

MASTER-SENSOR-NH3

Ammonia-sensitive sensor for measuring ammonia in aqueous solutions



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1 Notes



Note:

All necessary settings are described in this operating manual. If any difficulties should nevertheless arise during startup, please do not tamper with the sensor in any way. By doing so, you could endanger your rights under the instrument warranty! Please contact the nearest subsidiary or the head office in such a case.

Please read this operating manual before placing the instrument in service. Keep the operating manual in a place which is accessible to all users at all times.

For technical questions

Service hotline:

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2 Description

2.1 Areas of application

Refrigerating plants (such as indoor ice rinks, cold stores, etc.), frequently use ammonia as the refrigerant. Ammonia (NH_3) is a **toxic**, pungent-smelling and colorless gas. These refrigerating plants are monitored for escaping ammonia (leakage).

To do this, tubes and system parts filled with water are monitored to determine whether ammonia (NH_3) has penetrated (dissolved in the water). The ammonia-sensitive sensor MASTER-SENSOR-NH3 described here is suitable for this purpose.



Attention:

The ammonia-sensitive sensor MASTER-SENSOR-NH3 described here is **not** suitable for detecting ammonia in ambient air!

2.2 Function

A gas-permeable, hydrophobic PTFE film makes the connection between the process medium and the sensor electrolyte. A hydrogen ion-selective electrode is immersed in the electrolyte. Ammonia escaping through the PTFE film changes the pH value of the electrolyte. The NH_3 concentration in the process medium can be measured in this manner. The electrolyte contains ammonium (NH_4^+) ions, with which the sample gas is in chemical equilibrium.

2.3 Operating conditions

The concept of an ammonia leakage monitoring system must ensure that the escaping coolant reaches the ammonia-sensitive sensor MASTER-SENSOR-NH3 quickly.

The sensor must be installed in a quick-change fitting. The porous PTFE washer in this quick-change fitting must not be clogged! If it is, ammonia leakage will be detected too late or not at all. If necessary the customer should install a filter upstream from the sensor.

The flow rate of the monitoring circuit must be checked at regular intervals! A few drops over several hours is sufficient. If the flow rate

is too low the porous PTFE washer must be replaced, see Section 9.1.1 "Replacing the PTFE washer in the quick-change fitting", page 22.



Attention:

The process medium must not contain any substances that could damage the membrane (such as oils, greases, particles of dirt or surfactants).

The porous PTFE washer in the quick-change fitting matches the sensor must not be clogged!

A measurement taken in a mixture of ice and water is not diagnostically conclusive!

2.4 Coolant monitoring

The following components are required for coolant monitoring:

- Ammonia-sensitive sensor, MASTER-SENSOR-NH3.
- PP manual quick-change fitting
- DG-MASTER-NH3 transmitter/controller.
- Low-noise coaxial cable 1.5 m long
or
low-noise coaxial cable 5 m long
or
Low-noise coaxial cable 10 m long.

