ZIROX®-Electrolysis Device SGM5EL

Application Description Gas Analysis and Gas Preparation

Introduction

Measurement, adjustment and controlling of defined oxygen partial pressures in gas flows is an original field of application of the ZIROX® electrolysis and measuring cell [1].

The potentiometric measurement of the oxygen partial pressure in a test gas and the electrolytic oxygen transport are combined in a solid electrolyte module (Fig. 1).

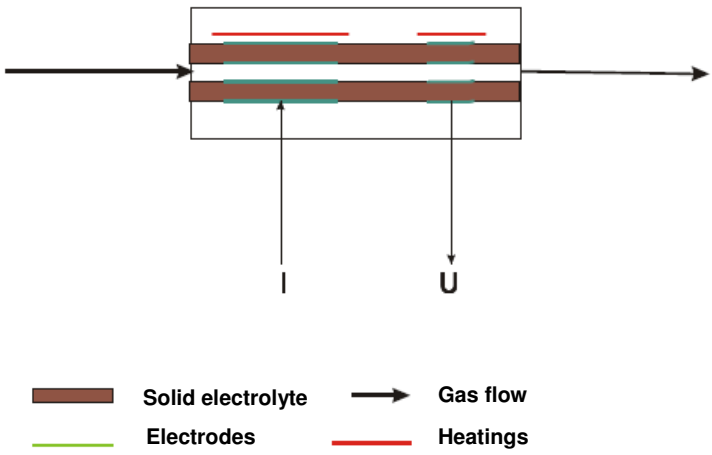

Fig. 1: *Scheme of the combined cell for oxygen measurement, monitoring and controlling*

The use of the combined solid electrolyte cell offers a lot of capabilities. The oxygen can be transported in the direction of the oxygen concentration gradient or in the opposite direction. It depends on the direction of the metered flow.

In both cases the limits of the flow rate must be followed. They result from the ohmic resistance, the electrode polarisation and the stability limit of the solid electrolyte.

Essential parameters of the dosing cell are electrode surface, cell temperature, ion conductivity and wall thickness of the solid electrolyte. For the ZIROX standard electrolysis cell a metered flow of 100mA delivers an oxygen flow of 8.3 µg/s. It corresponds to 418 Pa at a gas flow of 5 l/h. That means, in the two-component system inert gas/oxygen an oxygen lift can be generated whereas the oxygen partial pressure change is linearly proportional to the metered flow (FARADAY's Law).

Similar considerations apply to the oxygen (out-) pumping but the pump performance limit is reached first.

The flow control is carried out as a constant current or as a current control. The equations for the following application descriptions are summarised separately. In case of interest the document can be ordered by e-mail.

Oxygen dosing with constant current source

A constant electrolysis current with corresponding polarity (dosing or pumping) generates a current-proportional oxygen flow in an inert carrier gas flowing through an electrolysis cell. The oxygen concentration in the carrier gas must be considered for calculations.

Oxygen dosing with current control circuit

If a constant oxygen partial pressure in a test gas flow is to be adjusted (perhaps in cases of a drift behaviour of the test gas or test gas flow variations), a closed control loop between analysis cell and electrolysis cell should be used. In this case, the cell voltage value of the analysis cell (corresponds to the requested oxygen partial pressure) is the set point for the current control.

Adjustment of defined oxygen partial pressures in protective gas – redox – mixtures

If the oxygen partial pressure in inert gas/oxygen mixtures is not low enough, inert gas-redox-pairs like H_2O/H_2 or CO_2/CO are used. The redox-equilibrium is influenced by oxygen dosing or pumping. The oxygen partial pressure can be monitored simultaneously. Sometimes an inert gas/redox-pair mixture is used for the increase of oxygen lift caused by changes of the oxygen flow rate.

Combination of gas humidification and oxygen dosing

Based on an inert gas/hydrogen mixture you receive an inert gas/hydrogen/water vapour mixture by using oxygen dosing. For example: If Argon with 100 Pa hydrogen (a common test gas) flows through the electrolysis cell the hydrogen/water vapour ratio can be changed from approx. 100 to 0.01. This corresponds to oxygen partial pressures from approx. $2*10^{-19}$ Pa up to $3*10^{-11}$ Pa at 750 °C cell temperature.

Combination of gas humidification and oxygen pump

From a wet inert gas flow a requested oxygen flow can be pumped out. So a corresponding inert gas/hydrogen/water vapour mixture can be generated. It is possible to work with a constant pump current or a set point voltage or oxygen partial pressure.

The variation of the oxygen partial pressure in a wide range can be realized by changing the humidity and dosing or pump current.

The upper limit of the humidity is set at 100 % rH.

Humidity generator

Defined humidity traces in an inert gas/hydrogen flow can be adjusted by oxygen dosing. They either serve measuring problems at solid state bodies or the functional controlling or calibration of humidity sensors (adjustment of dew points).

[1] Manual SGM5EL, ZIROX Sensoren & Elektronik GmbH, Greifswald