Amperometric Hydrogen Peroxide micro-sensor

Determination of dissolved hydrogen peroxide in aqueous solutions

The amperometric H_2O_2 micro-sensor has been developed for the *insitu* determination of hydrogen peroxide containing aqueous solutions. Therefore the sensor is suitable for direct measurements in coloured and turbid solutions (waste water), in industrial plants, but also in biological research. Compared with all the other commercially available hydrogen peroxide sensors, this amperometric H_2O_2 micro-sensor works with such a *low analyte consumption*, that streaming of the sensor membrane or stirring of the analyte is not necessary. And, an additional stirrer is not necessary for stationary measurements. The second advantage of the AMT-micro-sensor is the *very fast response time* with $t_{90\%}$ =1-2 seconds. The third advantage of the new micro-sensor is based on the micro-sensor technology itself. High signal stability, *high local signal resolution* allows some new applications, as for instance the profiling in µm-steps.

The general working principle of the sensor

Because of the partial pressure of the gaseous H_2O_2 dissolved in the sample, the analyte is separated from the inner electrolyte by means of the membrane. The *membrane is only pervious to gases*, so that liquids, ions and solids are not able to reach the inner electrolyte or the electrodes of the sensor. The sensor contains inside a special electrolyte and 3 electrodes. The electrode materials have been selected and prepared very carefully to realize ideal electrochemical conditions. The time for the polarization, realized by means of the sensor's integrated electronic device, is approximately 5…15 minutes after the first switching on or long breaks. If the H_2O_2 has passed now the membrane, it reacts chemically with the redox catalyst and forms a new compound. After this, this compound is transported by diffusion to the working electrode followed by the electrochemical reaction. This causes a current depending on the hydrogen peroxide partial pressure/hydrogen peroxide concentration of the sample. The observed current within a range of 0...400 picoamperes is converted into a voltage of 0...5 Volt inside the integrated electronic device of the sensor. Besides, in opposite to other measuring principles, the current flow in the amperometric sensor leads to a rapid decrease of the analyte inside the sensor resulting in *very fast response times* even though there is a concentration jump from high to low concentrations.

All commercially available electrochemical sensors have to be combined with a temperature measurement and the amperometric H_2O_2 sensor too. When ordering a multi-sensor measuring system for laboratory use or a complete submersible probe system, the temperature measurement and the temperature correction of the sensor signal is already included. If measurements in a flow through system are required, special temperature sensors for the integration in AMT flow through cells are offered. When measuring in opened vessels or beakers in the laboratory, the customers have to realize the temperature measurement themselves. If a calibrated sensor is ordered, the temperature correction is very easy by means of a factor or for more accurate measurements by means of a mathematical formula, delivered with the sensor.

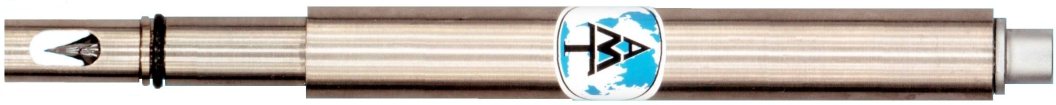
Technical data for all H_2O_2 micro-sensor heads independent from the sensor design *)

- ☞ measuring principle: amperometric membrane covered micro-sensor
- ☞ 3 sensor electrodes
- ☞ Polarisation voltage necessary (realized by means of the integrated electronics)
- ☞ necessary time for the polarization: approx. 5-15 minutes
- ☞ streaming of the membrane or stirring is not necessary, low analyte consumption
- ☞ measuring ranges: - type I: 0,02…10% H_2O_2
  others on request
- ☞ exchangeable sensor head
- ☞ accuracy of the sensor: ± 1% f.s.
- ☞ temperature range: 0°C to 30°C
- ☞ pH range: 0…11
- ☞ response times: $t_{90\%}$: 1-2 seconds
- ☞ life time: approximately 5-9 months, influenced by the sample's matrix and H_2O_2 stress
- ☞ pressure stability: laboratory sensor or shallow water version for pressures of up to 10 bar
- ☞ No cross sensitivities against: carbon dioxide, oxygen, methane, hydrogen, ammonia, carbon monoxide, organic solvents (less than 20% in aqueous solutions), acetic acid, dimethyl sulphide, HCN, solids
- ☞ No influence of the measuring signal in case of salt concentrations less than 40 g/l
- ☞ suitable for the determination of concentration gradients with high local resolution
- ☞ housing: all housings made of titanium

*) Changes for technical improvement are reserved.

Sensor designs of the amperometric H_2O_2 micro-sensors

1.) Laboratory micro-sensor with integrated electronic device



This sensor has been developed for the laboratory and simple field use and has to be combined with one of the offered measuring AMT instruments. The sensor consists of a titanium housing, a waterproof connection with the cable (IP 68), an exchangeable sensor head and a removable protection cage (on your own risk - no guarantee in the case of mechanical destruction). This sensor could be equipped both with the following sensor tips: hydrogen peroxide sensor tip type I (0,02…10% H_2O_2), galvanic oxygen sensor tip (0…200% saturation) or H_2S sensor tips type I (0,05…10 mg/l H_2S), type II (0,5…50 mg/l H_2S) and type III (0,01…3 mg/l H_2S). Other concentration ranges can be delivered on request. The exchange of the sensor head is very easy by pull off and push on. Please take note, that no liquid can get in to the plug connection when changing the sensor head.

2.) Shallow water microsensor for probe systems

The shallow water sensor has been developed for use in combination with so called CTD-probe systems for depths of up to 100 meters. Therefore every shallow water sensor is equipped with a special underwater connector, type Subconn BH-4-MP. Further characteristics are the integrated electronic device, the titanium housing and the exchangeable sensor tip. This sensor could be equipped both with the following sensor tips: hydrogen peroxide sensor tip type I (0,02…10% H_2O_2), galvanic oxygen sensor tip (0…200% saturation) or H_2S sensor tips type I (0,05…10 mg/l H_2S), type II (0,5…50 mg/l H_2S) and type III (0,01…3 mg/l H_2S). Other concentration ranges can be delivered on request. The exchange of the sensor head is very easy by pull off and push on. Please take note, that no liquid can get in to the plug connection when changing the sensor head.

Use of the amperometric hydrogen peroxide micro-sensors

1. Laboratory use:	laboratory sensor with integrated electronic device + measuring device with cable + temperature sensor
2. Field measurements (up to 1 m water depth):	a) laboratory sensor with integrated electronic device + measuring device with cable + temperature sensor b) H_2O_2 probe with sensors for H_2O_2 (shallow water version), pressure (depth), temperature + multi-core sea-cable + notebook/personal computer + software
3. Online insitu measurements (up to 100 meter water depth)	a) H_2O_2 probe with sensors for H_2O_2 (shallow water version), pressure (depth), temperature + multi-core sea-cable + notebook/personal computer + software b) Interfacing of a H_2O_2 shallow water sensor to already existing probe systems, provided that the probe contains one more free channel and provided it is quipped already with sensors for temperature and pressure + integration of the mathematical formula for the calculation of the dissolved H_2O_2 amount