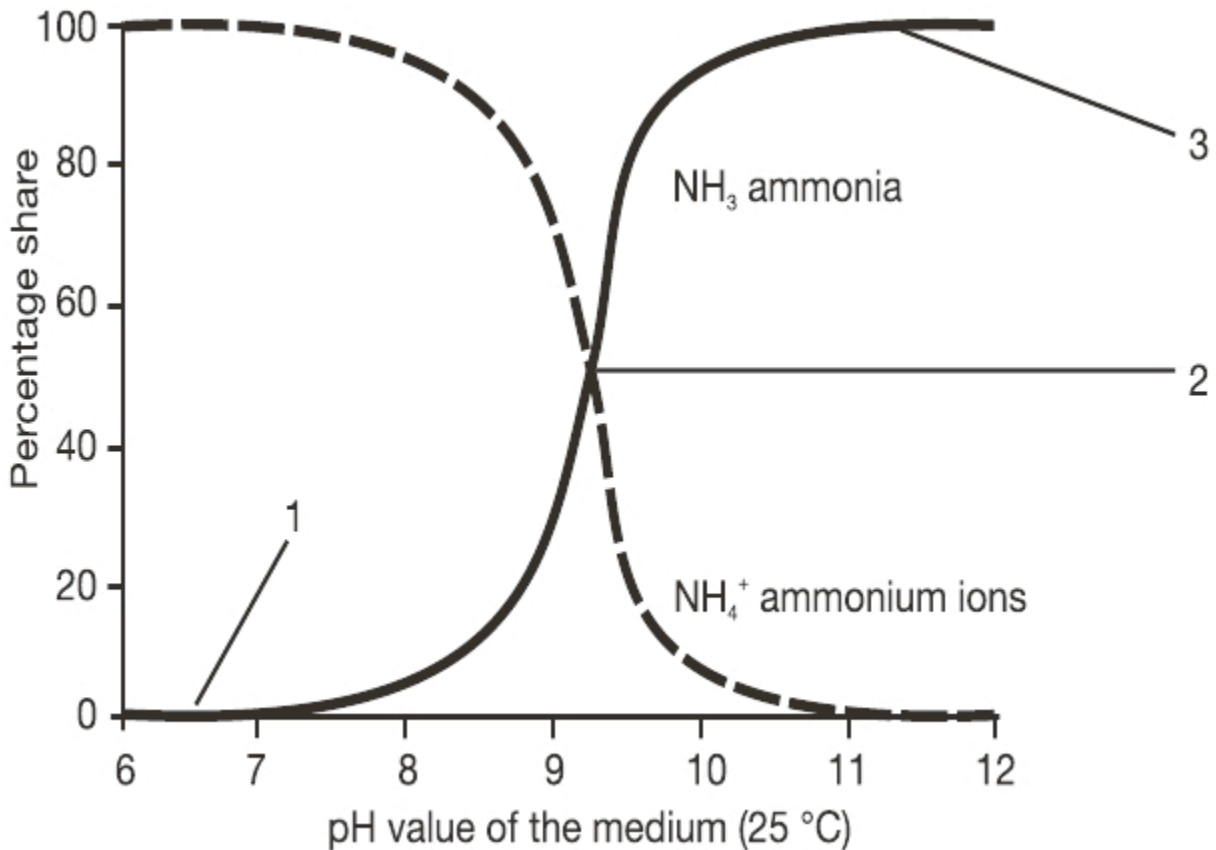
**Note:**

Use of an impedance converter is recommended at low temperatures as the electrical resistance of the ammonia sensor's glass membrane increases sharply.

3 Technical data

Measuring range:	0.01 to 9999 ppm (= mg/l) NH ₃
Temperature range:	
Standard version	0 to +50°C
Extra code 854 (low temperature)	-8 to +50°C
pH range:	7.5 to 14
Fitting length:	120 mm
Diameter:	12 mm
Connection:	Pg 13.5 screw-on head
Medium pressure	
Sensor in quick-change fitting	2 to 3 bar (max. 6 bar)
Sensor free pressure)	1 bar abs. (atmospheric)
Suitable transmitter:	DG-MASTER-NH3

4 Operating range



- (1) Only NH₄⁺ ions (ammonium) are present
- (2) The ratio of NH₄⁺ ions (ammonium) and NH₃ (ammonia) is 1:1
- (3) Only NH₃ (ammonia) is present



Note:

The presence of ammonia in the process medium is heavily dependent on its pH value (see above diagram).

In the acidic range, there will be a predominance of ammonium (NH₄⁺) ions that are **not** detected by the sensor!

At approx. 9.3 pH, the concentration ratio of ammonia (NH₃) and ammonium (NH₄⁺) is about 1:1.

It is only in the heavily alkaline range that ammonia is predominant.

4.1 Output signal

The electrochemical process in the thin electrolyte layer upstream from the glass membrane proceeds as per the following equation:



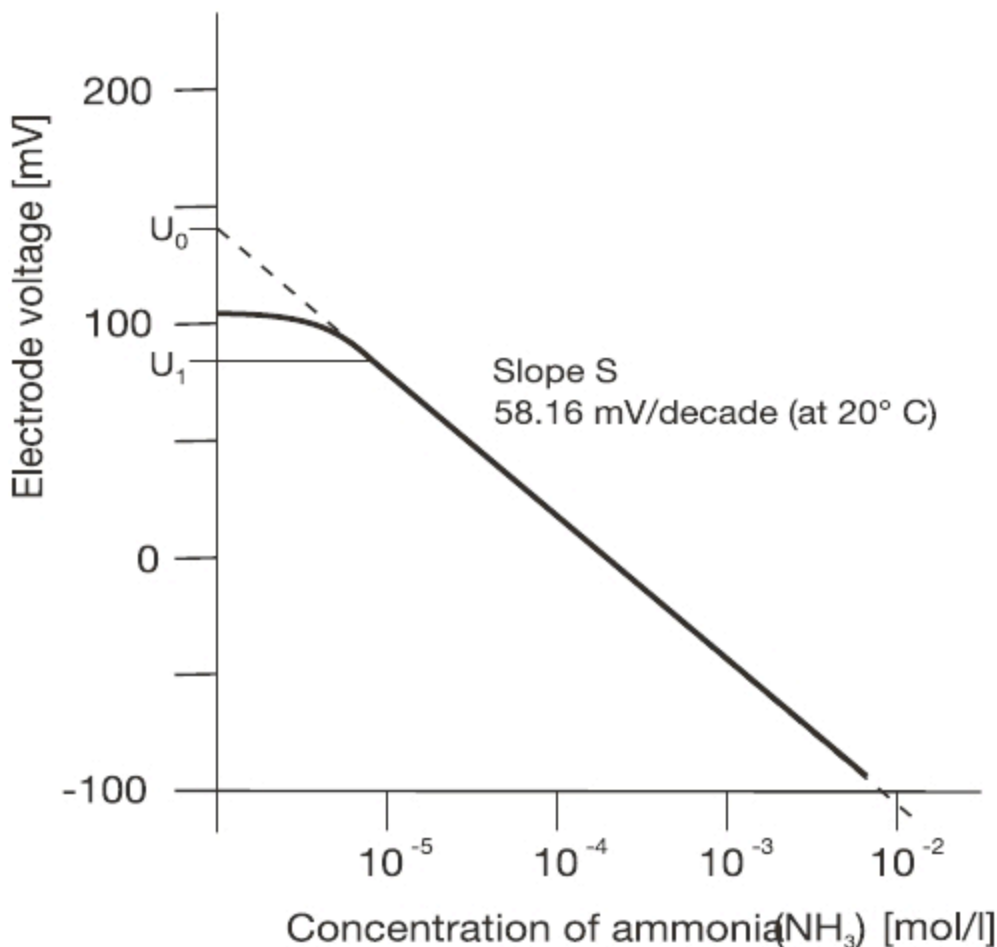
Hydrogen ions are taken out of the electrolyte, moving the pH value up to higher values.

