ppm O_2
Ambient temperature	0 to 45 degrees Celsius
Measurement accuracy	+/- 0.3 mV EMF sensor
Heating-up time for sensors	approx. 30 seconds
Stabilisation time	10-15 minutes
Response speed	approx. 2 seconds for changes
Dimensions	140 mm x 210 mm x 225 mm (H x W x D) without handle
Mains voltage	230 Volt AC
Heating capacity	approx. 200 VA
Regulating power	approx. 40 VA
Temperature of the measuring cell	approx. 700 ^{o}C
Temperature of gas being measured	max. 50 ^{o}C
Volume of gas being measured	min. 50 l/h – max. 100 l/h
Humidity	Dew point must be filtered out Attention! Condensate formation
Dust	Dust must be filtered out Filter out solid particles above 25 µ

8. Important Information

Calculated Oxygen

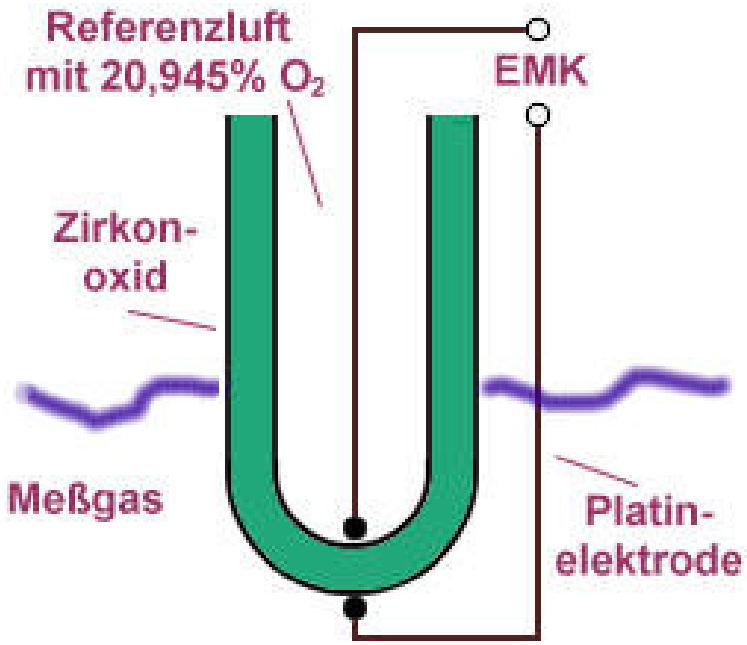
In the case of a nitrogen/hydrogen mixture in a so-called forming gas, the oxygen value from the hydrogen reaction with oxygen is calculated out and displayed. This procedure is necessary because at a sensor temperature of 700 °C the hydrogen reacts with the oxygen and gives rise to an extremely low oxygen partial pressure, whose value is rather academic when the oxidisation potential is being considered. A practical measurement technique therefore shows the oxygen value from the above-mentioned reaction in oxygen ppm.
The same reaction between hydrogen and oxygen occurs in industrial ovens or in contact with glowing metal or ceramic parts as occurs in a 700 °C hot sensor. For this reason, the procedure can be applied in the manner described above.
The oxidisation potential should vary with the hydrogen content and therefore the hydrogen content must be considered as an important element in the calculation. The hydrogen content is set via the selector switch, which allows a choice of 3 forming gas mixtures: 2%, 5% and 10% hydrogen in nitrogen. These values therefore cover the forming gas mixtures that are primarily used.
The **display of the values** with forming gas is **not comparable** with the measurement results in **inert gases** (Ar, N2, etc.). It is recommended that the user determines the values himself on the basis of welding tests and uses this **reference** for a **comparison**.

Note:
If the setting of the selector switch does not correspond to the forming gas mixture, this will only lead to an incorrect value being displayed and will not affect the function of the measuring instrument!

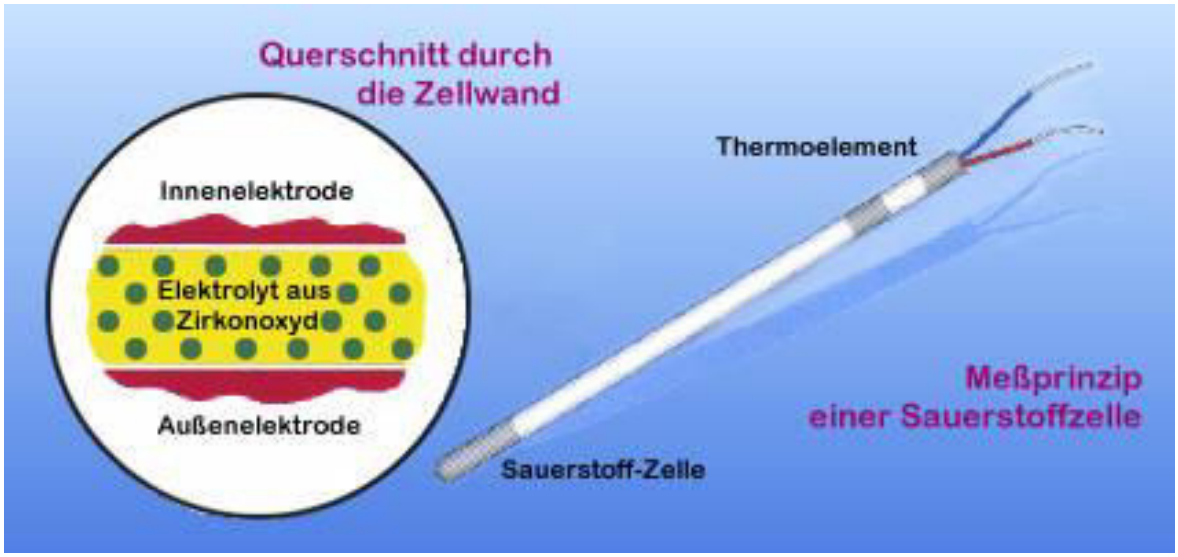
Peculiarities

After working with a forming gas, traces of the gas will remain on the surfaces of the gas conduits for some considerable time. Should an inert gas, such as nitrogen, be measured after operating with forming gas, the displayed value will fall towards 0 ppm faster than normal. When this occurs, air should be flushed through the instrument for some time.

9. Functionality of a Zirconium Oxide Cell for the Measurement of the Residual Oxygen Content in Forming Gases



Schema einer Sauerstoffsonde



10. Faults when Operating the Instrument

All instruments are subject to strict production controls and final inspections. Please inform ORBITEC GmbH should a fault occur at any time.

Any modifications, repairs or intervention inside the housing should only be carried out by trained specialist personnel.

11. Scope of Delivery / Optional Accessories / Spare Parts

Scope of Supply

- Oxy-2 with plastic tube, 3m, particle filter and stainless steel cannula
- IEC connector
- Lightweight carrying case
- Operating manual
- Calibration certificate
- BGV A3 certificate

Optional Accessories / Spare Parts

- Oxy-2 COM-cable/orbital controller for communication and documentation (analogue)
- Carrying case for Oxy-2
- Spare plastic tube for Oxy-2/Oxy-3, 3 m, particle filter and stainless steel cannula
- Spare filter

12. Appendix

- Calibration certificate
- BGV A3 certificate