The correlation between ammonia concentration $[\text{NH}_3]$ and voltage U , is given by the Nernst equation:

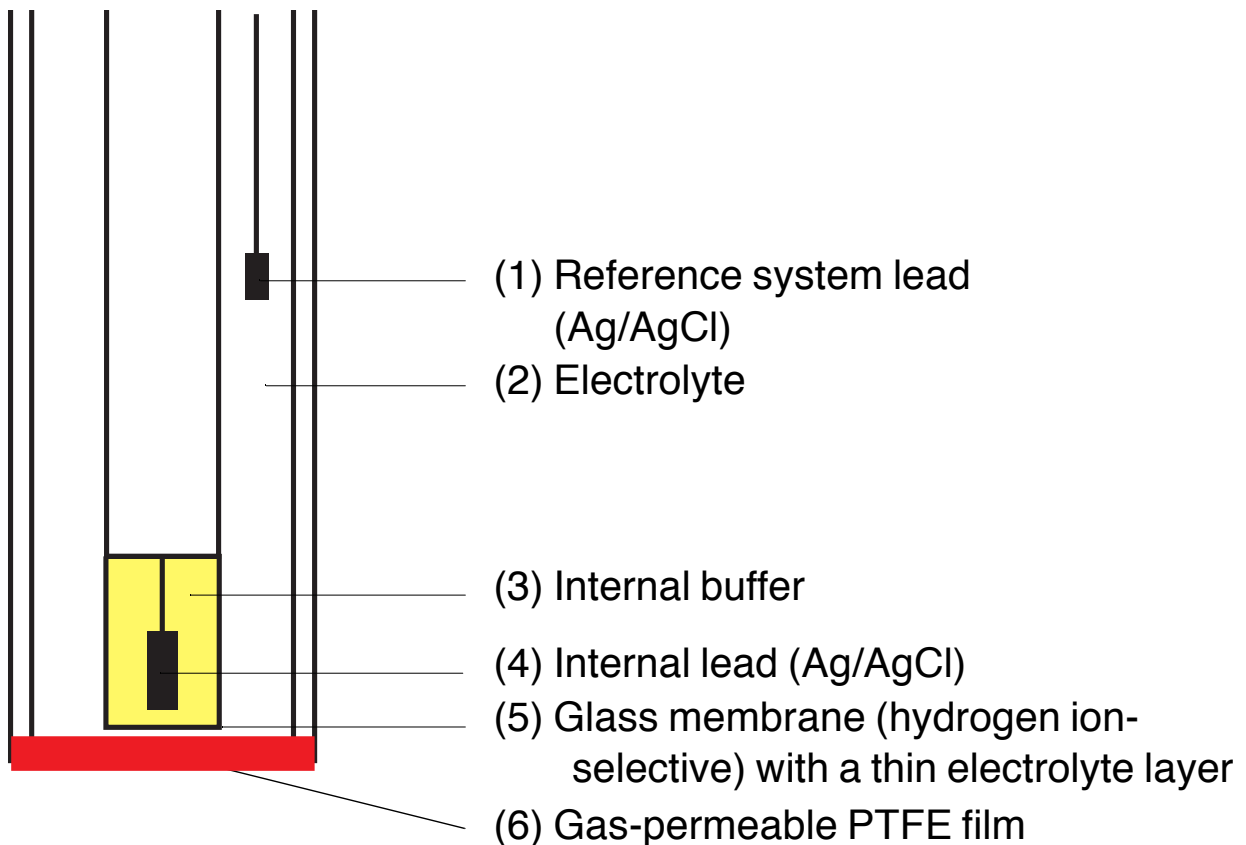
$$U = U_0 - S \cdot \log [\text{NH}_3] \quad (1)$$

In the ideal case, the value of slope S is 58.16 mV/decade (at 20°C). U_0 is the cell zero point.

The dependence levels off as the ammonia concentration falls, that is, there is a lower detection limit. The following diagram shows a typical characteristic line.



4.2 Design

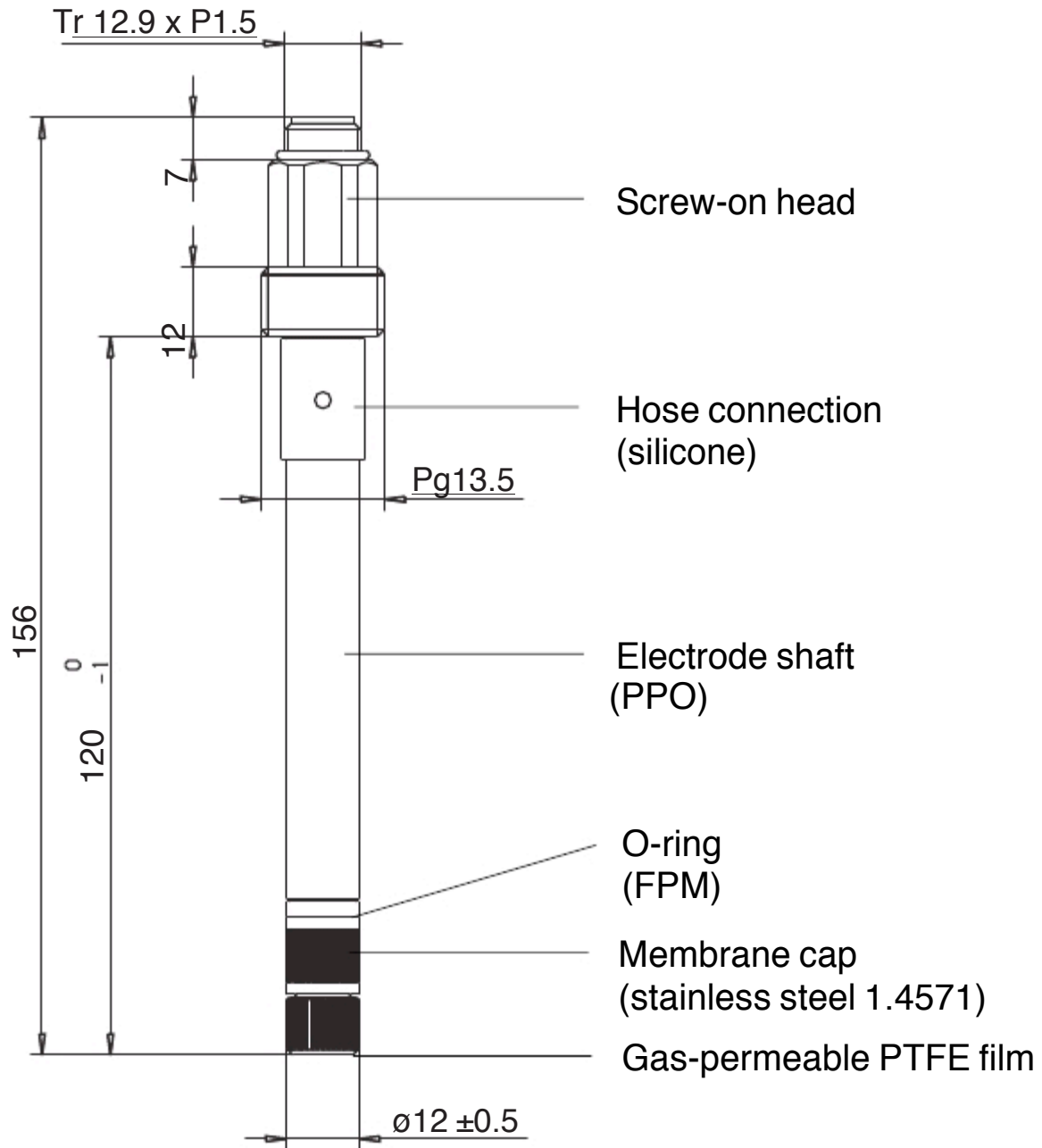


Reference system lead (1) is immersed in the electrolyte and provides a fixed reference potential for measurement as an Ag/AgCl electrode, with the chloride ions contained in the electrolyte.

If the sample solution contains ammonia (NH_3), for example, the gas diffuses through the gas-permeable PTFE film (6) until the partial pressure of the ammonia is the same on both sides of the film (6). As the partial pressure changes, so does the pH value in the thin layer of liquid upstream from the glass membrane (5). This process is recorded by the hydrogen ion-sensitive glass membrane (5). As the partial pressure depends on the concentration of ammonia in the sample solution, the pH value can be used to determine the ammonia concentration in the solution.

5 Mounting

5.1 Dimensions



Note:

The sensor may only be operated in the **vertical** position!

The process medium must be free of particles and dirt!

It may be necessary for the customer to provide a filter upstream from the quick-change fitting.

6 Electrical connection

A high-quality shielded cable is required to connect the ammonia sensor to a transmitter/controller, see Section 2.4 "Coolant monitoring", page 6.

Use of an impedance converter is recommended at low temperatures, as the electrical resistance of the gas-sensitive sensor's glass membrane increases sharply, Section 2.4 "Coolant monitoring", page 6.

Ammonia sensor connection

Internal conductor= measurement electrode

External conductor= reference electrode

7 Startup



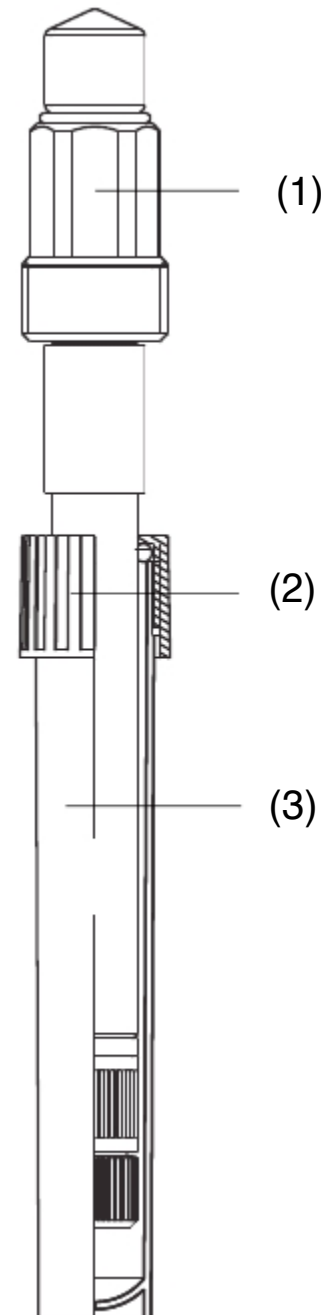
Attention:

The sensor (1) must only be removed from (or returned to) the storage container (3) once the union nut (2) has been **completely** unscrewed!

Otherwise the sensor will be destroyed by the buildup of negative (or positive) pressure.

The pipelines must be rinsed for a new installation so they are free of impurities or residue, which could clog the porous PTFE washer in the quick-change fitting.

-
- * Fully unscrew the union nut (2) and slide it up.
 - * Pull the sensor (1) out of the storage container (3).
 - * Remove the O-ring from the sensor shaft. The sensor is now ready to measure.
 - * Pour the electrolyte away. Keep the storage container, as it may be needed for later transportation or for storing the sensor.



7.1 Taking the temperature dependence of the ammonia sensor into account when using with DG-MASTER-NH3

The output signal of the gas-sensitive sensor is temperature-dependent, so the temperature of the sample solution must be known in order to measure correctly. The temperature can either be measured automatically by a temperature probe (e.g. Pt100/Pt1000), or the user must set it manually on the transmitter.

7.2 Calibrating the ammonia sensor

General information

The slope of the sensors varies somewhat from instance to instance and also changes during operation (caused by deposits such as lime, or by wear). This changes the output signal of the sensor.

The software of DG-MASTER-NH₃ transmitters is specifically geared to coolant monitoring. They use a typical, concentration-dependent characteristic line. The individual properties of the sensor are only taken into account here by offsetting the zero point. This considerably reduces the effort required for calibration.

Ammonia calculation

The ammonia sensor output signal follows a straight characteristic line up to voltage U_1 (default = 84 mV). Above U_1 , the characteristic line will be curved (see diagram on Page 9).

Lower detection limit U_0

U_0 is the voltage supplied by the ammonia sensor in an ammonia-free process medium.

The default setting for U_0 is 138 mV.

One-point calibration

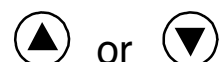
With one-point calibration, voltage U_0 is determined (in the ammonia-free process medium).

Requirement:

The process medium must be free from ammonia.

- * Immerse the ammonia sensor in the process medium.
- * Start one-point calibration on the OSAKA transmitter.
- * Wait until the voltage shown on the OSAKA transmitter has stabilized.

Please do not make any changes by pressing the



keys!

- * End calibration by pressing the  key.

The OSAKA transmitter shows 0.0 ppm.



Note:

With manual temperature compensation, the fixed temperature of the medium assigned by the user is shown on the OSAKA transmitter.

8 Maintenance



Note:

The flow rate of the medium through the quick-change fitting should be checked regularly! The nature of the process medium must be taken into consideration when determining the check interval. The typical flow rate is a few milliliters per day and depends on the parameters of the coolant (pressure, temperature, viscosity, etc.).

If no coolant emerges at the overflow of the quick-change fitting, check the porous PTFE washer in the quick-change fitting and replace it if necessary, Section 9.1.1 "Replacing the PTFE washer in the quick-change fitting", page 22.

If the flow rate of the medium is too low in general, the porous PTFE washer (white, standard) can be replaced by the less dense version (black, for higher flow rate), Section 9.1.1 "Replacing the PTFE washer in the quick-change fitting", page 22.

Typically the electrolyte of the gas-sensitive sensor must be replaced semi-annually or annually depending on the coolant that is used.

The gas-sensitive sensor has a high resistance. Therefore a greater tendency to drift must be factored in. This should be taken into consideration when selecting the limit values for alarms (ammonia leaks).

If the drift of the sensor signal is unusually great, the electrolyte must be replaced, Section 8.1 "Refilling/ replacing the electrolyte", page 17.

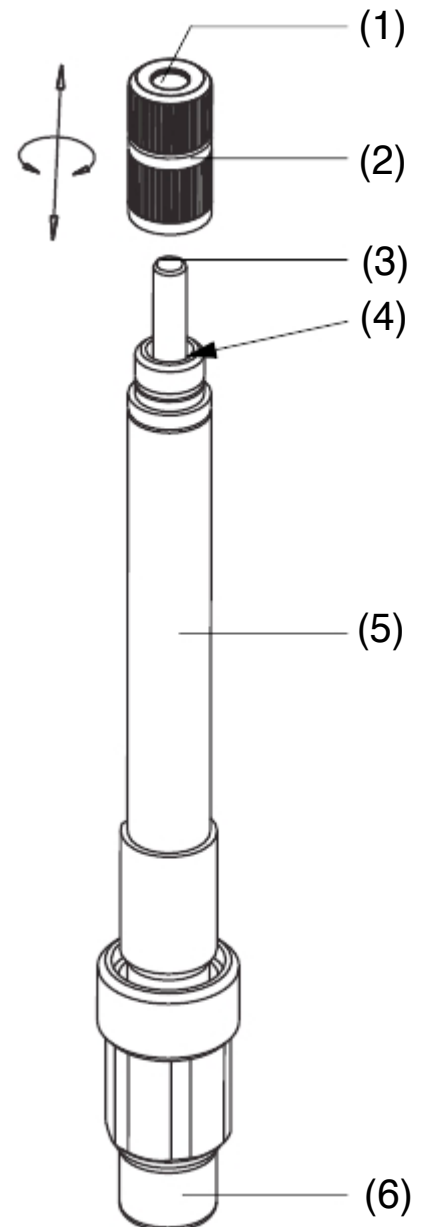
8.1 Refilling/replacing the electrolyte

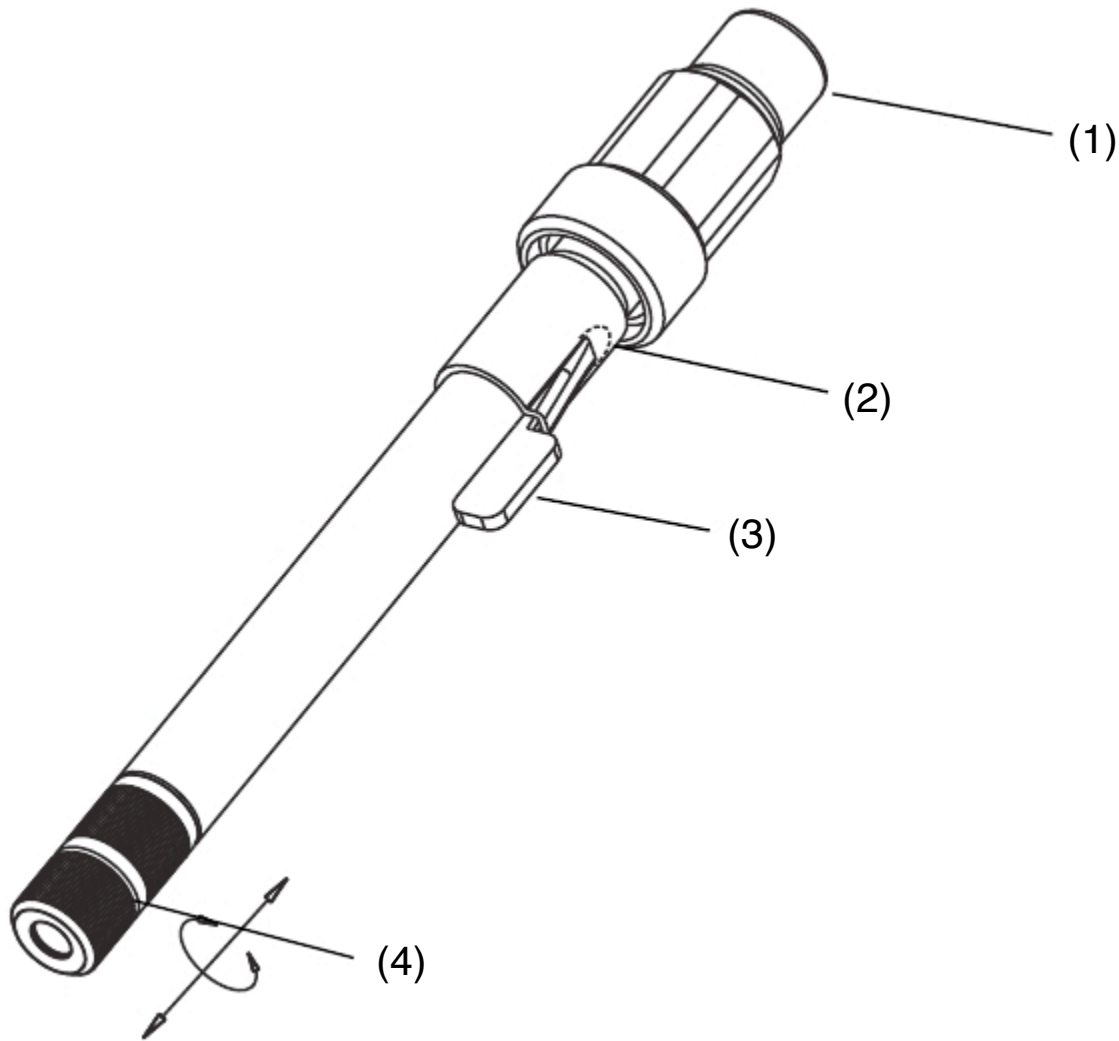
- * Hold the sensor (5) with its electrical connection (6) pointing vertically downward.
- * Remove the old membrane cap (2).
- * In the gap (4), top up the electrolyte to the brim.
- * Fill the new membrane cap (2) with three drops of electrolyte to "lubricate" the O-ring in the membrane cap. This will prevent the sensitive PTFE membrane (1) from being damaged by the glass membrane (3).
- * Fit the membrane cap (2) onto the thread until the O-ring makes a seal.



Attention:

Do not screw the membrane cap all the way down, as this could destroy it!





Attention:

The electrolyte must not get into the plug-type head (1) of the sensor! This causes contact problems.

- * Hold the sensor as shown in the above diagram.
- * At the level of the vent opening (2), slide the vent wedge (3) under the silicone tubing.
- * Screw the membrane cap (4) all the way down (excess electrolyte will escape).
- * Remove the vent wedge (3).
- * Use an absorbent cloth to soak up excess electrolyte.

The ammonia sensor is now ready for startup.

8.2 Storing the sensor in the storage container



Attention:

It is essential to keep to the procedure described below, as otherwise pressure buildup will destroy the sensor membrane!

The sensor must **not be stored dry!**

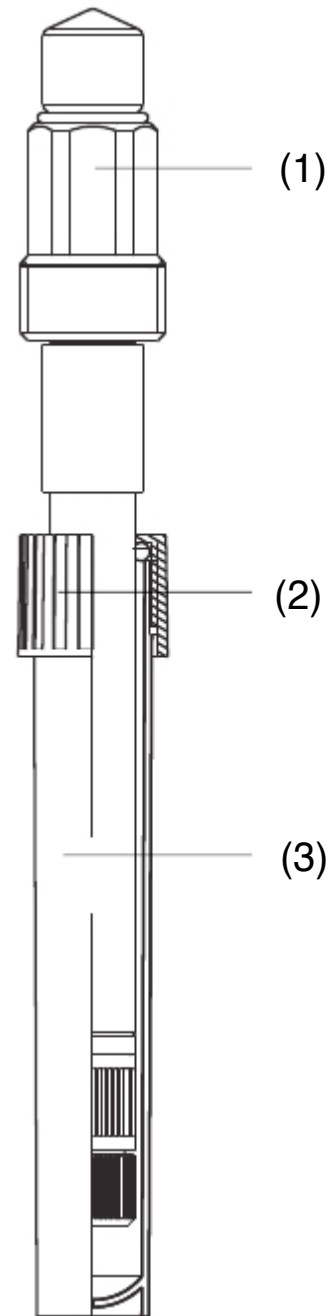
- * Slide the union nut (2) onto the sensor shaft.
- * Slide the O-ring of the union nut (2) onto the sensor shaft.
- * Insert the sensor into the storage container filled with **electrolyte** (to a max. level of 2 cm).
- * Seal the storage container (3) with the union nut (2).



Attention:

Do not move the sensor in the wet-storage container once the screw fitting is closed!

The positive or negative pressure that this produces will destroy the membrane.

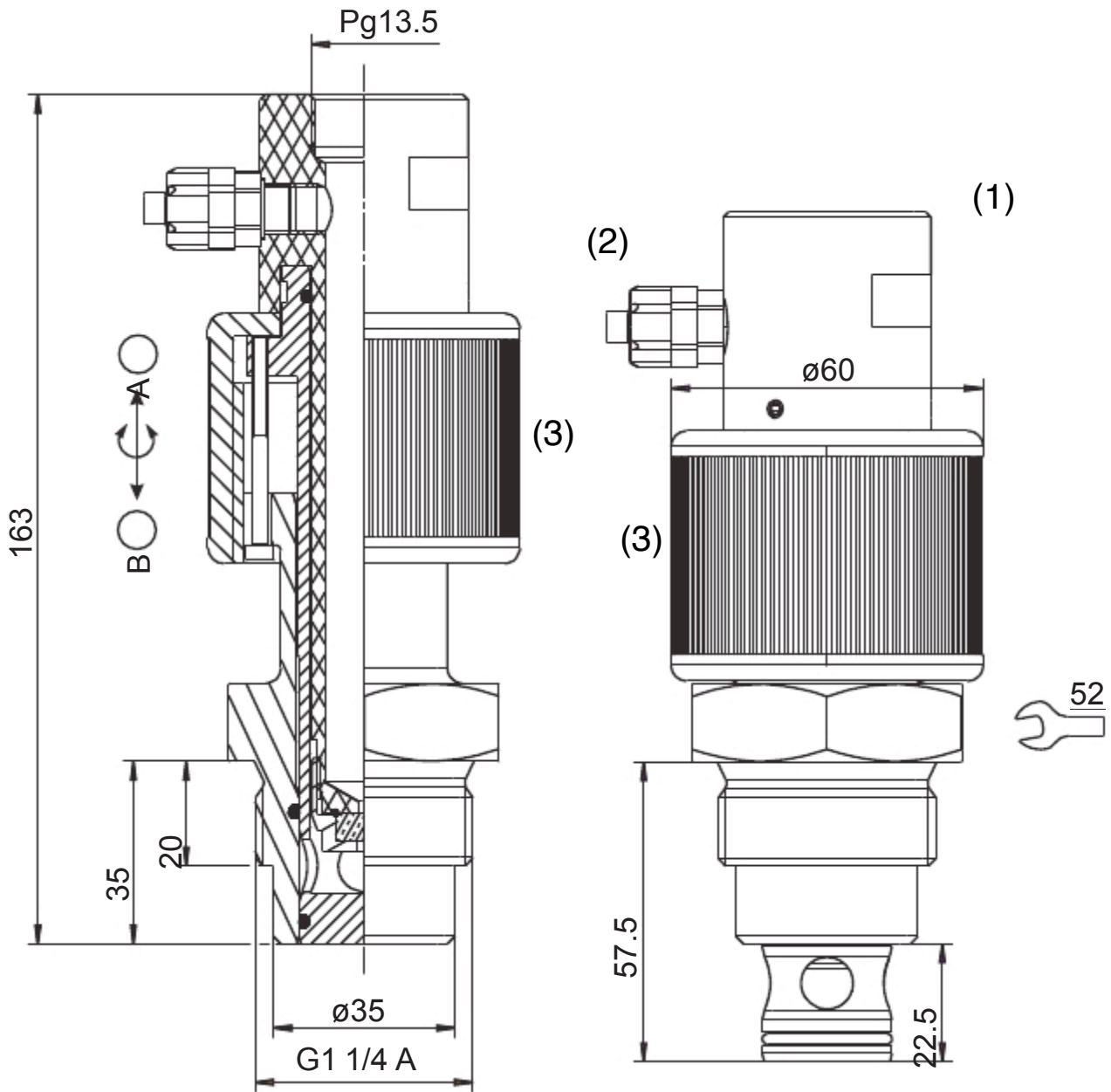


8.3 Removing the electrode from the storage container

- * **Fully** unscrew the union nut (2). Then take the sensor out of the storage container.

9 Accessories

9.1 Quick-change fitting for ammonia sensor



- (A) Turn the handwheel to close (maintenance)
- (B) Turn the handwheel to open (operation)
- (1) Quick-change fitting for ammonia sensor (PP)
- (2) Discharge: G1/8 A (POM) hose connection
- (3) Handwheel



Attention:

The installation position of the fitting is vertical (as shown in the drawing)!

The sensor may only be removed when the fitting is closed!

Do not close the discharge (4)!

Optimum operating pressure: 2 to 3 bar.

Maximum operating pressure: 6 bar.

- * Screw the ammonia sensor into the fitting and tighten to 3 Nm.
- * The process medium that escapes from the overflow (4) can be drained through a tube.
- * Turning the handwheel (3) left/counter-clockwise (A) opens the fitting, turning to the right/clockwise (B) closes the fitting.



Note

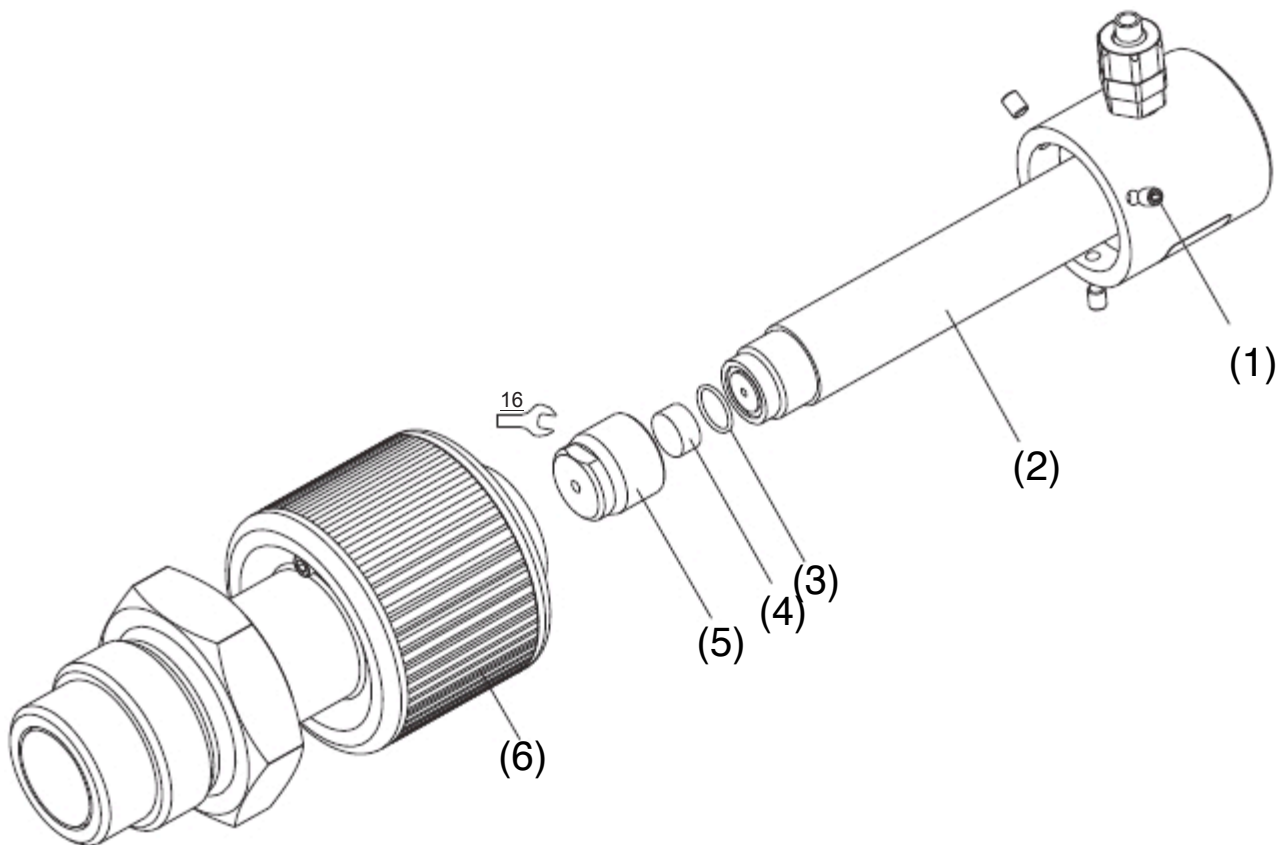
If too much process medium runs out of the overflow:

- Reduce the system pressure
- Mount the quick-change fitting in the bypass with a control valve upstream

If not enough process medium runs out of the overflow, the ammonia sensor may respond too late or not at all to an ammonia leak. In this case, the flow rate must be increased:

- Install the PTFE washer with higher porosity (black, for higher flow rate).

9.1.1 Replacing the PTFE washer in the quick-change fitting



- (1) Hexagon socket screws M4
- (2) Electrode fixture
- (3) O-ring
- (4) PTFE washer
- (5) Cap (stainless steel, wrench size 16, max 3.5 Nm)
- (6) Handwheel

- * Turning the handwheel (6) left (counter-clockwise) opens the fitting and moves the sensor out of the process medium.
- * Unscrew the gas-sensitive ammonia sensor from the fitting.
- * Dismantle the fitting: Loosen the three hexagon socket screws (1) (do not unscrew them completely)
- * Pull the electrode fixture (2) out of the fitting.
- * Unscrew the cap (5) on the lower end of the electrode fixture (2).
- * Replace the PTFE washer (4).

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- * Place the O-ring (3) in its groove before mounting.
 - * Screw the cap (5) onto the electrode fixture (2) (max. 3.5 Nm).
 - * Insert the electrode fixture (2) in the fitting.
 - * Tighten the hexagon socket screws (1).
 - * Screw the gas-sensitive ammonia sensor into the fitting (about 3 Nm).
 - * Turning the handwheel (5) to the right (clockwise) closes the fitting and moves the gas-sensitive ammonia sensor into the process medium.



Attention:

When mounting the PTFE washer (4) make certain the O-ring (3) is resting in the groove!

9.2 Maintenance kits

Designation

Maintenance kit for ammonia-sensitive sensor
(standard version)

Maintenance kit for ammonia-sensitive sensor
(low-temperature applications)

PTFE washers for manual quick-change fitting
(standard, white, 3 washers)

PTFE washers for manual quick-change fitting
(increased flow rate, black, 3 washers)

10 Possible errors

Error	Possible cause	Action
The measured value drifts	Pressure/ temperature fluctuations in the process medium	Keep values constant
	Coolant concentration is too high	Use an ammonia sensor (low- temperature applications)
Widely fluctuating measured values	Air bubble downstream from the membrane of the ammonia-sensitive sensor	Refill/replace electrolyte
No process medium escapes from the overflow of the manual quick- change fitting	Porous PTFE washer is dirty	Replace the PTFE washer. Customer- installed filter upstream from the manual quick- change fitting